Chinese Import Competition effects on Domestic Firms: Disentangling the role of firms on labor markets*

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May 30, 2016

Abstract

This paper examines the impact of rising Chinese import competition on several Chilean firms' dimensions exploiting variation at the four-digit ISIC level. We use the Encuesta Nacional Industrial (ENIA), a panel of Chilean plants from 1996 to 2006. First, we use the method developed by DeLoecker and Warzynski (2012) and by Ackerberg et al. (2015) to estimate markups and productivity measures at the plant level by standard GMM techniques. Second, we construct measures of Chinese import competition exposure at the four-digit ISIC level and estimate by 2SLS its effect on several firm's dimensions: i) survival rate; ii) market power; iii) productivity; and iv) access to international markets. We instrument local exposure with China's import penetration in other countries. The results suggest that plant survival, market power, productivity, and access to international market measures are negative associated with Chinese import competition. We proceed to disentangle the effect on manufacturing employment in different firms' components using the inverse labor demand function finding that the effect on markups explains 27% in the loss of manufacturing employment.

JEL codes: D22, D24, F14, F61.

*A preliminary version of this paper was presented as my second year econometrics paper. I'm very grateful to Dario Tortarolo for his valuable help in this project.

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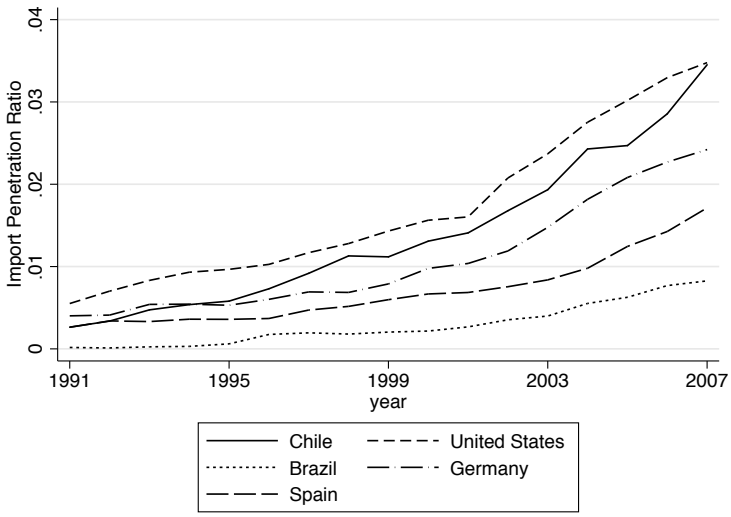
1 Introduction

Import competition in the manufacturing sector stemming from China has risen dramatically during the last two decades in developed countries. For instance, the import penetration ratio of China has increased from 0.6 percent in 1991 to 4.6 percent in 2007 in the United States (Autor et al., 2013), this phenomenon has occurred in other parts of the world as well. Figure 1 plots the import penetration ratio for the five countries used in the analysis of this paper: Chile, Germany, Spain, Brazil and the United States.[1] From the figure it can be seen that China's import penetration has increased dramatically from 1991 to 2007 for all countries. This phenomenon has created a fruitful and heated debate on the negative effects of international trade and Chinese imports on domestic outcomes.

Figure 1: China's Import Penetration Ratio

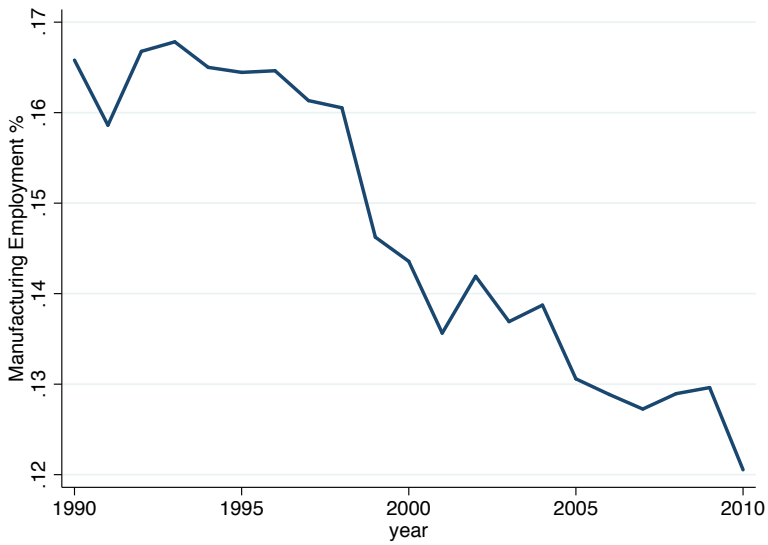


For instance, several papers have documented negative effects on domestic markets of rising Chinese import competition. For example, for the case of the United States Autor et al. (2013, 2014) (ADH) assessed the impact of this trade shock on local labor markets. The former paper using data at the Commuting zone level (CZ's) shows that rising imports from low income countries has caused higher unemployment, lower labor force participation and reduced wage in local labor markets. The latter paper using micro data shows that import shocks increased labor adjustment costs and that these effects are unevenly distributed across different types of workers. Similarly, most of the

[1] The aggregated import penetration ratio was constructed adding up over the 4 digit ISIC industries used in the analysis with the methodology that is explained below.

recent literature have focused their analysis in the negative effects of low-wage country imports on local labor markets and on the reallocation of workers across different sectors or regions. Most of these papers assume perfect competition (Caliendo et al., 2015), thus, firms do not have market power, and the effects on manufacturing employment are explained by reallocation of workers due to international competition.[2] This phenomenon has occurred in Chile as well, over the same period of time the fraction of Chilean workers employed in manufacturing fell by a fourth, from 16.5% to 12.0% (figure 2).

