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by

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**ABSTRACT -** This paper explores the effects of import competition on the manufacturing sector in Chile following the implementation of the country's two largest Free Trade Agreements (FTA) (with the USA and China). Exploiting cross-industry variation in import exposure, we analyse the effects on manufacturing sales, employment and labour productivity at the finest level of industrial classification (4 digit ISIC level). We detect an overall negative effect of increased Chinese import penetration, owing to substitution effects from low and medium tech imports and a less pronounced effect from USA imports. By introducing interaction effects, we find that the levels of foreign ownership and the export intensity of the domestic industries reverse the negative effect due to the opportunities offered via participation in global value chains. An IV strategy is applied to address standard endogeneity concerns and confirm the robustness of our estimates.

**JEL Codes:** F13, F14, F16

**Keywords**: import penetration, free trade, manufacturing, Chile, China, USA.

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## 1. Introduction

The global trade landscape has undergone significant transformations of recent, owing to the proliferation of free trade agreements (FTA) that accelerate economic integration processes across continents. The trade policy reforms in Latin America, China's WTO (World Trade Organization) accession in the early 2000s, and the rapid expansion of shipping, have invigorated trade flows (Rosales and Kuwayama, 2012).

Intensified competition is expected to alter the dynamics for incumbent industries and raises concerns regarding the long-term performance of domestic manufacturing sectors (Autor et al., 2013). The economic impacts from free trade, which have been hotly debated for decades, are receiving revived attention in the literature, due to the emergence of mega regional trade deals such as the TPP (Trans-Pacific Partnership), TTIP (Trans-Atlantic Trade and Investment Partnership), TiSA (Trade in Services Agreement) and the new strategic bilateral FTAs worldwide (i.e., EU-Japan FTA signed in 2019). These trade agreements often span several continents and jointly account for over 80% of global trade (WTO data). The expansion of trade relations between economic superpowers, such as China and the United States (USA), with smaller countries, such as Chile, offers a new avenue for the empirical investigation into the incumbent industry responses to increased trade exposure.

Chile is an interesting case for examining import penetration dynamics, as it is considered one of the most outward-looking economies in the world. It signed 26 FTAs with over 60 countries globally and is regarded as the most integrated country in Latin America (ECLAC, 2018). But in Chile discontent with the consequences of free trade has been brewing for some time, as seen in recent outbreaks of violence in the streets of the country. The analysis of the dynamic effects of trade in Chile serves also as a showcase for other Latin American countries embarking on similar policies. The vast majority of the existing research has focused predominantly on the effects of import competition in advanced economies such as USA, Belgium, Canada and other EU countries (Autor et al., 2013, Mion and Zhu, 2013). A much smaller fraction is devoted to developing[1] countries. The scarcity of evidence in the Latin American context reveals that import competition concerns are receiving a heavier political weight in the developed world compared to lower income countries at a time when trade in emerging countries is rapidly altering the dynamics for the domestic industry.

We aim to fill this empirical and conceptual gap by investigating the impact of trade in Chile following the two most important FTAs for the country in terms of market share and trade volumes: that with China and with the USA. Most existing studies on the Chilean experience cover the period up to 2000 (Pavcnik, 2002; Álvarez and Claro, 2009), before the large wave of imports attributed to the FTAs took place. The FTA between Chile and China entered into force in October 2006 and extended zero duty treatment phase by phase covering 97% of products (Export.gov. 2019). Chile imports relies heavily on manufactures from China and exports products of the extractive industry, especially mining (Edwards and Jenkins, 2015). The USA has also actively engaged in free trade with Chile. The United States-Chile FTA entered into force in 2004 and eliminated tariffs and reduced barriers for trade in services reaching a 100% duty-free entry of US exports.[2] This led to a significant rise of imports from the US (Office of the US Trade representative, 2016).

This study intends to detect the heterogeneous effects of import penetration from China and the USA, two countries at different stages of development, on domestic manufacturing in Chile. By examining the period following the substantial increases in trade, the analysis uses cross-industry variation in import volumes to detect the effects on domestic sales, employment and labour productivity. The focus on manufacturing is perceived in empirical studies (i.e., Autor et al., 2013; Bernard et al., 2006; Mion and Zhu, 2013) as the diffusion channel of the trade integration dynamics to the real economy.

Moreover, changes in the manufacturing sector entail strong employment effects and frequent changes in the location of economic activity because of the 'tradable character of its products and the multiple linkages it retains with the other sectors of production' (Petrakos et al., 2012: 347).

The key contributions of this paper are threefold: first the simultaneous integration of an emerging economy with two very different economic superpowers has not been studied before for Chile. Second, this is the first paper to analyse the conditional effects of two different types of trade at the finest industrial disaggregation level in order to detect and reveal the heterogeneity across industries with an emphasis on the different role played by the type of trade exposure and trade integration. Thirdly, we use a new dataset on firm performance (which we aggregate at the 4-digit industry level to build a panel dataset) that covers the critical period after the implementation of the two most important FTAs that the country has signed.

The remainder of the paper is structured as follows: the second section presents the theoretical underpinnings and the existing empirical evidence on import competition, as well as descriptive evidence from Chile. The third section provides an analysis of the data and the methodology. The fourth section is devoted to the empirical results followed by robustness checks. The last section concludes and offers a summary of the findings along with related policy implications.

