

# MARKET ACCESS AND THE EVOLUTION OF WITHIN PLANT PRODUCTIVITY IN CHILE

MARIA BAS  
IVAN LEDEZMA

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# MARKET ACCESS AND THE EVOLUTION OF WITHIN PLANT PRODUCTIVITY IN CHILE

## Abstract

This paper studies the impact of trade reforms on the evolution of plant's productivity in Chile (1979-2000). The main contribution of the paper is to construct detailed measures of trade liberalization disentangling the impact of export and import oriented policies. We find evidence of a positive impact of export oriented policies on productivity of traded sectors relative to non traded. On the other hand, the reduction of import barriers might have a positive impact on productivity in export oriented sectors, but it hurts local firms in import competing ones probably due to the existence of increasing returns.

JEL Code: F10, F12, F41.

Keywords: firm heterogeneity, trade reforms, productivity gains, plant's panel data.

*Maria Bas*  
*Pse-Ens*  
*48 bd Jourdan*  
*75014 Paris*  
*France*  
*bas@pse.ens.fr*

*Ivan Ledezma*  
*Pse-Ens*  
*48 bd Jourdan*  
*75014 Paris*  
*France*  
*ledezma@pse.ens.fr*

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# 1 Introduction

Trade liberalization was at the core of reform packages implemented in many developing economies during 1980's. Several empirical works have found evidence of a positive correlation between trade liberalization and productivity both at aggregated and plant's level (see Pavcnik (2002), Bernard and Jensen (2001), Clerides et al. (1998), Bernard, Jensen and Schott (2003)). In this paper we revisit the case of Chile, one of the earliest and most radical examples of trade liberalization in developing countries. We aim at testing the link between this reform and productivity in Chilean manufacturing plants. To test this relationship we first estimate plant's TFP taking into account firm heterogeneity in terms of productivity levels and then estimate the impact of market access on plant's productivity. To do so we use the annual industry ENIA survey (*encuesta anual industrial*) of manufacturing Chilean's plants and the Trade and Production database provided by CEPPII (*centre d'etudes prospectives et d'information internationales*).

Our contribution to previous works is to disentangle policy implications on both export and import sides. We construct a measure of trade liberalization which takes into account the evolution of market access over time and across industries between Chile and its main trading partners. These measures, usually referred as "border effects", essentially capture trade difficulties from the fact of crossing national border and selling or buying abroad. Considering only tariffs or year dummies may neglect two important features of trade policy. First, unilateral import tariff reduction may not be symmetric among trade partners. Second, the role of non tariffs barriers, fixed export costs and bilateral agreements may be an important determinant of trade flows. Taking into account the evolution of market access allow us identifying which industries benefit the most, in terms of productivity gains, from import or export oriented policies.

Arguments concerning the consequences of trade liberalization do not always go in the same direction. Foreign competition is usually highlighted as a positive engine of productivity. It would press less productive firms to exit the market and surviving firms to trim their inefficiencies. However, the presence of increasing returns to scale (IRS) and imperfect competition may introduce new ingredients to the model (Devarajan and Rodrik (1999), Rodrik (1992)). In particular one of the most important features of the Krugman (1980) model of economies of scales is precisely that average cost falls as output increases. In that sense, the size of local market plays an important role mapping cost structures. The monopoly power means that

firms integrate their demand in their decisions and so the advantage of price setting<sup>1</sup>. In a country like Chile, with a population nowadays of 16 million (11 million in the 1982 census), the opportunities for scales economies in import competing sectors after a radical change in foreign market competition are likely constrained. On the empirical grounds, Antweiler and Treffer (2002) show that indeed scales economies do matter to explain trade patterns.

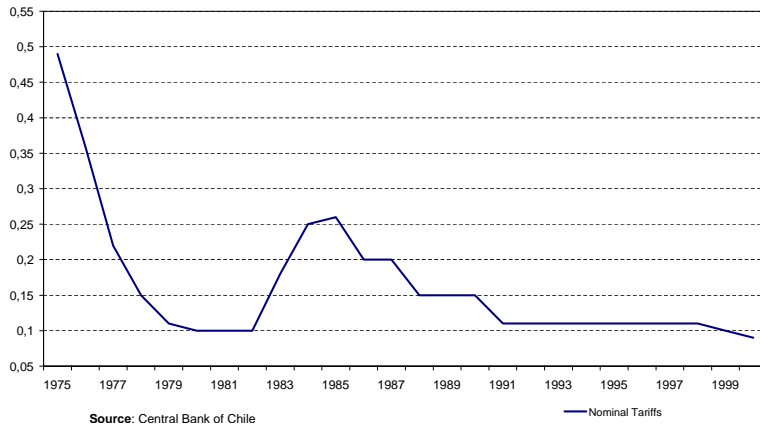
The literature also suggests learning by exporting as a plausible mechanism to explain the effects of trade liberalization on plant's productivity. Several empirical works find evidence of ex post increasing productivity gains arising from selling in foreign markets (See Aw, Chung, Roberts (1999) for Korea, Kray (1999) for Chinese firms, and Alvarez and Lopez (2005) for Chile). The undermining theoretical channel focuses on productivity improvements resulting from knowledge and expertise gained in the export process. One possible explanation is that exporters learn from their contacts in the export market, and as a result they adopt better production methods and achieve higher productivity. Clerides, Lach and Tybout (1998) construct a dynamic model based on Baldwin (1989), Dixit (1989) and Krugman (1989). In their model firm's current productivity depends on prior export experience. As a result, learning by exporting widens the gap between the productivity of firms that enter the export market and those that sell only to the domestic market. Related to this view Grossman and Helpman (1991) develop a trade and innovation model emphasizing the role of international spillovers in the growth process. By disentangling the nature of trade policies, using specific export and import oriented policies, We might capture benefits stemming from this mechanism.

Chilean dictatorship in power from 1973 to 1990, implemented a deep package of market reforms concerning every economic field. Among them trade liberalization took place in the second half of seventies. Since the beginning of the period, all trade barriers and restrictions to trade were removed. Average nominal tariff rates decreased gradually from 98% in 1973 to 10% in 1979. Specially, during nineties one of the main trade strategies of Chile was to pursuing several trade agreements with different countries and regions, without being tied to only one regional customs unions. Chile has signed trade agreements not only with almost all Latin American countries, but also with United States, European Union and Asia in recent years.