Figure 2: Manufacturing employment %



However, there has been little attention on the role of firms in this process. For example, there is little evidence on the impact of rising Chinese import competition on several firm's dimension such as market power and productivity and how it relates to the loss in manufacturing employment.[3] The main goal of this paper is to disentangle the effect of China's imports on manufacturing employment in different components explained by the role of firms, my main analysis focus in the effect on markups, the output elasticity with respect to labor, and value added. To that end, this paper uses the Encuesta Nacional Industrial Anual (ENIA) and the import penetration in Chile. The ENIA is

[2]Moreover, in traditional trade models such as Melitz (2003), the market power of firms remains constant after trade shocks, since these models assume CES preferences, thus, the elasticity of substitution across varieties is a sufficient statistic of firms' markups.

[3]In terms of the effect of imports on firms, Bernard et al. (2006) (BJS) assesses the effect of low-wage country imports on plant survival and growth from 1977 to 1997 in the US, finding a negative association between the two variables and Ashournia et al. (2014) finds evidence for the direct impact of low wage imports on the wage gap among Danish firms. Other papers such as Feenstra et al. (2014) and Feng et al. (2012) have studied the behavior of Chinese firms.

a panel of Chilean firms since 1979, due to data restrictions our analysis focuses over the period 1996 to 2006. In this regard, to the best of our knowledge this is the first paper that assesses the effect of China's import penetration on several firm‘s dimension, especially, market power and productivity. We divide our analysis in three parts.

First, we use the method developed by DeLoecker and Warzynski (2012) (DW) and by Ackerberg et al. (2015) (ACF) to estimate markups and productivity measures at the plant level by GMM. This method is based on cost minimizing firms, and a value added production function that depends on capital, labor, energy and materials. We consider two different production functions: Cobb-Douglas, and Translog. Second, we use China's import penetration to assess the effect on domestic firms following the main specification from Bernard et al. (2006) and ADH. Since there is potential correlation between China's imports and import demand shocks, and double causality between China's import penetration and Chilean firm's behavior, our strategy is based in a 2SLS estimation procedure following ADH. We instrument China's import penetration in Chile using an average of the import penetration in other countries: The United States, Germany, Spain, and Brazil. As in ADH, the identification assumption relies in the fact that the increase in Chinese imports is due to productivity shocks in China, and uncorrelated demand shocks across the five countries. Moreover, in order to test the exogeneity assumption we perform over-identification tests using as instruments China's import penetration ratio in Brazil and the original instrument.

We construct the import penetration ratio using the UN Comtrade Data Base at the six-digit Harmonized System (HS) product level. Since the firm's industry in the ENIA is at the the four-digit ISIC Rev 3 level, we use the mapping between various nomenclatures of industries developed by the World Bank to map from the HS 1992 nomenclature to the ISIC Rev 3 nomenclature.[4] Although, in order to construct the import penetration ratio we need to construct a measure of domestic output at the four-digit ISIC level, since this variable is unobservable in the UN Comtrade Database, we use the Input-Output tables at the two digit ISIC levels from the OECD to construct the share of output that is exported. Hence, each 4-digit ISIC industry within the same 2-digit level has the same export share. With this variable we are able to construct domestic output.

Finally, in the third part we proceed to disentangle the effect of Chinese imports

[4] `http://wits.worldbank.org/es/product_concordance.html`

on manufacturing employment explained by the role of firms. We use the inverse labor demand function which is obtained using the first order condition of the firms' cost minimization problem. In particular we can disentangle the effect in the role of markups, the output elasticity, the value added, and the average cost of employment. We find that the loss in the market power of firms is a relevant factor explaining the decrease in manufacturing employment, particularly, it explains 27% of the effect. On the other hand, the effect on value added explains 44%, the output elasticity with respect to labor 10%, and the effect on the average cost of employment 19%.

The results suggests that China's import penetration ratio is negative associated with the survival rate, market power, and productivity of Chilean firms. In particular, a 1 pp increase in the import penetration ratio stemming from China decreases the survival likelihood in 0.43 pp; decreases the growth rate of market power in 0.5pp, and decreases the growth rate of productivity in 0.35pp. In terms of international market access for Chilean firms, there are no effects on the total value that is exported. However, there are negative effects on the probability of becoming a non-exporter (exporter) given that the plant was a exporter (non-exporter) in the previous period. A 1pp increase in the import penetration stemming from China increases the probability of becoming a non-exporter in 1pp, and decreases the probability of becoming a exporter in 0.24pp.

The rest of the paper is organized as follows, in section 2 we describe the relevant literature for this project, section 3 explains the main ingredients of the method developed by DW to estimate markups that use as a reference the ACF productivity estimation procedure. Furthermore, it also shows how the effect on manufacturing employment can be decomposed in different terms explained by the role of firms. Section 4 presents the data and the empirical strategy, section 5 discusses the results and disentangles the role of firms in explaining the effect on manufacturing employment, and finally, section 6 concludes.

2 Related literature

The relative importance of manufacturing across the world has declined due to the fact that import competition stemming from China has risen dramatically in the last two decades, especially, after China joined the WTO in 2001. Different papers have studied this phenomenon in light of Feenstra (2010) who analyzed the impact of international

trade on U.S. labor markets.

For instance, Autor et al. (2013) analyzed the effect of rising Chinese import competition on US local labor markets between 1990 and 2007, finding that Chinese imports cause higher unemployment, lower labor force participation and lower wages in the commuting zones that were more affected by this phenomenon. Similarly, Caliendo et al. (2015) analyzed the reallocation of workers across different sector due to the China shock following the model by Artuc et al. (2010). The author built a framework that includes input-output linkages, the role of geographic factors, and labor mobility frictions finding that increased China competition reduces employment manufacturing share by 0.5 percentage points which represents 0.8 million manufacturing jobs, yet aggregate welfare has increased by 0.6%.

Similarly, Galle et al. (2015) quantify the effect of trade on aggregate welfare as well as the distribution of this aggregate effect across different groups of workers, the authors examine the shock in which China expands in the world economy finding that inequality-adjusted gains from trade are lower than the aggregate gains for the U.S and Germany after the rise of China in international trade. On the other hand, for the specific case of Latin America, Artuc et al. (2015) assesses the impact of the rise of China on the trade of Latin American and Caribbean economies. The authors are able to construct an index to measure the impact on trade of China's expansion finding that there are sizable effects on labor markets, especially in Argentina, Brazil, Chile, Honduras, Mexico, and Paraguay.