## 2. Theoretical and conceptual framework

### *2.1. Skills and comparative advantage*

The theoretical foundations of our empirical analysis touch upon both standard international trade theories and the new trade theory (NTT). The factor proportion framework (Heckscher–Ohlin model), partly explains our analysis as it is based on the comparative advantage principle. The key implication of the model is, first, that the set of industries produced by a country is a function of its relative endowments. In an open world trading system, relatively capital- and skill-abundant countries, like the USA, are expected to manufacture a more capital- and skill-intensive mix of products than relatively labour abundant countries, like China. However, in the case of China there is increasing evidence that, although still considered a labour abundant country, it no longer specializes solely in labour-intensive products but has moved up the value chain ladder,[3] exporting more capital-intensive products (Rodrik, 2006). This has led to a growing competition between China and the USA within the Chilean market. Chinese export prices are generally lower relative to countries with similar income per capita accentuating the impact on sectors producing close substitutes to Chinese products (Rodrik, 2006; Moreira, 2007). This competition will be more intensely felt in specific lower or medium tech sectors and labour intensive sectors. The intense pressure from Chinese competition is also demonstrated theoretically by Moreira (2017). In terms of endowments, with a population of 1.3 billion and a 640 million labour force, China has a massive comparative advantage in the production and export of labour-intensive goods. China's wages also still remain below Latin American country levels —Latin American and Chilean wages were, on average, five times higher than China's and the time of the signing of the FTA (Moreira, 2007). This translates into cost and price advantages for China when trading with Chile. Imports in Chile from China rose by 800% following the bilateral FTA in 2004 (UN Comtrade data).

The second line of reasoning is grounded on Ricardo's explanation of the productivity/technology link. The productivity differences between China and LAC (Latin America and the Caribbean) countries are lower than existing wage differences, while labour productivity in China has grown much faster than in LAC. With an average annual growth of 2% TFP, Chile remains Latin America's best performer in terms of productivity. However, Chile's growth is dwarfed by China's estimates of 3.4% productivity growth, leading to a considerable divergence in TFP (Total Factor Productivity) trends between the two trade partners. The strong differences in productivity intensify the import competition effect.

Another theoretical block, which explains the surge of trade with China, is scale. With the largest world population and an economy of more than 14 trillion US$, labour supply and production costs between China and Chile are expected to diverge. China's sheer scale provides a significant advantage in capital and technology-intensive industries, which is evident by the surge of Chinese exports in low and medium technology goods. Finally, the Chinese government's intervention[2] to promote industrialization and exports has been decisive, at a time when, as Moreira (2007) stresses, LAC countries "were busy dismantling the interventionist apparatus of the import substitution (ISI) era" (Moreira, 2007: 364). The above reasons, that touch upon the respective theoretical frameworks, are potential explanations of the growing concerns regarding the challenge posed by Chinese trade for Chile's incumbent manufacturing industry.

### *2.2. Effects from trade*

Import competition has two potential effects. On the one hand, increased trade can lead to increases in aggregate productivity that stem from lower productivity firms exiting the market and, to technology diffusion effects that increase domestic industrial competitiveness. On the other hand, it can result in a contraction of domestic manufacturing output, manufacturing employment, wage differentials across sectors, and firm shrinkage or closure (Artuç et al. 2015).

The import competition literature stresses two major channels explaining how exposure to imports affects the incumbent industry-level outcomes, including output, employment and productivity. Increased competition can lead to adjustments across several dimensions. Within firms, reshuffling of resources and changes in product mix are found to adjust in response to increasing competition (Pavcnik, 2002; Bernard 2006). Within industries, firms exit the market, follow defensive mergers and acquisitions strategies or promote product upgrading, as a consequence of intensified competition. This leads to higher industry-wide productivity. Across industries, shifts according to countries' comparative advantage are also detected with firms moving away from comparative disadvantage activities and towards comparative advantage industries (e.g., Bernard et al., 2006).

Two strands focusing on these great effects have emerged: one which focuses on the industry or firm level outcomes (sales, employment and productivity) and the second on the local labour markets effects (skill composition and wage structure). Our analysis is in line with the former strand, as we assess output responses proxied by sales, labour productivity and employment change.

Threats pertaining to employment losses, the contraction of manufacturing output, plant closure, plant decline and downward pressure on wages are among the principal effects of drastic import competition pressures, as identified in the literature (Topalova, 2007; Autor et al. 2013; Artuç et al. 2015, Álvarez and Claro, 2009; Bernard et al., 2006; Costa et al., 2016).

***Negative effects from trade***

Trade can bring about considerable negative effects for countries. Mion and Zhu (2013), for example, find that import competition from China reduced firm employment growth and wages for unskilled workers in Belgium. Similarly, exposure to Chinese import competition in the US was found to adversely affect manufacturing employment, triggered a decline in wages, and decreased household income between 1990 and 2007 (Autor et al., 2013). Evidence of these mechanisms at work bred the perception that free trade can crowd out domestic industries and put a downward pressure on wages and employment growth. In line with these results, import penetration from low wage economies in the USA, negatively affected employment growth but the effect was found to be lower for capital-intensive industries (Bernard et al., 2006).

In the more specific context of emerging economies, the impact of Chinese trade on manufacturing production and employment in South Africa decreased as a result of import penetration from China and caused manufacturing output to be 5% lower in 2010 than it otherwise would have been (Edward and Jenkins, 2015). Along the same lines of research, in a multi-country study on the impact of import competition on local labour markets, Costa et al. (2016) concluded that import-competing sectors experienced lower wages and employment losses, while low-paid workers saw a disproportionate reduction in wages. Territorial inequalities also increased as a consequence of openness to trade (Rodríguez-Pose, 2012; Ezcurra and Rodríguez-Pose, 2014). In the same vein, a multi-country comparative analysis showed that labour-intensive manufacturing was lower in 33 countries, owing to increased exposure to Chinese imports. The effect was larger in developing economies that produced goods similar to those produced in China (Wood and Mayer, 2011). Import competition from China could, therefore, have led to a decline in employment across Latin America, and, in certain cases, to an increase in informality, with little evidence of significant changes in wages (Moreira and Stein, 2019).