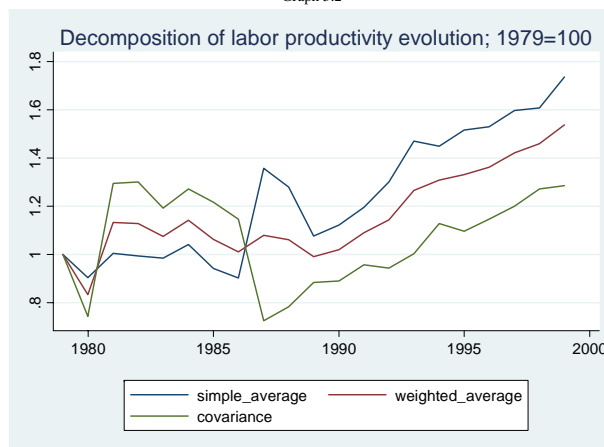
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<sup>1</sup>IRS in trade models are usually modeled by fixed and constant marginal costs, implying declining average costs. A more precise link to productivity can be made by assessing that the fixed cost might represent an investment in technology that is conditioned by the anticipation of the demand size and profits (Rodrik (1988), Bas and Ledezma (2006))

Graph 5.1:  
Evolution of Nominal Tariffs in Chile: 1979-2000



Graph 5.2



Graph 5.2 plots the average evolution of the weighted (by market share) and unweighted average labor productivity between 1979 and 2000. While the unweighted average labor productivity is directly related to within plant productivity, the weighted measure takes into account the gains due to the reallocation of market shares towards the most productive firms. As the graph shows, this evidence indicates that after 1987 within plant productivity gains

become a key mechanism rather than the reallocation process. Consequently we focus on mechanisms that modify individual productivity after a change in the exposure to trade rather than to ex-ante self-selection mechanisms that, holding individual productivity constant, alter the composition of the average weighted productivity.

Several works have estimated the effects of trade reforms on firm's productivity using specific methodologies to estimate production functions, such as Olley and Pakes (1996) (OP) or Levinsohn and Petrin (2003) (LP) (See section 4.1.1). These methodologies allow estimating production functions in a framework of firm heterogeneity. We are particularly interested in two works that have also studied the Chilean experience. Based on the ENIA Survey, Pavcnik (2002) estimates the impact of trade on plant's productivity in Chile during the period 1979-1986. She applies OP strategy and controls explicitly for simultaneity and selection issues. Using year dummy variables as proxies of trade reform (treatment effect in a difference in difference framework), the conclusion of Pavcnik (2002) is that aggregate productivity improvements are explained by two factors induced by trade liberalization: (a) the growth of within plant productivity in importing-competing industries and (b) the exit of less productive firms and the corresponding reallocation of market share towards most productive ones. However, as Bergoeing, Hernando and Repetto (2006) note tariffs rose between 1983 and 1985 (see graph 5.1 in Appendix 1). Due to the debt and recession crisis in 1982, the government increased tariffs and nominal averages to 26% between 1983 and 1985. Moreover these year dummies are also supposed to be a control of other macro economic shocks, namely the debt crises and other market reforms. Using year indicators in interactions with trade orientation sectors implies the implicit assumption that these macro economic shocks affect all sectors in a uniform way.

Chilean market reforms were recently revisited by Bergoeing, Hernando and Repetto (2006). They study the impact of trade and financial liberalization on productivity gains in Chile in a longer period of time (1980-2001) using the LP strategy. Their results show that aggregate productivity gains come from within plant improvements over time in traded industries relative to non traded ones (during the nineties) and from the entry of more productive firms than the exiting ones. They also find that the process of resources reallocation among incumbents play a minor role enhancing aggregate productivity. When explicitly regressing by effective tariffs productivity advantages of traded industries are not significant and import-competing sectors get (significantly) productivity gains from protection.

Unfortunately for identification issues the drop of Chilean tariffs was quite radical but homogeneous across industries. This is probably the reason why Pavcnik (2002) is constrained to use year dummies and the reason why Bergoeing, Hernando and Repetto (2006) can not get enough variance for their estimates. Estimating the evolution of market access (border effects) between Chile and its trading partners also allows us to identify heterogeneity across industries and time. In that sense this paper yields new findings of trade policy implications. In order to facilitate the comparison of the results with previous works we also distinguish between export oriented, import competing and non traded sectors. We start reproducing Pavcnik's (2002) results for the full sample period. Then we run the regressions of productivity using the measures of border effects in interaction with traded sectors relative to non traded ones. First, we find a positive significant effect of a reduction of export barriers on productivity in both export oriented and import competing sectors. Second, we also find evidence of a positive impact of the reduction of import difficulties on productivity in export oriented industries. Finally, the regressions show that the decrease in import barriers might have a negative impact on productivity in import competing industries. This latter result implies that industries in import competing sectors may actually suffer from foreign competition probably by reducing their domestic market size and the possibility to exploit increasing returns.

The rest of the paper is organized as follows. In Section 2 the estimation strategy in three steps is presented. Section 3 discusses the main estimation results. Section 4 concludes.

## 2 Estimation Strategy

The estimation strategy consists of three steps. In the first step we estimate the production function using OLS, Fixed Effects and LP methodology to obtain the factor elasticity coefficients and to calculate total factor productivity (TFP) of Chilean manufacturing plants. In the second step, we construct the measure of trade liberalization estimating the border effects coefficients using a gravity model developed by Fontagne, Mayer and Zignago (2006). Finally, in the third step we estimate the impact of trade difficulties regressing productivity on border effects coefficients in interaction with sectors defined by trade orientation (export, import competing and non traded industries).

## 2.1 Step 1: Specification of production function estimations

As usually plant's TFP is calculated as the residual between the observed value added and the estimates of factors contribution. In order to do so we must estimate the production function at two digit industry level. When estimating production functions using firm panel data eventual problems concerning simultaneity and selection should be considered. Simultaneity arises because inputs demand and productivity are positively correlated. Firm specific productivity is known by the firm but not by the econometrician and panel data information usually shows that productivity is heterogeneous among firms and it evolves over time. A high productivity shock implies greater demand and consequently firms must purchase more inputs. OLS will tend to provide upwardly biased estimates of labor coefficients. If capital is positively correlated with labor and labor's correlation with the productivity shock is higher than capital one, which is the realistic case, then the coefficient of capital may be underestimated.