Morover, other studies such as Bernard et al. (2006) and Khandelwal (2010) have assessed the exposure to imports stemming from low-wage countries at the plant and the industry level. The former paper shows that firms exposed to imports from low-wage countries has lower probability of surviving and experience a lower growth rate of employment. My empirical strategy relies in the measure of industry exposure that this papers constructs. The latter paper shows that long-ladder industries in quality experience smaller employment declines due to low-wage penetration.

This paper is also related to the branch of the literature that has studied different methods to estimate markups and productivity measures. Particularly, my strategy is based on the method developed by DeLoecker and Warzynski (2012) which relies in the assumption of cost minimizing firms and on the algorithm developed by Ackerberg et al. (2015) to estimate productivity measures. This method is able to identify separately

the effect on value added of P and Q estimating the markups that firms charge and a measure of productivity at the firm level. This method is explained below. The main conclusion of the literature that has estimated markups is that exporter firms charge higher markups and that markups increase upon export entry. A recent paper De Loecker et al. (2016) develops a framework to estimate markups from production data with multi-product firms, and examines how prices, markups, and marginal costs respond to trade liberalization, the method is also based on cost minimizing firms. The first order condition from the cost minimization problem allows me to decompose the effect on manufacturing employment.

For the particular case of Chile Garcia-Marin (2014) is able to estimate markups directly using a unique dataset of Chilean manufacturing firms that includes porduct-level data on the price and average cost, the author finds that the export markup premium is moderate, however, the trajectories of markups before and after export entry suggest that there is a premium after the firm starts exporting. The markups that the authors estimate are slightly lower than the ones that we estimate. In the next section, we explain the algorithm developed by DeLoecker and Warzynski (2012).

3 Markups and Productivity

This section describes the main ingredients of the GMM method developed by DW to estimate markups and productivity. In a first step DW derive an expression for markups and in a second step they develop an estimation procedure.

3.1 Expression for Markups

The method is based on cost minimizing producers free of any adjustment costs. A firm i at time t produces output using the following production technology:

$$Q_{it} = Q_{it}(X_{it}^1, ..., X_{it}^V, K_{it}, \omega_{it})$$

Where V are the number of variable inputs, K_{it} is the capital stock, and ω_{it} is a measure of productivity. The associated Lagrangian function for the cost minimization problem is:

$$\mathcal{L}(X_{it}^1, ..., X_{it}^V, K_{it}, \omega_{it}) = \sum_{v=1}^{V} P_{it}^{X^v} X_{it}^v + r_{it} K_{it} + \lambda_{it}(Q_{it} - Q_{it}(\cdot))$$

Where $P_{it}^{X^v}$ and r_{it} denote a firm's input price for a variable input v and capital. The first-order condition for a variable input is

$$P_{it}^{X^v} = \lambda_{it} \frac{\partial Q_{it}(\cdot)}{\partial X_{it}} \tag{1}$$

where λ_{it} is the marginal cost of production by the envelope theorem.[5] Defining the output elasticity on an input X_{it}^v as:

$$\theta_{it}^X \equiv \frac{\partial Q_{it}(\cdot)}{\partial X_{it}} \frac{X_{it}^v}{Q_{it}}$$

and using the standard definition of the markup μ_{it}

$$\mu_{it}\lambda_{it} = P_{it}$$

We can multiply at both sides by $\frac{X_{it}^v}{Q_{it}}$ in equation 1 and express the markup μ_{it} as:

$$\mu_{it} = \theta_{it}^X \frac{P_{it}^X X_{it}}{P_{it} Q_{it}}$$
$$\mu_{it} = \theta_{it}^X (\alpha_{it}^X)^{-1}$$

where α_{it}^X is the share of expenditures on input X_{it}. The previous expression implies that to estimate the markups we only need two statistics: the elasticity on a variable input and the expenditure share of the input. The latter is directly observed in most micro data. However, it is necessary to estimate the output elasticity of at least one variable input. That is the next step taken by DW in their estimation method which is explained below. Note that since labor is a variable input, we can disentangle the effect on manufacturing employment using the FOC from the firms' cost minimization problem. This is explained in more detail below.

3.1.1 Disentangling the role of firms

As mentioned above, we can disentangle the effect on manufacturing employment using the expression for markups. In particular for the case of employment, the expression for markups can be rewritten as:

$$\mu_{it} = \theta_{it}^L \frac{\bar{w} L_{it}}{P_{it} Q_{it}}$$

Where L is labor, and $\bar{w}$ is the average wage of workers in firm i, this term can be

[5] The derivative of the objective function with respect to output represents the marginal cost.

rearranged to solve for L_{it} and take logs to obtain that:

$$\ln L_{it} = \underbrace{\ln \mu_{it}}_{\text{Mark-ups effect}} + \underbrace{\ln P_{it}Q_{it}}_{\text{Value added effect}} + \underbrace{\ln \bar{w}}_{\text{Average wage effect}} - \underbrace{\ln \theta_{it}^{L}}_{\text{Output elasticity effect}} \tag{2}$$

Hence, we can disentangle the role of the different firms' components to explain the loss in manufacturing employment. Note that this decomposition just takes a labor demand perspective, since we are not considering the effects of Chinese imports on labor supply. The results of this decomposition are described in section 3.3. In the case of the Cobb-Douglas production function the output elasticity remains constant, thus, its contribution is null.