In the particular case of Chile, a number of studies has concluded that import competition induces a positive aggregate productivity effect, product upgrading, and positive effects on wages while, simultaneously, negatively impacting firm survival, employment and productivity growth (Almeida and Fernandes, 2013; Levinsohn, 1999; Pavcnik, 2002; Álvarez and Claro, 2009). Álvarez and Claro (2009) evaluated China's import penetration on manufacturing plants in Chile using annual data for the period 1990-2000. They showed that increases in China's market share, negatively affected employment growth and the probability of survival of manufacturing plants. They found no evidence of output upgrading or of increases in the probability of exporting, meaning that the ability of Chilean firms to elude China's competition has been limited. Low levels of capital and skilled labour in Chile have impeded product upgrading (ibid). Studies on Mexico by Iacovone et al., (2013) have shown that the surge of imports from China challenged Mexican firms and led to plant exit, product exit and sales contraction, especially for larger plants. These results are partly in line with the findings by Utar and Ruiz (2013), who also found a negative effect of Chinese import competition on employment and plant growth in the Mexican maquiladoras, especially for unskilled labour-intensive sectors, while simultaneously contributing to industrial upgrading among maquiladoras in response to competition with China.

***Positive or mixed effects from trade***

On the more positive side, import competition from China may have led to skill upgrading in low-tech manufacturing industries in Belgium and to an increase in the demand of non-production workers in low-tech manufacturing sectors (Mion and Zhu, 2013). Further positive effects from Chinese import penetration were detected in the form of firms eluding competition by switching industries and by moving towards sectors with less import penetration from low-wage countries. These industries were more capital- and skill-intensive revealing a new margin of adjustment via changes in product mix (Bernard et al., 2006). However, higher productivity was not shown to shield firms from competition pressures unlike skill intensity, which was significant in reducing the negative effect of import competition.

In other cases, it has been found that the import-competing sectors experienced plant productivity improvements (Pavcnik, 2002). This is attributed to the reshuffling of resources and output from less to more efficient producers. As an extension to this research line, evidence on product quality upgrading for Chilean firms, using unit-value increases as a proxy for product upgrading, has revealed a positive effect of import competition on upgrading (Fernández and Paunov, 2013). Further, strong positive impacts of tariff liberalization on plant productivity and productivity gains of manufacturing firms were detected for Colombia (Fernández, 2006).

***Hypotheses***

Putting the positive and negative effects of trading with countries at different levels relative to the technological frontier on a balance, we can propose some hypotheses. The development of global trade linkages in the case of Chile may have contributed to integrate Chilean industry into global production networks (GPNs), contributing to the upgrading of the local production processes by improving cost efficiency and technology transfer. Trade integration can also have transformed industrial structures and created new sources of specialization. In this context, exporting industries and the shares of foreign ownership can play a decisive role in the adjustment process of the manufacturing sector when exposed to high import competition from abroad. However, trade integration with countries that produce goods that are in direct competition with those of local firms —as in the case of China's imports— can lead to substitution effects and to shedding employment without necessarily increasing productivity. This will be less the case when the technological component of imports is different from those of local firms, as in the case of trade with the US. Therefore, three different hypotheses can be tested regarding Chile's trade integration with China and the US:

$H_1$: Increased penetration from low and medium-tech imports from China can lead to a substitution effect on the domestic industry, compared to high skilled imports from USA.

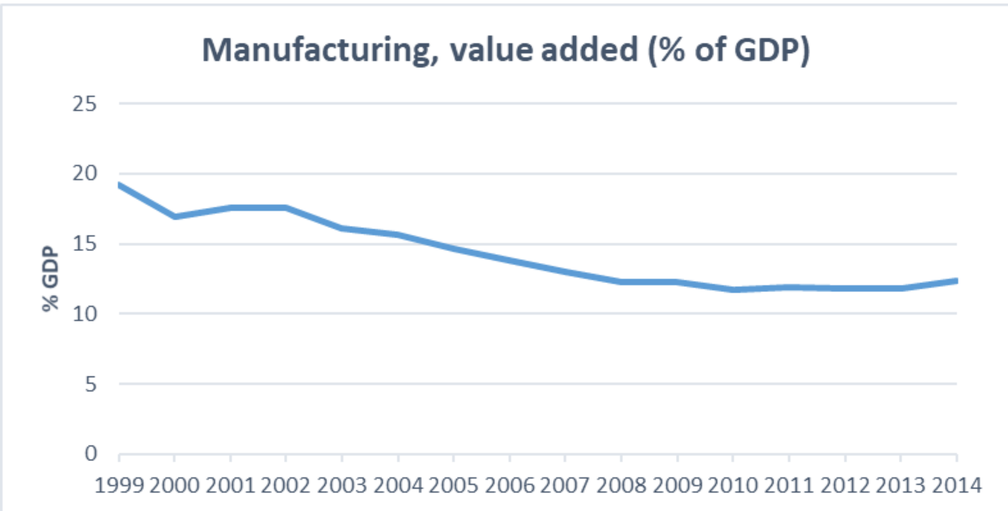
$H_2$: Industries more integrated in global value chains can reap the benefits from increased import exposure.

$H_3$: Industries with higher shares of foreign ownership are able to escape foreign competition and translate increased trade into efficiency gains.

## 3. Basic trade facts in Chile

The temporal evolution of the manufacturing Gross Value Added (GVA) in Chile is presented for the period preceding and following the country's FTAs in Figure 1 below. The share of the manufacturing sector's GVA as a percentage of the GDP declined from almost 20% in 1999 to 12% 2014. The high contraction of manufacturing within the period of analysis incorporates the effects of import penetration before and after the agreements went fully into force, China's WTO accession, and the outbreak of the global financial crisis.