Selection problems are likely to be present because unobserved productivity influences the exit decision and we only observe those firms that decide to stay. On the other hand, if capital is positively correlated with profits, firms with larger capital stock will anticipate higher profits and decide to stay in the market even for low realizations of productivity shocks. So at the end, there is a potential source of negative correlation in the sample between productivity shocks and capital stock. This negative correlation means a downward bias in capital elasticity estimates.

Olley and Pakes (1996) (OP) propose a methodology of three stages to control for unobserved productivity incorporating exit and investment rules derived from firm optimal behaviour. In the first stage they use the investment rule, a function of capital stock and unobserved productivity, to address simultaneity. OP invert this investment rule to express unobserved productivity as a function of investment and capital. This inverted function is used as a proxy for productivity in the estimation. In the second stage, based on the exit rule they estimate the probability of survival conditional on available information to the firm. Following an optimal behaviour their exit rule states that firms decide to exit the market if productivity realization shocks are lower than a specific productivity cut-off which in turn is determined by capital stock and productivity. The estimates of this survival probability are used to control for selection bias. To obtain the capital coefficient, we substitute the estimates of labor coefficient (stage 1), the productivity function



(inverted investment decision) and the survival probability (stage 2) into the production function equation.

Besides some technical differences (such as the use of GMM criterion and bootstraps), Levinsohn and Petrin (2003) (LP) make use of this strategy and extend it showing that inputs (like electricity or materials) can be better proxies to control for unobserved productivity when one deals with simultaneity. Inputs adjust in a more flexible way, so they are more likely to have better response to productivity shocks. Moreover, inputs usually have more non-zero observations than investment, a property that has consequences on estimation efficiency. In the case of the ENIA this property is important. As LP show the risk of selection biases are significantly reduced by considering a non balanced panel.

There are some advantages of OP-LP strategy over alternative methods. Firstly, it performs better than fixed effects because it does not assume that the unobserved individual effect (productivity) is constant over time when controlling for simultaneity. Secondly, approaches based on instrumental variables can be limited by the instruments availability. Finally, it does not assume restrictions on the parameters. For instance, an alternative approach is the one developed by Katayama, Lu and Tybout (2005). They show how misleading can be the use of sale revenues to measure output in productivity accounting. Factor prices and mark-ups can produce important distortions if they are not homogeneous. However, the methodology proposed in their paper assumes constant returns to scales and neglect entry-exit process to facilitate likelihood estimates. Again both assumptions are not neutral in the case of the ENIA.

In order to maximize sample size with a reduced risk of selection we keep the LP strategy and use electricity as a proxy for unobserved productivity. In the first step, we will estimate the following specification of a Cobb Douglas production function:

$$(1) \quad y_{it} = \beta_0 + \beta_1 x_{it} + \beta_2 k_{it} + \varepsilon_{it}$$

Where all variables are expressed in natural logarithms, " $y_{it}$ " is the value added of plant "i", " $x$ " are variable inputs (skilled and unskilled labor) and " $k$ " is the stock of capital. Consequently, TFP in log ( $a_{it}$ ) is computed as the residual of this function, given by:

$$\hat{a}_{it} = y_{it} - \hat{\beta}_1 x_{it} - \hat{\beta}_2 k_{it}$$

## 2.2 Step 2: Specification of Border Effects estimation

It is well known that the reduction of tariffs in Chile was homogeneous across industries. As a consequence we do not have variance in tariffs measures among industries. Even their rise in early eighties, during the deep Chilean debt crisis, was homogeneous. On the other hand, tariffs are not the only measure that matter in trade. One should consider bilateral agreements, asymmetries between export and import costs and industrial specific difficulties to trade, not only concerning directly policies but also home biases, tastes and the like. Actually, by considering all these issues we obtain heterogeneity in both industrial and time dimensions.

Using a gravity equation framework, we measure the difficulties of bilateral trade explained by the fact of crossing the border between two countries. We apply to Chile and Chilean's trade partners the methodology developed by Fontagne, Mayer and Zignago (2005)<sup>2</sup>. The gravity bilateral trade equation that we estimate is based on a comparison between international ( $m_{ijs}$ ) and intra-national trade flows ( $m_{iis}$ ), the latter being a kind of ideal type of free trade.

$$\frac{m_{ijs}}{m_{iis}} = \left(\frac{a_{ij}}{a_{ii}}\right)^{\sigma-1} \left(\frac{p_j}{p_i}\right)^{-\sigma} \left(\frac{\tau_{ij}}{\tau_{ii}}\right)^{1-\sigma} \left(\frac{v_{js}}{v_{is}}\right)$$

$m_{ijs}$ : imports of industry "s" in country "i" from country "j"

$m_{iis}$ : volume of trade within a country measured as the overall production minus total exports in industry "s" in country "i".

$a_{ij}$ : consumer preferences of country "i" with respect to varieties produced in j.

$v_{js}$ : the value of production in industry "s" in country "j"

$p_j$ : Index price in country "j"

Trade costs ( $\tau_{ij}$ ) are composed by distance ( $d_{ij}^\delta$ ) (related to transport costs), advalorem tariffs ( $t_{ij}$ ) and "tariff equivalent" of non tariff barriers ( $NTB_{ij}$ )

$$\tau_{ij} p_j \equiv d_{ij}^\delta (1 + t_{ij}) (1 + NTB_{ij}) p_j.$$

The structure of protection varies across all partner pairs and depends on the direction of the flow for a given pair. To capture this protection

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<sup>2</sup>Omitted here, they develop further steps to disentangle the origin of the border effect. We are interested in the residual measure involving all policy difficulties, tariff and non tariff barriers, agreements, political efforts and the like.

framework, taking the example of the US as trade partner, the following dummy structure is defined:

$$(1 + t_{ij})(1 + NTB_{ij}) \equiv \exp[\eta USA - CHL_{ij} + aCHL - USA_{ij}]$$

$USA-CHL_{ij}$ : is a dummy variable set equal to 1 when  $j (\neq i)$  is Chile and  $i$  the USA (related to imports of USA from Chile).

$CHL-USA_{ij}$ : is a dummy variable set equal to 1 when  $j (\neq i)$  is the US and  $i$  Chile (imports of Chile from USA).