3.2 Output elasticity and Markups estimation procedure

The main contribution of DW is to develop a method to estimate the output elasticity that is based on the ACF approach to estimate productivity. The procedure consists of two steps. In the first step, the authors estimate the coefficients of a value added production function, and, in a second step the authors use the standard GMM techniques to estimate the production function coefficients. Let's consider a value added translog production function:

$$y_{it} = \beta_l l_{it} + \beta_k k_{it} + \beta_{ll} l_{it}^2 + \beta_{kk} k_{it}^2 + \beta_{lk} l_{it} k_{it} + \omega_{it} + \epsilon_{it} \tag{3}$$

where l is the log of labor, in this case the variable input, and k is the log of capital. In the case of the Cobb Douglas production function $\beta_{ll} = \beta_{kk} = \beta_{lk} = 0$.[6] In a first stage, DW fit the following model

$$y_{it} = \phi(l_{it}, k_{it}, m_{it}, \mathbf{z}_{it}) + \epsilon_{it}$$

where $\phi(\cdot)$ is a measure of expected output. DW obtain estimates of expected output ($\hat{\phi}_{it}$) and an estimate for ϵ_{it}. Expected output is given by:

$$\phi_{it} = \beta_l l_{it} + \beta_k k_{it} + \beta_{ll} l_{it}^2 + \beta_{kk} k_{it}^2 + \beta_{lk} l_{it} k_{it} + h_t(m_{it}, k_{it}, \mathbf{z}_{it})$$

$$h_t(m_{it}, k_{it}, \mathbf{z}_{it}) = \delta_m m + \delta_{mm} m^2 + \delta_{mk} mk + \epsilon_{it}$$

[6] We also include in the production function estimation time fixed effects and 2 digit ISIC industry fixed effects.

where m is the log of intermediate materials and energy. The second stage relies on the law of motion for productivity providing estimates for all coefficients of the production function,

$$\omega_{it} = g_t(\omega_{it-1}) + \xi_{it}$$

$$\omega_{it} = \gamma_{1t}\omega_{it-1} + \gamma_{2t}\omega_{it-1}^2 + \gamma_{3t}\omega_{it-1}^3 + \xi_{it}$$

After the first stage, DW are able to compute a level of productivity ω_{it} for any value of the vector $\beta = \{\beta_l, \beta_k, \beta_{ll}, \beta_{kk}, \beta_{lk}\}$. DW can recover the innovation to productivity given β, $\xi_{it}(\beta)$, and form moments to obtain estimates of the production function,

$$E\left[\xi_{it}(\beta)\begin{pmatrix} l_{it-1} \\ k_{it} \\ l_{it-1}^2 \\ k_{it}^2 \\ l_{it-1}k_{it} \end{pmatrix}\right] = 0$$

The authors use standard GMM techniques to estimate the production coefficients. Finally, in order to construct the output elasticity, DW use the estimated coefficients. For the case of Cobb Douglas and translog production function the output elasticity is given by:

$$\hat{\theta}_{it}^{L_{cd}} = \hat{\beta}_l$$

$$\hat{\theta}_{it}^{L_{tl}} = \hat{\beta}_l + 2\hat{\beta}_{ll}l_{it} + \hat{\beta}_{lk}k_{it}$$

DW do not observe the correct expenditure share for input X_{it} directly since they only observe $\tilde{Q}_{it} \equiv Q_{it}\exp(\epsilon_{it})$. Therefore, the authors use the estimate for ϵ_{it} of the first stage, DW compute the expenditure share for input X_{it} as follows

$$\hat{\alpha}_{it} = \frac{P_{it}^X X_{it}}{P_{it}\frac{\tilde{Q}_{it}}{\exp(\hat{\epsilon}_{it})}}$$

With all these ingredients we are able to estimate markups for firm i at each period of time t.

3.3 Markup Estimates

We estimate the value added production function by OLS and by the method developed by DeLoecker and Warzynski (2012) to estimate markups. Table 1 shows the results for the

value added production function estimated coefficients. The results suggest that the DW method corrects a small bias of the OLS coefficients for both production functions: Cobb Douglas and Translog. In both specifications for the case of the Cobb Douglas production function we can't reject the null hypothesis of constant returns to scale. Moreover, the estimated coefficients suggest that a Translog production function fits a better model.

Table 1: Production function estimates

	(1)	(2)	(3)	(4)
Est.	CD-OLS	CD-DW	Trlog-OLS	Trlog-DW
β_l	0.856***	0.905***	1.287***	1.375***
	(0.004)	(0.011)	(0.018)	(0.050)
β_k	0.190***	0.236***	-0.466***	-0.489***
	(0.002)	(0.015)	(0.011)	(0.177)
β_{ll}			0.036***	0.0419***
			(0.002)	(0.008)
β_{kk}			0.038***	0.044***
			(0.001)	(0.007)
β_{lk}			-0.063***	-0.073***
			(0.002)	(0.006)
Obs	52735	52735	52735	52735

Note: Production function estimate results. Columns (1) and (2) show the results for the Cobb Douglas production function, and columns (3) and (4) for the translog production function. Standard errors are reported in parentheses and are clustered at the state level. * significant at 10%; ** significant at 5%; *** significant at 1%.

In the case of markups, we restrict my analysis for the years: 1996, 1998, 2000, 2002, 2004, and 2006 due to the fact that my specification is based on the BJS empirical model that is explained below. Following DW, table 2 presents the median markup by year of analysis.

Table 2: Estimated median markup by year of analysis

	(1)	(2)	(3)	(4)	(5)
Year	CD-OLS	CD-DW	Trlog-OLS	Trlog-DW	Observations
1996	2.36	2.48	2.24	2.25	4635
1998	2.24	2.38	2.11	2.13	4550
2000	2.18	2.30	2.04	2.08	4184
2002	2.12	2.27	1.96	2.01	4276
2004	2.17	2.34	2.02	2.06	4453
2006	2.20	2.36	2.04	2.09	4434

Note: Estimated markups. Columns (1) and (2) show the results for the Cobb Douglas production function, columns (3) and (4) for the translog production function, and column (5) the number of observations.