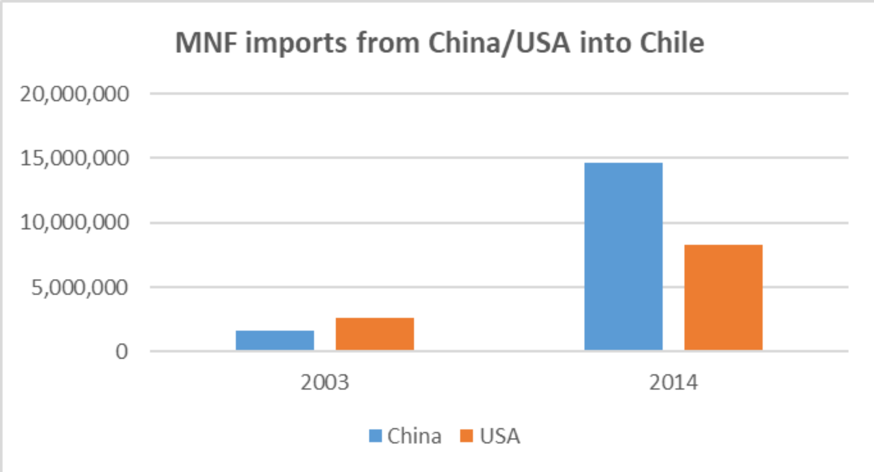
**Figure 1.** Evolution of Manufacturing GVA in Chile (1999-2014)




*Source: Own elaboration using data from World Bank*

Figure 2 offers two snapshots of manufacturing imports from China and the USA into Chile before and after the implementation of the FTAs. The increase in Chinese imports is much higher compared with imports from the USA.

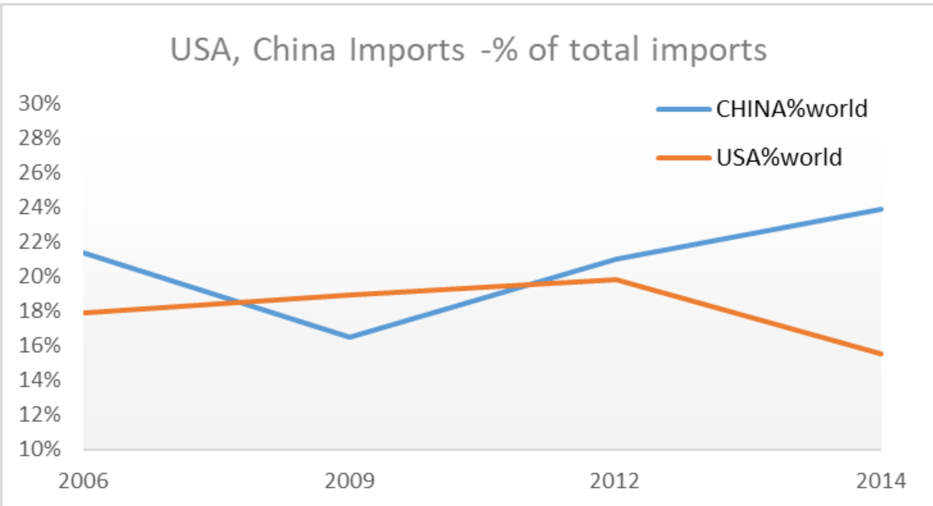
**Figure 1.** Total Manufacturing imports from China, USA into Chile




*Source: Own elaboration using data from UNComtrade. Note: values are in thousands USD (current prices)*

Specifically, the share of Chinese imports increased steadily, surpassing USA's share of imports from 2012-2014 suggesting a direct competition between the two partners within the Chilean market (Figure 3). The differences in the annual growth rate and composition of imports from China and the USA is presented in Appendix 1.

**Figure 2.** Evolution of Chinese and USA imports share




*Source: Own elaboration using data from UNComtrade*

## 5. Methodology and data

### *5.1 Data and sources*

The model to test the impact of Chile's opening to trade on the sales, employment and productivity of its industries is based on extensions of Krugman's New Trade Theory (NTT) proposed by Melitz (2003) introducing firm heterogeneity. The analysis is performed at the industry level, with the aggregation at the finest level possible (4-digit ISIC classification). The analysis is based on a version of the traditional Heckscher-Ohlin model that focuses on industry-level adjustments as a response to changes in market and trade relations.

The dataset combines data from two different sources: the global trade database provided by UN Comtrade and the Annual National Industrial Survey (ENIA) provided by the National Statistical Office of Chile. The main variable of interest is import penetration normalized on apparent consumption. A number of proxies on import penetration have been proposed in the literature. Bloom et al. (2006) use the value of imports originating from China as a share of total world imports, following the 'value share' approach. More customary in the related trade literature is the use of imports normalized on apparent consumption; the latter refers to the denominator of the index and is calculated as domestic production plus imports minus exports (following Bernard et al., 2006; Álvarez and Claro, 2009). The variable captures the sectoral import penetration from China and the USA into Chile (formulas 1 and 2).

$$ImPen\ CHN_{j,t} = \frac{M_{j,t}^{China}}{M_{j,t}^{Total} + Q_{j,t} - X_{j,t}^{Total}} \qquad (1)$$

$$ImPen\ USA_{j,t} = \frac{M_{j,t}^{USA}}{M_{j,t}^{Total} + Q_{j,t} - X_{j,t}^{Total}} \quad (2)$$

The variables are constructed as follows: *ImPen* denotes the import penetration variable; *M* denotes imports; *Q* represents domestic production; *X*, exports; while *j* and *t* correspond to industry and year, respectively. Import penetration captures the share of imports in the four-digit sector from each import partner (China and the USA) divided by the total value of imports in the four-digit sector plus domestic production minus exports in the same sector. Bilateral annual sectoral trade flows are provided by BACI, the world trade database developed by the CEPII at a high level of product disaggregation, using original data from the United Nations Statistical Division (UN COMTRADE database).

Firm-level sectoral data are provided by the Annual National Industrial Survey (ENIA), which is administered by the National Institute of Statistics of Chile (INE). The survey covers the universe of Chilean manufacturing firms with 10 employees and above. Firm-level data are classified according to the International Standard Industrial Classification (ISIC) Rev.3, at the 4-digit level. The firm level variables for sales, employment, fixed assets, exports, and foreign ownership are aggregated at the 4-digit level. The sectoral identifier is used to match domestic sales, employment and all other variables of interest with the values of sectoral imports and exports, which are categorized according to the Harmonized System (HS)[4] 6-digit product disaggregation and converted to ISIC Rev.3 (using the corresponding tables provided by UN Comtrade) to construct an industry-year panel data set. Overall, an unbalanced panel dataset of 110 industry categories is created. Given that some firms enter or exit the market at various points within the study period, their corresponding sectors may have missing values for some of the years of the study period giving rise to a slightly unbalanced panel. However, the percentage of sectors not fully reported for the entire period is less than 10%. Although a similarly constructed dataset has been employed in a previous study for Chile by Álvarez and Claro (2009), the current dataset includes data from ENIA and is, to the best of our knowledge, used for the first time for the analysis of the post-FTA period. Appendix 2, Table A3 contains the description of all variables, their definition, and sources.