Preferences  $a_{ij}$  are composed by a random component  $e_{ij}$  and the coefficient  $\beta$  which represents a systematic preference for goods produced in the home country. This "home market bias" is reduced to  $(\beta_i - \lambda)$  when the countries share the same language ( $L_{ij} = 1$ ):

$$a_{ij} \equiv \exp[e_{ij} - (\beta_i - \lambda L_{ij})(USA - CHL_{ij} + CHL - USA_{ij})]$$

Combining the previous equations, we obtain the estimable equation:

$$(2)\ln\left(\frac{m_{ijs}}{m_{iis}}\right) = \ln\left(\frac{v_{js}}{v_{is}}\right) - (\sigma - 1)\delta \ln\left(\frac{d_{ij}}{d_{ii}}\right) + (\sigma - 1)\lambda L_{ij} - \sigma \ln\left(\frac{p_j}{p_i}\right) \\ - (\sigma - 1)[\beta_i + \eta]USA-CHL_{ij} - (\sigma - 1)[\beta_i + a]CHL-USA_{ij} + Z_{ij} + \epsilon_{ij}$$

This equation can be estimated at country level (considering all industries) and also at industry level. From the latter estimation we obtain the global border effect measure for each industry as a weighted average of all trading partners. The border effect coefficient of each import (export) flow will be weighted by the share of the flow on total imports (exports). Since we drop the constant and incorporate dummy variables for each combination, the coefficients of the dummy variables can be interpreted as the border effect of each combination. For example, the exponential of the coefficient of  $USA - CHL_{ij}$  multiplied by -1,  $\exp((\sigma - 1)[\beta_i + \eta])$  indicates the difficulty for Chilean's exporters in accessing to the US markets. The part of missing trade mainly caused by trade policy is captured in these coefficients.

In the estimation we consider not only the US but also other countries trading with Chile. To determine the main trading partners of Chile we use the aggregated trade flows data of ECLAC. Between 1990 and 1999 the main destination countries of Chile manufacturing exports are Latin America

(AL), the United States (USA) and the European Union (UE). At the same time, most manufacturing imports from Chile come from these countries. In the Border Effects regressions we consider nine countries of European Union , which were members through out the whole period (1979-1999).<sup>3</sup>

Finally, there is a potential source of endogeneity since in step three we will use these border effect coefficients to estimate the impact of trade liberalization on plant's TFP in different sectors. Most productive sectors or those producing high quality goods will tend to increase their trade flows and to have a smaller border effect. To address this issue we use relative wages and productivity as control variables ( $Z_{ij}$ ) in the estimation of border effects. In that sense the residual measure of missing trade that is captured by the border effect will be free of productivity concerns.

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<sup>3</sup>Germany, France, Great Britain, Italy, Belgium, Luxembourg, Ireland, Netherlands and Denmark

### 2.3 Step 3: Specification of the estimation of the impact of trade liberalization on TFP

In this final step we use the (weighted average) border effect estimated for each industry to measure the impact of trade liberalization on productivity across export and import competing sectors relative to non traded industries. We estimate the following reduced equation similar to the difference in difference framework implemented by Pavcnik (2002):

$$(3) \hat{a}_{it} = \alpha_0 + \beta(BE) + \gamma(Sector) + \delta(BE * Sector) + \lambda Z_{it} + \epsilon_{it}$$

$a_{it}$ : log of plant's TFP estimated by LP strategy or by Fixed Effects.

$BE$ : vector of import border effect ( $BE\_M$ ) and export border effect estimates ( $BE\_X$ ) at two digit industry level

$Sector$ : vector of trade orientation dummies <sup>4</sup>: export oriented (Export) and import competing (Import) industries.

$Z_{ij}$ : vector of plant characteristics: industry affiliation (ISIC 3 Ind), competition (ind\_comp) and indicators of entry and exit (Entry\_indicator; Exit\_indicator))

The excluded categories are non traded sector, the year 1979 and the sector 385 <sup>5</sup>. We are principally interested in the estimates of the vector coefficient  $\delta$ . It is usually expected a negative and significant coefficient meaning that a reduction of trade barriers has a higher positive effect on productivity in traded industries (export oriented and import competing) than in non traded ones. The vector coefficient  $\gamma$  informs about the relative productivity advantage of traded industries in Chilean manufacture.

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<sup>4</sup>We classified sectors by trade orientation using 4 digit industry classification. Plants belonging to 4 digit industry which have more than 15% of exports over total production are classified as exported oriented plants; while plants belonging to 4 digit industry which have more than 15% of import penetration indicator are classified as import competing plants. The rest are considered as non traded plants. See Pavcnik (2002) for further details concerning this classification.

<sup>5</sup>Manufacture of professional and scientific, measuring and controlling equipment not elsewhere classified, and of photographic and optical goods

## 2.4 Data

In the first step we use manufacturing plant level data from the ENIA Survey provided by the Chilean institute of statistics INE (Instituto Nacional de Estadísticas). This survey is a manufacturing census of Chilean plants with more than 10 employees. Our data covers the period 1979-2000 and contains information concerning mainly added value, materials, labor, investment and exports (only available from 1990). The ENIA survey has been used in previous studies such as Pavcnik (2002), Liu and Tybout (1996), Levinsohn and Petrin (2003) and Bergoeing, Hernando and Repetto (2006) for different sample periods. We used several specific deflators (at three digit Isic-Rev2 and year base 1992) for added value, exports, materials and investment. Capital series were constructed using the methodology developed by Bergoeing, Hernando and Repetto (2006). Table 5.2 (Appendix 1) shows general descriptive statistics of the sample.

In the second step we use data from "Trade and Production Database" constructed by CEPII using mainly data of the World Bank. In this compilation, production variables are completed with the UNIDO and the OECD STAN databases, and trade variables with the international trade database (BACI) available from CEPII. This database is provided at the ISIC rev2 3-digit industry level over the period 1976-1999 for 67 developing and developed countries. For distance variables, contiguity and common language, we also used the CEPII database of internal and external distances. Distances variables between two countries are measured based on bilateral distance between cities weighted by the share of the city in the overall country's population. Finally, price indexes stem from Penn World Table as price level of GDP expressed relative to United States. Following Fontagne, Mayer and Zignago (2005), we use aggregate price indexes instead of industrial wages or (the unavailable) prices at industry level to reduce potential endogeneity problems.<sup>6</sup>

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<sup>6</sup>There is an endogeneity issue that arise using price indexes in the estimation of border effects. Trade flows are determined by relative prices which are also a function of border barriers and consequently, they also depend on trade flows. Fontagne, Mayer and Zignago (2006) estimate border effects at industry level and they address this issue using aggregate price indexes, which are less likely to be correlated to industry level changes in expected profits than industry prices

## 3 Results

### 3.1 Results step 1: T.F.P. estimations

In this step we estimate the equation (1) a Cobb Douglas production function at 2 ISIC industry level using OLS, Fixed Effects and LP strategy. Table 3.1. shows the results. As expected, LP estimates of unskilled labor elasticities are generally the lowest and those of capital elasticities the highest, meaning that the biases induced by the higher responsiveness of the labor input respect to capital are addressed. Considering LP estimates, in five industries<sup>7</sup>, among them the main exporters, we can not reject at 5% the null hypothesis of constant returns to scale in the Wald test. On the other hand, industries presenting increasing returns to scale are mainly importers. For these industries the size of the market may affect positively their productivity.