The results from table 1 suggest that there is a bias in the estimated markups from column (1) to column (3) in table 2, since a translog production function fits a better

model. For instance, the estimated median markup for the Cobb Douglas case is far bigger than the results found by DW.[7] Therefore, for the empirical strategy we only present the results for the estimated markups and productivity of the translog production function using the DW method. The median markup estimates for the translog production function varies in a range between 2.06 and 2.25.[8]

4 Data and Empirical Strategy

This paper combines three different data sets: 1) The ENIA, a panel of Chilean plants with more than 10 employees from 1979 to 2013, although, due to the fact that we only can identify each firm at each period of time for some years, the analysis is restricted for the 1996-2006 period; 2) UN Comtrade Data Base that provides trade flow information at the HS codes at the six-digit level; and 3) The Input-Output tables of the OECD Data base from 1995 to 2005. We use this information to construct the export share at the ISIC two-digit level since domestic output at the four-digit ISIC level is unobservable. Since the industry affiliation of each plant in the ENIA is at the four-digit ISIC Rev 3 level, we use the map between the different nomenclatures of industries developed by the World Bank to aggregate six-digit HS codes to four-digit ISIC codes.

The paper constructs a measure of Chinese import exposure based on BJS. This measure focus on where imports originate as well as the level of trade flows between a pair of countries. In order to construct this measure, we need to observe domestic output, nevertheless, domestic output is unobservable at the four-digit ISIC levels, hence, we construct an export share at the two-digit ISIC level using the Input-Output tables of the OECD. This means that there is no variation within each two-digit industry of this export share. The variable of interest at the 4-digit ISIC level is:

$$\text{CHPEN}_{it} = \left(\frac{M_{it}^{CH}}{M_{it} + \frac{X_{it}}{s_{it}} - X_{it}} \right)$$

Where i an industry subindex, and t a time subindex; M_{it}^{CH}, M_{it} corresponds to the import stemming from China and the World respectively; X_{it} corresponds to total exports; finally s_{it} is the export share constructed using the Input-Output tables. In some specifications

[7] The median markup estimated by DeLoecker and Warzynski (2012) in Slovenia for the Cobb Douglas production function is 1.17.

[8] The estimated markups seems a little bit big. I'm checking my codes.

we control for the import penetration rate from other parts of the world,

$$\text{OTHPEN}_{it} = \left(\frac{M_{it}^{OTH}}{M_{it} + \frac{X_{it}}{s_{it}} - X_{it}} \right)$$

Where OTH is a reference for other countries. The average China's import penetration in Chile is 0.9% with a standard deviation of 0.026 in 1995, and 4.36% with a standard deviation of 0.081 in 2005. In terms of plant characteristics, we are able to observe total value added, number of workers (transformed to efficiency labor units), wage bill, materials and energy, the stock of capital, export status, exports income, and the industry affiliation. With this information, we construct measures of market power (markups) and productivity using the DW method. In the main specification we use as covariates these variables. The outcome between years t and year $t+2$ are related to a set of year t plant characteristics (V_{pt}), and China's import penetration in year $t-1$ (CHPEN_{cit-1}). The analysis is restricted for the even years from 1996 to 2006, and the main specification can be described as follows:

$$\text{Outcome}_{pt}^{t:t+2} = f(V_{pt}, \text{CHPEN}_{it-1})$$

Where p is a subindex of plant. We include in the vector V_{pt}, the log of labor efficiency units (l), the log of capital k, the relation between capital and labor (K/L), and the log of the wage bill (log(Wagebill)). Our strategy focuses on several firm's dimensions: 1) survival rate, 2) markups, 3) productivity, and 4) international market access. We analyze the effect of rising Chinese import competition on three binary and six continuous outcomes including the value added, output elasticity with respect to labor, and average cost of employment.

Table 3: Outcomes

Outcome	Type	Description
$\Pr(\text{Death}_p^{t:t+2})$	Binary	Probability of death between the two periods
$\Pr(\text{Exporter}_p^{t:t+2})$	Binary	Probability of becoming a exporter
$\Pr(\text{NonExporter}_p^{t:t+2})$	Binary	Probability of becoming a non-exporter
$\Delta \ln \mu_p^{t:t+2}$	Continuous	Markup growth rate
$\Delta \omega_p^{t:t+2}$	Continuous	Productivity growth rate
$\Delta \ln \text{ExportsIncome}_p^{t:t+2^*}$	Continuous	Exports income growth rate
$\Delta \ln \text{VA}_p^{t:t+2}$	Continuous	Value added growth rate
$\Delta \ln \bar{w}_p^{t:t+2}$	Continuous	Average employment cost growth rate
$\Delta \ln \theta_p^{t:t+2^*}$	Continuous	Output elasticity growth rate

Note: Outcomes at the plant level between years t and year $t+2$.

In the case of continuous outcomes we restrict our analysis for a balanced panel of firms. In total there are 1532 firms, and 99 industries at the four-digit ISIC level. Table 3 describes the different outcomes. The parameter μ_p describes the estimated markup, and ω_p the level of productivity at the plant level.[9] We use the estimates of the translog production function by the DW method. On the other hand, we include the variables VA_p, $\bar{w}_p$, and θ_p since these are the different terms derived from the manufacturing employment decomposition in equation 2, that is, the value added, average cost of employment, and output elasticity with respect to labor. In the case of binary outcomes, we fit the following model

$$\Pr(I_p^{t:t+2}) = \Pr\left(V_{pt}'\alpha + \text{CHPEN}_{it-1}'\beta + \delta_t + X_i\right) \tag{4}$$

Where $I_p^{t:t+2}$ denotes one of the different binary outcomes, and X_i are industry characteristics at the two-digit ISIC level. We estimate a linear probability model in the OLS and in the 2SLS. On the other hand, in the case of continuous outcomes, we use a balanced panel and fit the following model:

$$\Delta \ln y_p^{t:t+2} = c + V_{pt}'\alpha + \text{CHPEN}_{it-1}'\beta + \delta_t + \delta_p + \epsilon_{pt} \tag{5}$$

Where y_p describes one of the continuous outcomes at the plant level, δ_t are year fixed effects, and δ_p are plant fixed effects. The coefficient of interest in both models is β, and it is expected $\beta < 0$ for most of the outcomes. Nevertheless, in the case of productivity and based on standard trade models such as Melitz (2003) or Melitz and Ottaviano (2008) there should be positive effects of the import penetration ratio stemming from China. However, a major concern for subsequent estimation is that Chile imports stemming from China in equations 4 and 5 may be correlated with industry import demand shocks. If this is the case OLS estimates will underestimate the impact of rising China import competition.