### 5.2 Methodology

The econometric specification is based on a standard Cobb-Douglas production function, where output *Y* is proxied by constant sales, while labour (employment) and capital (fixed assets) enter the regression as controls. For the empirical specification relating to manufacturing production performance. We estimate specification of the following form (3):

$$Y_{j,t} = \beta_1 ImPenChina_{j,t} + \beta_2 ImPenUSA_{j,t} + \beta_3 Z_{j,t} + \beta_4 Z_{j,t} * ImPenCH_{j,t} + \beta_5 Z_{j,t} * ImPenUSA_{j,t} + \lambda_t + \lambda_j + \varepsilon_{j,t}$$

where $Y_{j,t}$ refers to the dependent variable —the logarithm of sales, the rate of employment growth (in logs), and the logarithm of labour productivity— in industry *j* in year *t*. *ImPenChina* denotes import penetration from China and *ImPenUSA* is the equivalent for the USA; Z is a vector of industry-specific characteristics that are shown to affect sales and employment growth, such as capital intensity, skill intensity, the export orientation of the industry and foreign investment, proxied by the percentage of foreign ownership. Interactions with the vector Z are included to determine the conditional effect of import penetration. Finally, $\lambda_j$ denotes industry fixed-effects and $\lambda_t$ stands for year fixed-effects. Industry-level fixed-effects are included to control for unobserved time-invariant industry characteristics and year fixed-effects to capture temporal macroeconomic shocks that limit within-industry and within year omitted variable bias, respectively. All monetary values have been converted to constant Chilean pesos, using industry-level deflators provided by the Central Bank of Chile.

In the following section, we analyse the impact of import competition from both China and the USA on three, industry performance measures: aggregate sales, employment growth and labour productivity.

## 6. Results

### *6.1 Domestic Sales*

In Table 1, we report the results from the baseline and the extended models[5] (Columns 1-6). The analysis includes industry and year fixed-effects with robust standard errors (White correction for heteroskedasticity), clustered at the four-digit industry levels to address standard concerns pertaining to the serial correlation in the error term.[6] The parameter estimates of the control variables in all regression models have been tested for potential multicollinearity. The standard tests based on the variance inflation factor (VIF) reject any degree of multicollinearity.

We detect a negative and statistically significant association between import penetration from China and domestic sales at the 1% level in all specifications, suggesting possible crowding out effects from products of a lower cost component combined with production scale effects, which may act as substitutes to domestic production. Chinese imports are significantly lower in cost, making them more competitive than domestic production (Moreira, 2007; Álvarez and Claro, 2009). The results are in line with similar studies that find negative effects of Chinese exports on the manufacturing sector in Latin American countries (e.g., Honduras, Mexico, Haiti) and only positive effects on other sectors, such as agriculture and mining. Manufacturing in Chile is most exposed to trade and, therefore, it faces the biggest threat to its survival (Artuç et al. 2015).

The heterogeneous effects stemming from industry-level characteristics reveal that exporting industries, more skill intensive ones, and those with higher percentages of foreign ownership have been shielded from competition pressures and benefit form trade with China. Our results suggest that more dynamic industries in terms of higher skills, levels of foreign investment, and export intensity are able to both compete and reap benefits from Chinese trade attributed to potential efficiency enhancing effects from cheaper intermediates.

Import penetration from the USA is, by contrast, not statistically significant in all specifications. As competition from the USA is concentrated in higher-tech industries, imports from North American firms represent less of a threat to the domestic manufacturing sector and exhibit a smaller substitution effect. In other words, USA imports do not directly compete with Chilean domestic industries. The USA import exposure does not allow for margins of productivity adjustments, due to the unevenness between domestic production and imported US goods.

The control variables, capital and labour, as well as foreign investment, have the expected positive and significant signs. Industries with higher assets and labour have higher output, while foreign investment is positively related to sales. Industries with a high presence of foreign-owned firms (or firms with high percentages of foreign investment) are more productive, a result in line with the literature stressing the superiority of foreign firms in terms of productive capacities (Fernandes and Paunov, 2012).

Exporting industries in the case of both US and China benefit from trade, which constitutes the only characteristic that shields industries from competition from both trade partners and allows for positive effects in terms of sales growth to materialize (Columns 2 and 4). The analysis confirms the findings of Bernard et al. (2006) for the USA, who stress that more capital-intensive firms manage to escape competitive pressures better.

The higher integration of an industry in global trade (proxied by export intensity) may implicitly capture the impact of participation into global value chains. This assumption is tested by means of an interaction between the import penetration variable and the export orientation of the industry. The interaction term could potentially imply a higher participation in Global Value Chains (GVCs) based on the following reasoning: to the extent that an industry benefits from increased exports as a result of import penetration, then the latter is most likely attributed to backward and forward linkages generated within a value chain in which intermediate imports are factored into exports. However, this is an assumption and not a strictly defined proxy that would measure actual GVC integration. The results show that backward integration has potentially been accelerating in Chile, as indicated by the share of foreign value-added in each sector's exports. To illustrate this with an example, the chemicals and non-metallic minerals sectors foreign value-added accounts for 35% of exports, while foreign value-added in textiles accounts for 32% of exports (OECD, 2015).