After estimating production function coefficients we calculate TFP as a residual measure. In Graph 3.1 the evolution of different measures of plant's productivity is presented: fixed effects (TFP\_fe), LP (TFP\_lp), OLS (TFP\_ols) and the sample mean of valued added over labor (lnproductivity)

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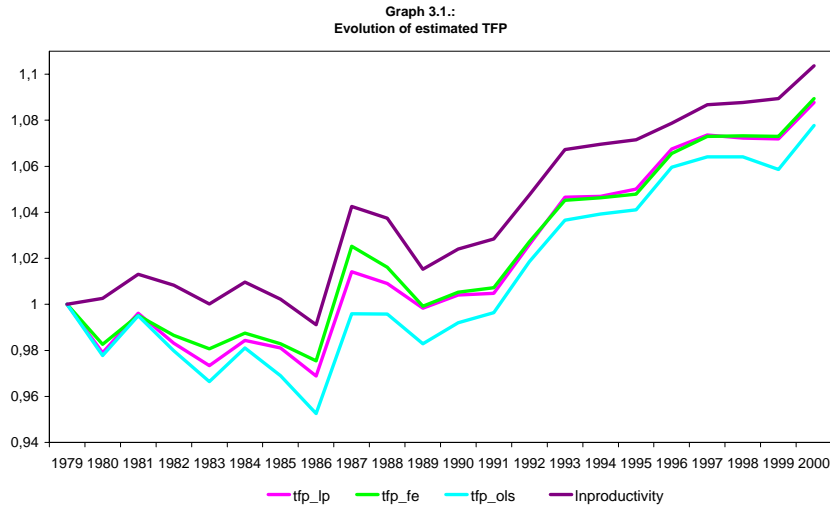
<sup>7</sup>Food (31), wood (33), non metallic minerals (36) and basic metals (37) and other (39)

Table 3.1.: Estimates of Production Function

Industry	Factors	OLS		FIXED EFFECTS		L.P. Semiparametric	
		Coef <sup>[1]</sup>	S.E.	Coef <sup>[2]</sup>	S.E.	Coef <sup>[3]</sup>	S.E.
Food and Beverage	U	<b>0,815</b>	0,010	<b>0,627</b>	0,012	<b>0,570</b>	0,024
	S	<b>0,359</b>	0,009	<b>0,159</b>	0,008	<b>0,212</b>	0,015
	K	<b>0,250</b>	0,005	<b>0,083</b>	0,007	<b>0,208</b>	0,046
	N	<b>18559</b>					
Textil	U	<b>0,833</b>	0,011	<b>0,777</b>	0,014	<b>0,710</b>	0,024
	S	<b>0,202</b>	0,010	<b>0,165</b>	0,009	<b>0,174</b>	0,018
	K	<b>0,206</b>	0,005	<b>0,102</b>	0,008	<b>0,249</b>	0,034
	N	<b>11063</b>					
Wood	U	<b>0,865</b>	0,017	<b>0,849</b>	0,021	<b>0,681</b>	0,034
	S	<b>0,208</b>	0,015	<b>0,095</b>	0,014	<b>0,131</b>	0,021
	K	<b>0,209</b>	0,009	<b>0,104</b>	0,013	<b>0,275</b>	0,040
	N	<b>5711</b>					
Paper	U	<b>0,763</b>	0,018	<b>0,539</b>	0,024	<b>0,692</b>	0,044
	S	<b>0,252</b>	0,014	<b>0,175</b>	0,015	<b>0,207</b>	0,025
	K	<b>0,229</b>	0,010	<b>0,182</b>	0,014	<b>0,299</b>	0,055
	N	<b>3175</b>					
Chemicals	U	<b>0,604</b>	0,016	<b>0,639</b>	0,017	<b>0,528</b>	0,045
	S	<b>0,337</b>	0,015	<b>0,168</b>	0,013	<b>0,266</b>	0,028
	K	<b>0,294</b>	0,008	<b>0,149</b>	0,011	<b>0,354</b>	0,057
	N	<b>6588</b>					
Non metallic products	U	<b>0,780</b>	0,028	<b>0,797</b>	0,031	<b>0,577</b>	0,074
	S	<b>0,241</b>	0,026	<b>0,130</b>	0,025	<b>0,103</b>	0,049
	K	<b>0,244</b>	0,013	<b>0,136</b>	0,018	<b>0,281</b>	0,074
	N	<b>2153</b>					
Basic Metals	U	<b>0,280</b>	0,070	<b>0,346</b>	0,061	<b>0,217</b>	0,104
	S	<b>0,485</b>	0,063	<b>0,161</b>	0,045	<b>0,263</b>	0,094
	K	<b>0,412</b>	0,042	<b>0,059</b>	0,049	<b>0,290</b>	0,189
	N	<b>640</b>					
Machinery	U	<b>0,897</b>	0,012	<b>0,766</b>	0,015	<b>0,767</b>	0,033
	S	<b>0,242</b>	0,011	<b>0,204</b>	0,011	<b>0,178</b>	0,022
	K	<b>0,164</b>	0,006	<b>0,111</b>	0,010	<b>0,236</b>	0,058
	N	<b>8524</b>					
Other	U	<b>0,880</b>	0,054	<b>0,669</b>	0,063	<b>0,671</b>	0,114
	S	<b>0,214</b>	0,042	<b>0,214</b>	0,046	<b>0,160</b>	0,081
	K	<b>0,093</b>	0,022	<b>0,180</b>	0,032	<b>0,277</b>	0,082
	N	<b>647</b>					