Therefore, following ADH, this paper instruments CHPEN_{it-1} in Chile using the average import penetration rate in other four different countries: the United States, Germany, Spain, and Brazil.[10] We denote this variable $\text{CHPEN}_{it-1}^{\text{Other}}$. The 2SLS strategy will identify the effect of Chinese competition if the increase in China's import penetration stems

[9]* There are not significant effects neither in the OLS, nor in the 2SLS estimation.

[10] Autor et al. (2013) studies the effect of rising Chinese import competition on local US labor markets. They instrument the variable of interest using the contemporaneous composition and import growth of eight other-high income countries: Austria, Denmark, Finland, Germany, Japan, New Zealand, Spain, and Switzerland.

from China's rising comparative advantage. Hence, the main identification assumption is that the instrument should capture an increment in China's productivity and not correlated demand components among Chile and the other countries. The average value of the instrument is 0.69% with a standard deviation of 0.016 in 1995, and 2.26% with a standard deviation of 0.045 in 2005. Moreover, as a robustness check, we also run a 2SLS strategy using two instruments: China's import penetration in the US and the original instrument to perform overidentification tests.

Figure 3: First stage scatter plot

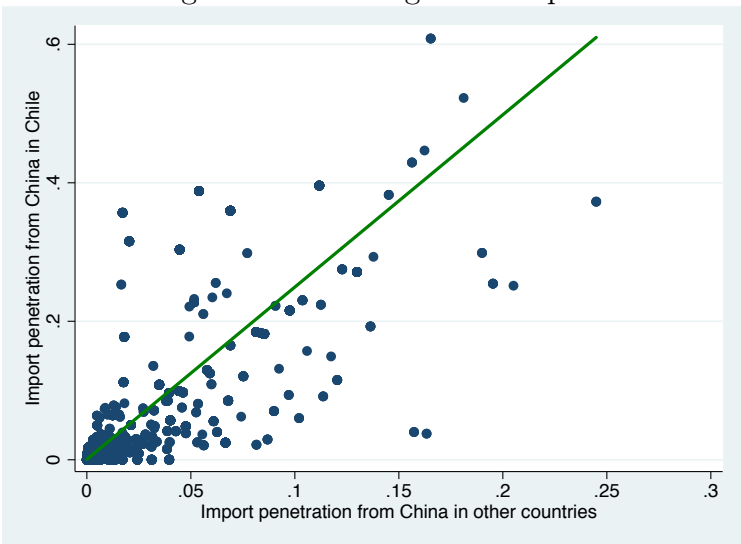


Figure 3 plots a scatter plot between the import penetration stemming from China in Chile vs the import penetration stemming from China in other countries. There is a positive association between the two variables, the effect of the rise of China will be identified if the positive correlation between the two variables is driven by productivity increases in China, and not correlation in the demand across Chile and the other countries.

5 Results

This section discusses the main results obtained after estimating model 4 and 5 for the different outcomes in table 3.

5.1 *Plant survival*

Table 4 shows the estimate of China's import competition on Chilean plant's survival rate. In terms of the First Stage, the instrument explain China's import penetration in

Chile. The F-first stage statistic is 36.00 in the specification of column (1) and 38.89 in the specification of column (2).[11] In particular a 1pp increase in the average import penetration in other countries increases China's import penetration in Chile approximately in 2pp.

Table 4: Plant survival results

	(1)	(2)	(3)	(4)	(5)	(6)
	FS1	FS2	OLS1	OLS2	2SLS1	2SLS2
Dependent variable	CHPEN_{it-1}	CHPEN_{it-1}	$\Pr(\text{Death}_p^{t:t+2})$			
$\text{CHPEN}_{it-1}^{\text{Other}}$	2.261***	2.013***				
	(0.108)	(0.105)				
CHPEN_{it-1}			0.103*	0.061	0.420***	0.439***
			(0.053)	(0.064)	(0.138)	(0.160)
OTHPEN_{it-1}		-0.147***		0.041		-0.026
		(0.008)		(0.031)		(0.040)
Observations	13280	13280	13280	13280	13265	13265
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Plant level fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Plant level characteristics	Yes	Yes	Yes	Yes	Yes	Yes

Note: Plant-level probit and 2SLS estimation results for the survival rate. Columns (1) and (2) presents the results for the Firs Stage, columns (3) and (4) the OLS, and columns (5) and (6) the 2SLS estimates. Standard errors are reported in parentheses and are clustered at the four-digit ISIC level. * significant at 10%; ** significant at 5%; *** significant at 1%.

In terms of China's import competition effect on the survival rate of plants, there is a negative association between the two variables. A 1pp increase in China's import penetration at the four-digit ISIC level increases on average the likelihood of plant's death in 0.43pp. This result is lower than the one found by BJS for the United States. The authors found that the import penetration from low income countries decreases the likelihood of surviving in 3.4pp, the different results may come from the fact that they include more low income countries rather than China in their analysis.

5.2 *Market power and productivity*

Table 5 shows the result for markup growth rate at the plant level, we restrict our analysis for a balanced panel of 1532 firms and 99 industries. From columns (1) and (2), we can infer that China's import penetration in other countries is a good instrument for China's import penetration in Chile. The results are very similar to table 4. The F-First stage statistic for both columns is higher than 90. In terms of the impact of China's import penetration at the four-digit ISIC level, there is a negative association between this

[11] In terms of the overidentification test, when we instrument using the original instrument and China's import penetration in the US, the p-value of the overidentification test is 0.48 and 0.63. This means that the instrument seems valid. These results are not reported to to space limits.

variable and markups. The markups used in the analysis are translog markups estimated by DW method. For instance, a 1pp increase in the previous year import penetration stemming from China decreases the growth rate of markups in 0.56pp in our preferred specification.