Drawing on the results from the extended models, although import penetration has an overall negative and significant effect on domestic sales, the inclusion of the interactions confirms the assumption that the impact of trade is asymmetric across industries. The positive and significant impact of Chinese import penetration in the case of export-oriented industries (columns 2 and 4) is indicative of a dichotomy of import-*using* versus import-*competing* industries with export intensity acting as an efficiency-enhancing channel, in the case of Chinese imports, and a knowledge-diffusion channel, in the case of USA imports. This indicates that "trade is a conduit for disembodied technology diffusion by exporting to knowledgeable buyers who provide them with blueprints and give technical assistance" (Tybout, 2001:77).

To assess the heterogeneous responses of the domestic industry with respect to foreign investment, we test this hypothesis by means of an interaction term between the percentage of foreign investment by industry and the import penetration variable (Table 1). Considering that as much as one third of Chile's backward linkages is attributed to FDI openness,[7] combined with the fact that foreign firms import 18% of their intermediate inputs (OECD, 2015), industries with higher shares of foreign ownership could be more integrated in GVCs. This is confirmed by the positive sign and statistical significance of the interaction term between foreign ownership and Chinese import penetration (Column 2). Import exposure from China benefits foreign owned firms in terms of cost and operating efficiency, due to a higher use of cheaper inputs fuelled by the FTAs. To this end, intensified trade with China, which has also increased trade in intermediate inputs, may disproportionately benefit foreign owned firms within industries due to their higher financial capacities and scale economies (compared to non-foreign firms) (Moreira, 2007). The results provide evidence that industries with higher foreign presence are positively affected by increases in Chinese import penetration, but not by USA imports. In the case of USA imports, foreign firms do not seem to gain in terms of sales growth as the interaction term is not statistically significant (Column 4). This reflects the fact that USA imports refer mainly to final products (not intermediates) and thus do not have a specific efficiency enhancing effect compared to Chinese imports.

The fact that foreign manufacturing firms in Chile are more capital-intensive and generate greater value-added per worker (OECD, 2015), in combination with the fact that using foreign inputs positively affects export performance, confirms our results regarding the positive impact of Chinese penetration for both foreign and export-oriented industries.

The skill ratio does not have a significant effect in reversing the effect of import competition. This could reflect a plethora of factors, such as the way firms self-define their personnel as skilled or may cast doubt as to real quality of skills.

**Table 1.** Import penetration and manufacturing sales.

| **Dep. Var.:** *Domestic Sales* | (1) China | (2) China | (3) USA | (4) USA | (5) Both | (6) Both |
|---|---|---|---|---|---|---|
| *ImPen China* | -1.030*** | -1.427*** | | | -0.992*** | -1.306*** |
| | (0.364) | (0.388) | | | (0.370) | (0.394) |
| *ImPen USA* | | | -0.372 | -1.839*** | -0.276 | -1.615** |
| | | | (0.284) | (0.620) | (0.275) | (0.644) |
| *Log K* | 0.218*** | 0.213*** | 0.228*** | 0.223*** | 0.217*** | 0.206*** |
| | (0.039) | (0.038) | (0.040) | (0.039) | (0.039) | (0.037) |
| *Log L* | 0.568*** | 0.550*** | 0.590*** | 0.559*** | 0.568*** | 0.527*** |
| | (0.090) | (0.086) | (0.090) | (0.086) | (0.090) | 0.527*** |
| *Foreign Inv.* | 0.017* | 0.015 | 0.017* | 0.014* | 0.017* | 0.012* |
| | (0.009) | (0.009) | (0.009) | (0.009) | (0.009) | (0.008) |
| *Export intensity* | -0.084*** | -0.083*** | -0.091*** | -0.086*** | -0.084*** | -0.078*** |
| | (0.009) | (0.010) | (0.015) | (0.015) | (0.009) | (0.009) |
| *Skill ratio* | -0.010 | -0.016 | -0.011 | -0.006 | -0.010 | -0.005 |
| | (0.010) | (0.011) | (0.010) | (0.015) | (0.010) | (0.018) |
| *ImpChina*Exp* | | 4.321*** | | | | 3.795*** |
| | | (0.728) | | | | (0.711) |
| *ImpChina*Skill* | | 0.066** | | | | 0.039 |
| | | (0.034) | | | | (0.035) |
| *ImpChina*Foreign* | | 0.003** | | | | 0.003*** |
| | | (0.001) | | | | (0.001) |
| *ImpUSA*Exp* | | | | 2.827*** | | 2.502*** |
| | | | | (0.830) | | (0.874) |
| *ImpUSA* Skill* | | | | -0.035 | | -0.043 |
| | | | | (0.081) | | (0.079) |
| *ImpUSA* Foreign.* | | | | -0.000 | | -0.001 |
| | | | | (0.001) | | (0.001) |
| Industry FE | YES | YES | YES | YES | YES | YES |
| Year FE | YES | YES | YES | YES | YES | YES |
| Observations | 1321 | 1321 | 1321 | 1321 | 1321 | 1321 |
| $R^2$ | 0.91 | 0.91 | 0.90 | 0.91 | 0.91 | 0.91 |

Notes: A constant is included but not reported; Standard errors are clustered at the four-digit ISIC level; Robust standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1. Dependent variable is the logarithm of Domestic sales in constant prices.

The export orientation of the industries is negative and statistically significant, which may imply that exporting industries in general are not performing well in our treatment period due to competitive pressures and that only the import-using[8] exporting industries are reaping the benefits of increased exposure due to efficiency gains. This result is in line with Kasahara and Lapham (2013), who identify complementarity effects from imports of inputs and export performance in Chilean plants. In this case, complementary effects prevail over substitution, if the latter enhance domestic production and complement, rather than compete with, domestic production activities.

### *6.2 Employment growth*

Another critical margin of adjustment for foreign competition are the responses related to domestic employment losses.

Table 2 reports the results of the impact of import penetration on employment growth. The dependent variable, $\Delta Employment_{t,t+1}$, is the employment change (in logs) between *t* and $t + 1$ of industry *j* in year *t*. Following the literature, we add industry specific characteristics that have been shown to affect employment growth, such as input intensities measured as the ratio of capital per worker, proxying within industry capital deepening (Álvarez and Claro, 2009).