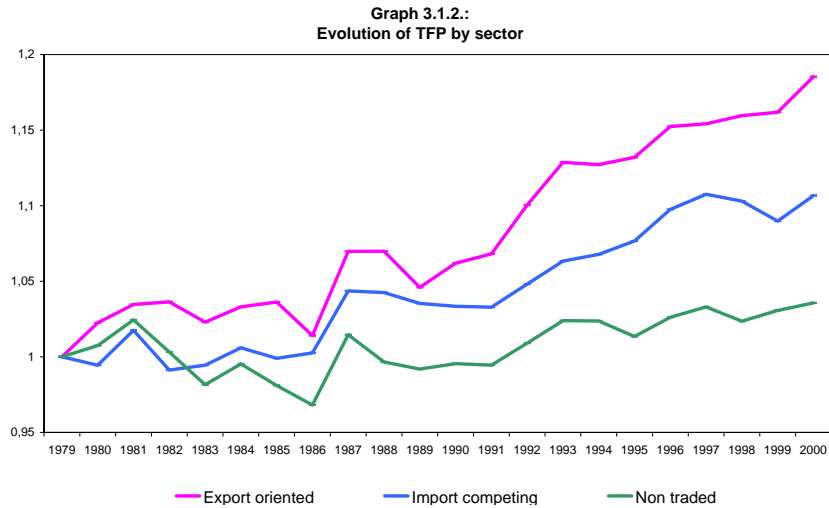
Note: U: unskilled labor, S: skilled labor, K: Capital and N: Observations





As a first robustness check of our performance measures, the graph shows that labor productivity and all TFP measures depict similar evolutions. Although the elasticities estimated by fixed effects and LP show some differences, the TFP path illustrated by both measures is very similar. Even if fixed effects TFP may overestimate capital coefficient and underestimate labor coefficient, after computing all factors contribution the evolution of the residual is not drastically affected.

Graph 3.1.2. shows the evolution of TFP (LP) by sector classified by trade orientation. Plants in export oriented sectors are in average more productive than those in import competing sectors. The productivity of non traded plants slows down during the eighties and it slightly recovers during the nineties but it is always behind the TFP of traded sectors.



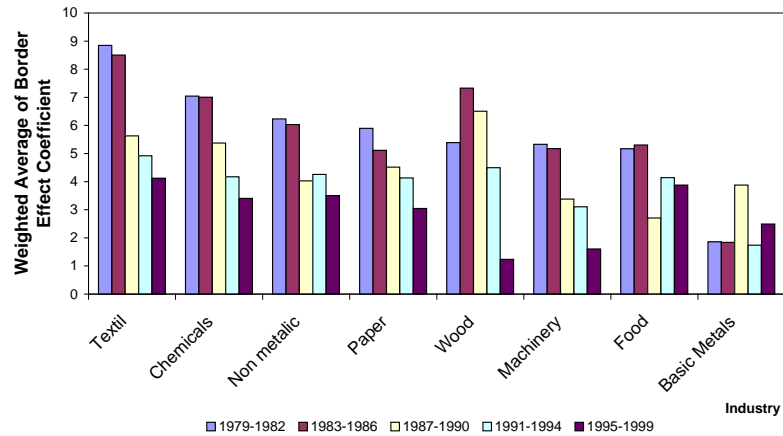
## 3.2 Results step 2: Estimations of Border Effects

In the second step we construct our measure of market access by estimating equation 2 to obtain border effects for five periods at two digit industry level. Graphs 3.2.1 and 3.2.2 show the evolution of the weighted average of border effects between Chile and the United States, Latin American countries and the European Union (weighted by the share of trade flows of each trade partner). All coefficients of border effects are significant at least at 10%. Graph 3.2.1 shows the evolution of export border effects measuring the difficulties for Chilean's exporters to access foreign market. Export barriers were almost constant during the first half of eighties and even in some industries like woods they increased during this period. Reflecting asymmetries between import and export policies, export difficulties have considerably diminished in all industries during nineties (except for food industry) even if tariffs were already very low.

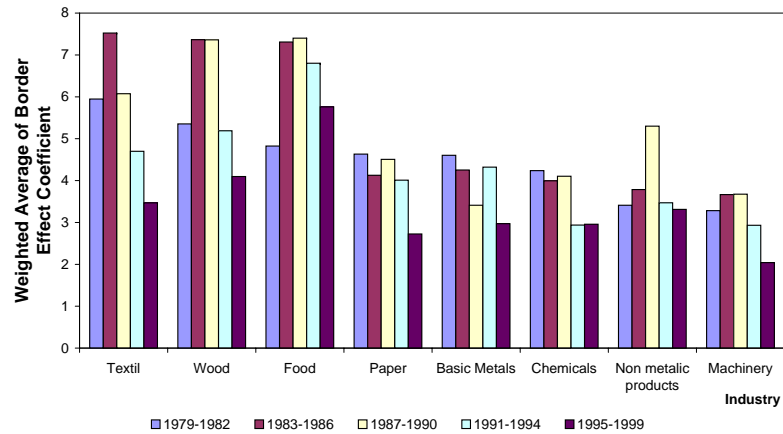
Graph 3.2.2 shows the evolution of the weighted average of import border effect measuring barriers faced by UE, LA and USA to access Chilean markets. In this case, in many industries the market access difficulties increased during the first half of eighties, which seems very consistent with the raise in import tariffs during this period. From 1987 to the end of nineties import

border effects have been drastically reduced in almost all industries with the exception of basic metals, a traditional exporter industry.

**Graph 3.2.1:**  
**Estimation of Market access of Chilean's exporters**  
 (weighted average of its main trading partners: UE, LA and USA)



**Graph 3.2.2:**  
**Estimation of the weighted market acces of**  
 UE, LA and USA to Chile



### 3.3 Results step 3: The impact of Trade Liberalization on TFP

The final step consists in identifying the influence of specific trade reforms on the evolution of plant's productivity. Equation (3) disentangles the variation in productivity due to changes in trade policy depending on trade orientation. We are interested in the coefficient vector  $\delta$ , concerning the interactions between the indicator of a plant's trade orientation and the measure of trade policy. These coefficients show the productivity differential for plants belonging to traded sectors relative to those belonging to non traded sectors, which is explained by the effect of trade policy.

In order to give baseline estimation, we first run the regressions in fixed effects using year dummy indicators as a measure of trade liberalization and we obtain similar results to Pavcnik (2002). Once controlling for exit and plant's specific characteristics, trade liberalization (if captured by year dummies) has a positive impact on productivity of traded sectors (export oriented and import competing) relative to non traded ones (see Appendix 2).