Table 5: Markup growth rate results

	(1)	(2)	(3)	(4)	(5)	(6)
	FS1	FS2	OLS1	OLS2	2SLS1	2SLS2
Dependent variable	CHPEN_{it-1}	CHPEN_{it-1}	$\Delta \ln \mu_p^{t:t+2}$			
$\text{CHPEN}_{it-1}^{\text{Other}}$	2.152***	1.969***				
	(0.146)	(0.143)				
CHPEN_{it-1}			-0.005	-0.132*	-0.426*	-0.563**
			(0.069)	(0.079)	(0.219)	(0.236)
OTHPEN_{it-1}		0.115***		0.125***		0.185***
		(0.009)		(0.038)		(0.046)
Observations	7660	7660	7660	7660	7660	7660
Number of plants	1532	1532	1532	1532	1532	1532
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Plant level fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Plant level characteristics	Yes	Yes	Yes	Yes	Yes	Yes

Note: Plant-level results for the growth rate of markups. Columns (1) and (2) presents the results for the Firs Stage, columns (3) and (4) the OLS, and columns (5) and (6) the 2SLS estimates. Standard errors are reported in parentheses and are clustered at the four-digit ISIC level. * significant at 10%; ** significant at 5%; *** significant at 1%.

This effect is very big since it corresponds to approximately 3 standard deviations of the base line growth rate. This implies that firms are losing their market power due to the China shock. The results suggests that for trade models it is important to consider variable markups to quantify the effects of the China shock. With respect to overidentification tests when we include two instruments the p-value is equal to 0.69 in our preferred specification, which implies that we do not reject the null hypothesis that the instruments are exogenous.

Table 6 shows the result for the growth rate of productivity. The results on productivity are very similar to the markup results since there is a negative association between the import penetration stemming from China and this variable. For instance a 1pp increase in China's import penetration decreases the growth rate of productivity in 0.39pp in our preferred specification. This result is big since the standard deviation of productivity growth rate is 0.18. This means that China's import has a huge effect on the growth rate of firm's productivity. When we compare this result with the main predictions of trade models such as Melitz (2003), Bustos (2011) or Arkolakis et al. (2012) this result is a little bit weird since we should observe that the firms which face a fiercer competition should become more productive. Hence, we should not observe a decreasing growth

rate productivity in more exposed firms to China's import penetration.[12] The results are inconsistent with this prediction.

Table 6: Productivity growth rate results

	(1)	(2)	(3)	(4)
	OLS1	OLS2	2SLS1	2SLS2
Dependent variable		$\Delta\omega_p^{t:t+2}$		
CHPEN_{it-1}	-0.067	-0.135*	-0.313**	-0.389***
	(0.061)	(0.069)	(0.129)	(0.142)
OTHPEN_{it-1}		0.068**		0.103***
		(0.032)		(0.036)
Observations	7660	7660	7660	7660
Number of plants	1532	1532	1532	1532
Year fixed effects	Yes	Yes	Yes	Yes
Plant level fixed effects	Yes	Yes	Yes	Yes
Plant level characteristics	Yes	Yes	Yes	Yes

Note: Plant-level results for the growth rate of productivity. Columns (1) and (2) shows the estimates for the OLS, and columns (5) and (6) the 2SLS estimates. Standard errors are reported in parentheses and are clustered at the four-digit ISIC level. * significant at 10%; ** significant at 5%; *** significant at 1%.

5.3 *International Market Access*

The last set of outcomes that we examine are export outcomes. There are three different outcomes related to the export status of a firm: probability of becoming a exporter (non-exporter) from period t to period $t+2$ given that plant p was a non-exporter (exporter) at period t, and the growth rate of exports income. Since there are not significant effects for $\Delta \ln \text{ExportsIncome}^{t:t+2}$), we only present the results for the probability of becoming a exporter or a non-exporter.

The results are presented in table 7. Similarly to the other estimations, the average China's import penetration in other countries seems as a relevant instrument given the fact that it explains China's import penetration in Chile. For instance, the F-statistic for columns (1) and (2) is higher than 60.[13] In terms of the probability of becoming a non exporter, there is a negative association between China's import penetration and the probability of plant p to maintain its export status. For instance, a 1pp increase in China's import penetration increases the probability of becoming a exporter in approximately 1pp. This result is big and significant since the standard deviation of the outcome variable is 0.36 for the sample of analysis.

[12]For the overidentification test using the original instrument and China's import penetration in the US, the pvalue is 0.47 for column (3) and 0.25 for column (4).

[13]Similarly, the p-value of the overidentification test when we use the two instruments is higher than 0.1 for both specifications in column (5) and (6), 0.32 and 0.33 respectively.

Table 7: Non-exporter status results

	(1)	(2)	(3)	(4)	(5)	(6)
	FS1	FS2	OLS1	OLS2	2SLS1	2SLS2
Dependent variable	CHPEN_{it-1}	CHPEN_{it-1}		$\text{Pr(NonExporter}_p^{t:t+2}\text{)}$		
$\text{CHPEN}_{it-1}^{\text{Other}}$	2.615***	2.206***				
	(0.227)	(0.211)				
CHPEN_{it-1}			0.941***	0.965***	0.975**	1.006**
			(0.253)	(0.280)	(0.394)	(0.476)
OTHPEN_{it-1}		0.141***		-0.020		-0.027
		(0.016)		(0.085)		(0.112)
Observations	4448	4448	4448	4448	4448	4448
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Plant level fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Plant level characteristics	Yes	Yes	Yes	Yes	Yes	Yes

Note: Plant-level linear probability model and 2SLS estimation results for becoming a non exporter. Columns (1) and (2) presents the results for the Firs Stage, columns (3) and (4) the OLS, and columns (5) and (6) the 2SLS estimates. Standard errors are reported in parentheses and are clustered at the four-digit ISIC level. * significant at 10%; ** significant at 5%; *** significant at 1%.