We find that increased import penetration from China (Columns 1, 2 and 5) is negatively associated with employment growth, albeit at a low significance level. Employment is therefore negatively affected by the increase of Chinese import penetration. This could imply that domestic producers in Chile react to increased competition through downsizing. This is in line with similar studies on Chinese import competition for Mexico that find that increases in Chinese imports generate a reduction on the labour demand for Mexican workers (Caamal-Olvera and Rangel-González, 2015).

Two margins of adjustment are in play. First, the negative impact may be attributed to imports, which embody efficiency-enhancing/labour-saving new technologies. As Autor and Dorn (2013) argue, "if the trend towards the automation of routine jobs in manufacturing continues, the application of these new technologies is likely to do much more to boost growth in value added than to expand employment on the factory floor." Second is the downsizing transmission channel, due to substitution effects in import-competing industries, in line with previous studies exploring firm-level data (e.g., Álvarez and

Claro, 2009 for Chile, Acemoglu et al., 2016, and Revenga 1992 for US; Mion and Zhu, 2012 for Belgium).

**Table 2.** Import penetration and employment growth.

| **Dep. Var.:** Δ Log $Employment_{t,t+1}$ | (1) China | (2) China | (3) USA | (4) USA | (5) Both |
|---|---|---|---|---|---|
| *ImPen China* | -0.100** | -0.093* | | | -0.099** |
| | (0.047) | (0.054) | | | (0.047) |
| *ImPen USA* | | | -0.014 | -0.120 | -0.007 |
| | | | (0.025) | (0.081) | (0.024) |
| *Log (K/L)* | -0.012** | -0.008* | -0.012** | -0.009** | -0.012** |
| | (0.005) | (0.005) | (0.005) | (0.004) | (0.005) |
| *Skill ratio* | -0.009*** | -0.009*** | -0.010*** | -0.012** | -0.009*** |
| | (0.003) | (0.003) | (0.003) | (0.005) | (0.003) |
| *Foreign Inv.* | -0.000 | 0.000 | -0.000 | -0.000 | -0.000 |
| | (0.001) | (0.000) | (0.001) | (0.001) | (0.001) |
| *Export intensity* | -0.000 | -0.000 | -0.000 | | -0.000 |
| | (0.000) | (0.001) | (0.001) | | (0.000) |
| *ImPen China*Foreign* | | 0.000 | | | |
| | | (0.000) | | | |
| *ImPen China*Export* | | 0.139 | | | |
| | | (0.101) | | | |
| *ImPen USA* Foreign* | | | | 0.000 | |
| | | | | (0.000) | |
| *ImPen USA*Export* | | | | 0.162 | |
| | | | | (0.105) | |
| *ImPen China*Skilled* | | -0.004 | | | |
| | | (0.008) | | | |
| *ImPen China*K/L* | | -0.002*** | | | |
| | | (0.000) | | | |
| *ImPen USA*Skilled* | | | | 0.014 | |
| | | | | (0.014) | |
| *ImPen USA*K/L* | | | | -0.008*** | |
| | | | | (0.002) | |
| Industry FE | YES | YES | YES | YES | YES |
| Year FE | YES | YES | YES | YES | YES |
| Observations | 1,205 | 1,205 | 1,205 | 1,205 | 1,205 |
| $R^2$ | 0.25 | 0.25 | 0.23 | 0.23 | 0.24 |

Notes: A constant is included but not reported; Standard errors are clustered at the four-digit ISIC level; Robust standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

We show evidence that the negative effect of import competition is significantly higher for more capital-intensive firms, as suggested by the negative sign and significance of the interaction term

(Columns 2 and 4 for import exposure from China and the USA respectively). This evidence hints that capital-intensive firms are exposed to low- and medium-tech import competition, which pose a stronger substitution effect for those firms producing at a similar technological level. In the case of USA, the negative sign of imports is attributed to technologically advanced labour-saving inputs.

Interestingly, the interaction with the export orientation of industries suggests that, although import competition on export-oriented industries has a positive effect on sales (as shown in the previous section), these industries do not translate the trade-related benefits into employment gains. Skill intensity and foreign ownership do not alter the substitution effect from Chinese or US trade in boosting employment, as the interaction terms are not statistically significant.

Overall, the observed negative association between employment and import penetration leads to a higher fragmentation within industries. The closure of larger plants in Chile have consequently resulted in job losses and in the increase of small self-owned or home-based firms (much smaller in size) established by the recently laid off personnel.

### 6.3 Labour productivity

The next critical adjustment margin is labour productivity. Labour productivity is assumed to increase via production efficiency improvements used as a 'defence' mechanism for escaping import competition by rising competitiveness (Bloom et al., 2016). Given the lack of detailed data[9] to measure (industry-level) total factor productivity, we resort to sales per worker as a proxy for labour productivity[10] (Baccini et al., 2019).

The results in Table 3 indicate suggest that productivity has not increased as a result of intensified import penetration from China. Imports from China have resulted in a higher contraction of output relative to potential employment losses. Our result partly corroborates the work of Álvarez and Claro (2009), who found no effect of Chinese imports on productivity improvements or product upgrade and no evidence that Chilean firms have altered their production techniques from low- to high-capital intensity in response to import competition from China. The controls have the expected signs. Capital-intensive and foreign firms have higher labour productivity, confirming the superiority of FDI (Foreign Direct Investment) intensive industries in productivity growth (Baccini et al., 2019; Sjöholm, 1999).

The interaction terms show that the association between import penetration and labour productivity is conditional upon specific industry characteristics. Higher skill intensity across industries, higher foreign investment, and export orientation are positively affected by increases in Chinese import penetration (Column 4). Our assumption that heterogeneity in terms of trade integration, factor intensities, and within industry variation in ownership structure/FDI presence is confirmed in determining the extent and significance of the substitution effects. We show that export-intensive industries react positively (in terms of labour productivity) to increases in import competition, while capital-intensive industries are negatively impacted, due to escalated competition from both trade partners. This result contrasts with Bernard et al., (2006) who show that more capital-intensive firms in the USA are less affected by Chinese competition[11] and with Álvarez and Claro (2009), who show that factor intensity does not condition the import effects in Chilean firms.