Now we use the weighted measures of border effects for each industry estimated in step 2 to analyse the impact of the outcome of export and import trade policies on plant's TFP. We check robustness of our results using as dependant variable TFP measured by fixed effects (Table 2) and LP (table 3) estimations. Once we use year and industry indicators to control for industry specific effects and macro economic shocks, the coefficients of the rest of variables will only capture the effects of within industry productivity variation. We also use Huber-White estimator of variance to correct standard errors.

In the first column (table 2 and table 3) we run the regression without controlling for exit, entry indicators and domestic competition. Giving our framework we interpret the coefficients of interactions relative to non traded sector, the omitted category. The export border effect in the two interactions terms (with the export oriented and the import competing dummies) presents a negative and significant coefficient. This suggests a positive impact of a reduction of export barriers on plant's productivity in both export oriented and import competing sectors. The regression aims at capturing within plant productivity improvements as a consequence of trade policies rather than aggregate productivity improvements coming from reallocation and firm renewal. In that sense what we observe may be related to externalities captured after exporting such as learning by exporting and knowledge spillovers coming from international markets (Aw, Chung, Roberts, 1999).

Regarding the called "import competing sectors", this positive effect of the reduction of export barriers can be driven by exporters inside these sectors. It is well documented in firm heterogeneity literature that even in narrow defined industries exporters and importers compete with some degree of differentiation. The reduction of export costs will allow new firms start exporting. Bergoeing, Micco and Repetto (2005) show that there were many plants that started exporting during the nineties in Chilean industries having a small aggregate export share.

Concerning the impact of import barriers, the results depend on the sector. We find evidence of a negative effect of a reduction of import barriers on productivity of plants belonging to import competing sectors (the interaction between import border effect and import competing sector). Therefore, increasing foreign competition will dampen the productivity of plants in these sectors. As suggested by Bergoeing, Hernando and Repetto (2006) this fact may be related to increasing returns. We observed in the estimates of production functions that import competing industries present in general increasing returns to scale. Foreign competition reduces the market shares of domestic firms shrinking the opportunities to exploit economies of scales.

On the other hand, the reduction of the difficulties of foreign exporters to access the Chilean market (the reduction of import barriers) has a positive impact on productivity in export oriented sectors (the interaction between import border effect and export oriented sector). A better access to new technologies and to high quality inputs may explain this within plant productivity improvement. In the case of import competing sectors, the negative effect of market size may be negative enough to counteract this positive outcome.

Once we control for exit (column 2), entry (column 3) and domestic competition using a Herfindahl indicator of market concentration (column 4) the results remain almost unchanged. As expected, the exit indicator has a negative coefficient meaning that exiting firms are less productive than those that decide to stay in the market. Exiting plants are on average 17% less productive than surviving plants. The coefficient of the entry indicator is also negative indicating that new firms are roughly 5% less productive than incumbents. The coefficient of domestic competition is negative (though less significant), implying that a reduction of market concentration will enhance productivity. Finally note that the coefficients of both border effects (without interaction) are positive and significant, meaning that the improvement of market access in both sides may have negative effects on productivity in non traded sectors (put zeros in import competing and export oriented dummies). This may be explained by general equilibrium effects that should be

studied in more detail <sup>8</sup>. By the moment we will concentrate on relative effects.

We also check robustness of these results using a moving average of border effects to take into account the possible "lagged" impact of trade reform on plant's productivity. It might be the case that plants do not react instantaneously to changes in trade policies. To control for this issue, we construct a moving average of four years of each border effect at industry level. For example, the border effect of the year 1982 is an average of border effects from 1979 to 1982. Therefore, in the regression of TFP on border effects we lose the three first years (1979,1980 and 1981). The last column reports the results of this estimation. In the case of the TFP measured by fixed effects (table 2) the coefficients of all interactions between border effects and sector trade orientation remain significant and with the same sign but they have a lower value. Nevertheless, when we used the TFP estimated by LP strategy (table3), the coefficients of the interaction between import barriers and import competing sector is non significant. In this last specification, all other coefficients remain significant and with the same sign.

To sum up, we find robust evidence that traded sectors increase their productivity, relative to non traded sectors, as a consequence of export oriented policies. In the case of import oriented policies the effects on productivity depends on sectors. While export oriented sectors improve their productivity, probably thanks to the increase in the foreign demand and the easier access to imported inputs and technology, domestic plants competing with imports may suffer from this foreign competition.

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<sup>8</sup>One possible mechanism may be the increase in the cost of the (mobile) labor factor as a consequence of the increasing foreign demand. This may induce imperfect substitution in consumption towards foreign exporter. This will reduce the size of local firms and avoid the exploitation of economies of scales.

Table 1: The impact of TL on productivity: TFP\_FE

<i>Model</i>	[FE (1)]	[FE (2)]	[FE (3)]	[FE (4)]	[FE (5)]
Export	1.295*** (0.351)	1.310*** (0.347)	1.307*** (0.345)	1.160*** (0.348)	0.878** (0.435)
Import	0.827*** (0.319)	0.842*** (0.314)	0.833*** (0.312)	0.722** (0.314)	-2.154*** (0.462)
Export*BE_X	-0.023*** (0.006)	-0.022*** (0.006)	-0.021*** (0.006)	-0.021*** (0.006)	-0.012* (0.007)
Import*BE_X	-0.098*** (0.007)	-0.097*** (0.007)	-0.096*** (0.007)	-0.096*** (0.007)	-0.046*** (0.007)
Export*BE_M	-0.037*** (0.009)	-0.036*** (0.009)	-0.035*** (0.009)	-0.032*** (0.009)	-0.058*** (0.010)
Import*BE_M	0.066*** (0.010)	0.064*** (0.010)	0.064*** (0.010)	0.067*** (0.010)	0.022** (0.011)
BE_X	0.072*** (0.006)	0.072*** (0.006)	0.072*** (0.006)	0.073*** (0.006)	0.076*** (0.007)
BE_M	0.042*** (0.009)	0.043*** (0.009)	0.043*** (0.009)	0.040*** (0.009)	0.038*** (0.010)
Exit_ind	NO	-0.165*** (0.012)	-0.170*** (0.012)	-0.169*** (0.012)	-0.149*** (0.013)
Entry_ind	NO	NO	-0.055*** (0.014)	-0.055*** (0.014)	-0.067*** (0.015)
ind_comp	NO	NO	NO	-0.247*** (0.090)	-0.187* (0.100)
ISIC 3 Ind	YES	YES	YES	YES	YES
YEAR Ind	YES	YES	YES	YES	YES
Obs	56372	56372	56372	56372	46894
R-sq	0.213	0.221	0.222	0.223	0.253