This means an effect China's import penetration of 1.25 standard deviations. The effect on the export status is one of the channels that can explain the effect on productivity as in Bustos (2011) and Pavcnik (2002). Similarly, table 8 shows the results for the probability of becoming a exporter.

Table 8: Non-exporter status results

	(1)	(2)	(3)	(4)	(5)	(6)
	FS1	FS2	OLS1	OLS2	2SLS1	2SLS2
Dependent variable	CHPEN_{it-1}	CHPEN_{it-1}		$\text{Pr(Exporter}_p^{t:t+2}\text{)}$		
$\text{CHPEN}_{it-1}^{\text{Other}}$	2.212***	1.968***				
	(0.112)	(0.107)				
CHPEN_{it-1}			-0.128**	-0.036	-0.281**	-0.245**
			(0.057)	(0.060)	(0.113)	(0.125)
OTHPEN_{it-1}		0.158***		-0.088***		-0.050*
		(0.007)		(0.023)		(0.028)
Observations	16494	16494	16494	16494	16494	16494
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Plant level fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Plant level characteristics	Yes	Yes	Yes	Yes	Yes	Yes

Note: Plant-level linear probability model and 2SLS estimation results for becoming a exporter. Columns (1) and (2) presents the results for the Firs Stage, columns (3) and (4) the OLS, and columns (5) and (6) the 2SLS estimates. Standard errors are reported in parentheses and are clustered at the four-digit ISIC level. * significant at 10%; ** significant at 5%; *** significant at 1%.

The results suggest that it is more difficult to becoming a exporter in the sectors that face a fiercer competition with China. Particularly, the probability of becoming a exporter condition on being a non-exporter the previous period decreases in 0.25pp as the import penetration ratio stemming from China increases in 1pp.

5.4 Disentangling the role of firms

In this section we present the results when we decompose the role of different firms' components based on equation 2. We can decompose the effect on manufacturing employment as follows:

$$\Delta \ln L_p^{t,t+2} = \underbrace{\Delta \ln \mu_p^{t:t+2}}_{\text{Mark-ups effect}} + \underbrace{\Delta \ln \text{VA}_p^{t:t+2}}_{\text{Value added effect}} + \underbrace{\Delta \ln \bar{w}_p^{t:t+2}}_{\text{Average wage effect}} - \underbrace{\Delta \ln \theta_p^{t:t+2^*}}_{\text{Output elasticity effect}} \tag{6}$$

Thus, estimating the impact of the import penetration ratio stemming from China in these 4 components allow us to decompose the effect on manufacturing employment since this equation is derived from the firms' first order condition. As above we use the estimates of a Translog production function. We expect a negative estimate of CHPEN_{it-1} on markups, value added, and average cost of employment, and a positive effect on the output elasticity. Table 9 shows the point estimates when we estimate equation 5 by 2SLS including as covariates the import penetration stemming from other countries OTHPEN_{it-1}.

Table 9: Manufacturing employment decomposition results

	(1)	(2)	(3)	(4)
Dependent variable	$\Delta \ln \mu_p^{t:t+2}$	$\Delta \ln \text{VA}_p^{t:t+2}$	$\Delta \ln \bar{w}_p^{t:t+2}$	$\Delta \ln \theta_p^{t:t+2^*}$
CHPEN_{it-1}	-0.563**	-0.907**	-0.398	0.200***
	(0.236)	(0.366)	(0.263)	(0.060)
OTHPEN_{it-1}	0.185***	0.114*	0.009	-0.031**
	(0.046)	(0.067)	(0.054)	(0.014)
Observations	7660	7660	7660	7660
Number of plants	1532	1532	1532	1532
Year fixed effects	Yes	Yes	Yes	Yes
Plant level fixed effects	Yes	Yes	Yes	Yes
Plant level characteristics	Yes	Yes	Yes	Yes

Note: Estimation results for the manufacturing employment decomposition by 2SLS. Column (1) presents the results for mark-ups, column (2) for value added, column (3) for the average cost of employment and column (4) for the output elasticity. Standard errors are reported in parentheses and are clustered at the four-digit ISIC level. * significant at 10%; ** significant at 5%; *** significant at 1%.

The results show that the sign of the point estimates are as we expected. In particular the overall effect for the demand of manufacturing employment decreases in 2.05pp when the import penetration ratio stemming from China increases in 1pp. This effect is explained in 27% by the effect on market power, 44% by the effect on value added, 19% by the effect on the average cost of employment, and the remaining percent is explained by the effect on the output elasticity.

6 Conclusion

This paper has studied and estimated the effect of rising China's import penetration on different domestic firm's outcome using Chilean data. The different outcomes are: plant's survival, markups and productivity, and export status. In the first part of the paper, we use the method developed by DeLoecker and Warzynski (2012) to estimate markups and productivity at the plant level at each period of time, this method relies on standard GMM techniques.

In the second part, we use the main specification of Bernard et al. (2006) and a 2SLS estimation procedure, in which we construct an instrument following Autor et al. (2013). The results suggests a negative association between China's import penetration and, survival rate, markups, productivity, and export status, however, there are no effects on the exports extensive margin (Exports income). In the third part of the paper, we proceed to decompose the effect on manufacturing employment from a labor demand perspective, finding that the effect on market power explains 27% of the loss in manufacturing employment experienced by the survival firms.

The paper sheds light on new topics of rising China's import competitions effects since it is the first paper that analyzes at the industry level the impact of China's imports on the market power and productivity of firms. Moreover, the significant effect of the import penetration from China on markups supports the literature that has considered varible markups in trade models such as Arkolakis et al. (2015), since, in most trade models markups are constant and expressed as a function of the elasticity of substitution. This topic can be an interesting topic for future research since most trade models that has analyzed the impact of the rise of China has considered perfect competition or constant markups.

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