Note: Huber White Standard errors in parentheses

\* $p < 0.10$ , \*\* $p < 0.05$ , \*\*\* $p < 0.01$

Table 2: The impact of TL on productivity: TFP\_LP

<i>Model</i>	[FE (1)]	[FE (2)]	[FE (3)]	[FE (4)]	[FE (5)]
Export	2.168*** (0.366)	2.182*** (0.363)	2.179*** (0.361)	2.056*** (0.366)	-0.012 (0.415)
Import	1.524*** (0.337)	1.538*** (0.334)	1.530*** (0.331)	1.437*** (0.334)	-1.789*** (0.441)
Export*BE_X	-0.030*** (0.007)	-0.029*** (0.007)	-0.028*** (0.007)	-0.028*** (0.007)	-0.016** (0.007)
Import*BE_X	-0.103*** (0.007)	-0.102*** (0.007)	-0.102*** (0.007)	-0.103*** (0.007)	-0.046*** (0.008)
Export*BE_M	-0.037*** (0.009)	-0.036*** (0.009)	-0.036*** (0.009)	-0.033*** (0.009)	-0.067*** (0.010)
Import*BE_M	0.063*** (0.011)	0.061*** (0.011)	0.061*** (0.011)	0.063*** (0.011)	0.010 (0.012)
BE_X	0.085*** (0.007)	0.084*** (0.006)	0.084*** (0.006)	0.085*** (0.006)	0.085*** (0.007)
BE_M	0.042*** (0.009)	0.042*** (0.009)	0.042*** (0.009)	0.039*** (0.009)	0.045*** (0.010)
Exit_ind	NO	-0.156*** (0.012)	-0.161*** (0.012)	-0.160*** (0.012)	-0.139*** (0.013)
Entry_ind	NO	NO	-0.050*** (0.015)	-0.050*** (0.015)	-0.064*** (0.016)
ind_comp	NO	NO	NO	-0.239** (0.094)	-0.097 (0.103)
ISIC 3 Ind	YES	YES	YES	YES	YES
YEAR Ind	YES	YES	YES	YES	YES
Number of Obs	56372	56372	56372	56372	46894
R-sq	0.243	0.243	0.250	0.250	0.253

Note: Huber White Standard errors in parentheses

\* $p < 0.10$ , \*\* $p < 0.05$ , \*\*\* $p < 0.01$



As we mentioned, there is a potential endogeneity problem if we want to measure the impact of border effects on plant's productivity because border effects may depend on productivity. We already addressed this issue in the previous section when we estimated the border effects controlling by relative wages and productivity measures. Therefore, we expect that our estimates of border effects are free of the impact of industry productivity. Furthermore, we use border effects estimates at 2 digit industry level, while the dummy of industry trade orientation is defined at 3 digits. As an additional check we run quantile regressions (Koenker and Hallock, 2001). The idea is to estimate models for conditional quantile functions, that is, quantiles of the conditional distribution of TFP expressed as functions of the observed covariates. This allows asking whether the conditional fit of the mean is also representative for the median or other conditional quantiles. In that sense, if the weight of the border effect in the regression is driven by the most productive firms, this disparity should be reflected at different quantiles. Table 4 compares the coefficients in the estimation at the 25, 50 and 75 quantiles with the fixed effect estimation (around the mean) and shows that the magnitude, the significance and the sign of coefficients among the different fits do not change our conclusions.

Table 3: **Quantile Regression**

<i>Model</i>	[q25]	[q50]	[q75]	[Mean]
Export*BE_X	-0.027*** (0.008)	-0.031*** (0.006)	-0.025*** (0.007)	-0.028*** (0.007)
Import*BE_X	-0.089*** (0.008)	-0.095*** (0.006)	-0.097*** (0.008)	-0.103*** (0.007)
Export*BE_M	-0.043*** (0.011)	-0.041*** (0.009)	-0.030*** (0.010)	-0.033*** (0.009)
Import*BE_M	0.046*** (0.011)	0.056*** (0.009)	0.059*** (0.012)	0.063*** (0.011)
Controls	YES	YES	YES	YES
Export				
Import				
Exit_indicator				
Entry_indicator				
ind_comp				

Note: Huber White Standard errors in parentheses

\* $p < 0.10$ , \*\* $p < 0.05$ , \*\*\* $p < 0.01$

Another strategy would be to instrument the border effect with policy variables such as tariffs in order to keep only the (exogenous) information of trade policies. However, at the industry level we do not have too much variance for imports and for exports the data is only available from 1996 in the CEPII compilation. Moreover, as exposed above, the fact that trade policies have gone far beyond tariffs reduction arise the question about the potential missing information in this instrument.

## 4 Conclusions

This study addresses the effect of import and export oriented policies on the evolution of plant's productivity using Chilean data of manufacturing plants. To measure plant's TFP we estimate the production function of each two digit industry using a semiparametric methodology that takes into account the heterogeneity of productivity among firms. The main contribution of the paper is to construct an accurate measure of the outcome of trade liberalization at the industry level to disentangle the impact of the reduction of export and import barriers on plant productivity.

The incorporation of a more detailed measure of trade liberalization introduces two new results. First, the reduction of export barriers improves productivity of plants belonging to both export oriented and import competing sectors, relative to non traded sectors. As the export costs fall, more firms are able to export increasing their size and probably benefiting from knowledge spillovers arising from the foreign market.

Second, the reduction of import barriers shows a positive impact on the evolution of plant's productivity of export oriented sectors relative to non traded. However, this is not the case for plants competing with foreign exporters. It seems that the reduction of import barriers might hurt the benefits from increasing returns since it reduces the domestic share of local firms. This has consequence on policy implications. Trade policy should by rather focused on export oriented measures such as reinforcement of bilateral or multilateral trade agreements and reducing the fixed export costs of adapting the product to the new market.

To our point of view, further research should be oriented in two directions. Firstly, the possible endogeneity issue mentioned in the previous paragraphs

should be completely tackled by means of good instruments for border effects such as policy indicators at the industry level for exporter and importers over the full sample period. Secondly, theoretical and empirical efforts should be focused on general equilibrium effects by which the consequences of specific oriented policies are transmitted to the rest of the economy.

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