The interaction term between high export-oriented industries and increased import penetration allows industries to reap the benefits from increased exposure. The impact turns positive, when the interaction with the export orientation of the industry is included (column 4). This potentially implies that the competition effect turns into a productivity-enhancing effect with the use of more sophisticated imports (from USA) and lower-cost intermediates (from China).

**Table 3.** Import Penetration and Labour productivity

| **Dep. Var.:** **Labour productivity** (log) | (1) China | (2) USA | (3) Both | (4) China | (5) USA |
|---|---|---|---|---|---|
| *ImPen China* | -0.666** | | -0.629* | -0.927*** | |
| | (0.333) | | (0.338) | (0.333) | |
| *ImPen USA* | | -0.328 | -0.253 | | -1.493*** |
| | | (0.237) | (0.225) | | (0.530) |
| *Log (K/L)* | 0.235*** | 0.242*** | 0.234*** | 0.267*** | 0.266*** |
| | (0.038) | (0.039) | (0.039) | (0.036) | (0.036) |
| *Skill ratio* | -0.004 | -0.005 | -0.004 | -0.010 | -0.010 |
| | (0.013) | (0.012) | (0.012) | (0.012) | (0.014) |
| *Foreign Inv.* | 0.017* | 0.017* | 0.016* | -0.081*** | 0.015* |
| | (0.009) | (0.009) | (0.009) | (0.010) | (0.008) |
| *Export Intensity* | -0.085*** | -0.092*** | -0.085*** | 0.015* | -0.078*** |
| | (0.009) | (0.016) | (0.009) | (0.010) | (0.008) |
| *ImPen China*Foreign* | | | | 0.002** | |
| | | | | (0.001) | |
| *ImPen USA* Foreign* | | | | | -0.001 |
| | | | | | (0.001) |
| *ImPen USA*ExportOr* | | | | | 2.399*** |
| | | | | | (0.702) |
| *ImPen China*ExportOr* | | | | 3.885*** | |
| | | | | (0.672) | |
| *ImPen China*Skilled* | | | | 0.062* | |
| | | | | (0.033) | |
| *ImPen China*K/L* | | | | -0.020*** | |
| | | | | (0.003) | |
| *ImPen USA*K/L* | | | | | -0.020*** |
| | | | | | (0.003) |
| *ImPen USA*Skilled* | | | | | 0.029 |
| | | | | | (0.075) |
| Industry FE | YES | YES | YES | YES | YES |
| Year FE | YES | YES | YES | YES | YES |
| Observations | 1,321 | 1,321 | 1,321 | 1,321 | 1,321 |
| $R^2$ | 0.68 | 0.67 | 0.68 | 0.69 | 0.67 |

Notes: A constant is included but not reported; Standard errors are clustered at the four-digit ISIC level; Robust standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

In the case of Chinese imports, skill-intensive and foreign-owned firms record higher productivity improvements from import exposure. The fact that skill-intensity offers some immunity to increased import penetration is of high relevance to policy-making, given that foreign —mainly US affiliates— in Chile "spend very little on R&D activities (0.06% of their sales in 2012)" (OECD, 2015: 87).

Consequently, foreign investment and skill intensity offers a channel to improvements in performance as a result of increased trade, if foreign[12] firms were to participate in more high-value added sectors and invest more in R&D.

Overall, the results on productivity hint that it is not capital deepening that plays the role in eluding competition, but higher investments in skills, the potential diversification of foreign owned firms in higher value added sectors, and the exploitation of dynamic export capacities in manufacturing. Some tests are performed to check the robustness of these results. They are provided in Appendix 3.

## 7. Conclusion

The ascent of China to the world's largest manufacturing powerhouse has raised concerns about the future of Chile's position in the international division of labour. Despite the numerous studies on the competition pressures in the developed world, there is still a scarcity of empirical evidence in less economically advanced countries. Moreover, the opportunities and threats from deeper integration with partners of different income levels remain poorly understood. In this respect our contribution offers insight into the asymmetric effects based on the level of integration and foreign investment across industries.

We examined the conditional effect of increased import penetration on the domestic manufacturing sector by assessing the effect in favour of both, export-oriented industries as well as industries with higher levels of foreign investment, skills, and factor intensity. By focusing on the period corresponding to the implementation of Chile's two most important free trade agreements, we find an overall negative effect of import penetration on domestic manufacturing sales, employment growth, and labour productivity, which turns to positive when interactions with the export orientation and foreign ownership are introduced in the model.

Considering the significant positive impact of import penetration on export-oriented industries, policies that support Chilean firms' exporting strategies need to be promoted with a focus on domestic enterprises at the higher end of the value chain. Therefore, the detrimental impact of increased import penetration can only be reversed by 'upgrading' Chile's presence in global and regional value chains and providing ways of avoiding the 'resource curse', which the country faces due to its heavy reliance on copper exports.

In order to increase the benefits of exposure to economic superpowers, such as USA and China and boost the immunity of the domestic sector, Chile needs to design policies promoting higher skilled-industries, which, in turn, will attract FDI in more skill-intensive, and higher value-added products. This will ensure higher participation in global value chains..

The emergence of Chile in global value chains (OECD, 2015) may give rise to a winner-loser pattern where exporting industries can not only escape foreign competition but also prosper in the participation in backward linkages, essentially using cheaper or technologically more advanced foreign value-added into their gross exports. Overall, an industrial policy targeting industries with an emphasis on low- and medium-tech due to severe Chinese competition should be combined with a strategic focus on high-skill industries. The latter, acting as a source of knowledge and innovation diffusion, should be emphasized before further deepening of trade relations. This will ensure that the domestic industry is sufficiently prepared for the competition and enhanced with the absorptive capacity necessary to benefit from trade. This dual approach will also facilitate the transition and, perhaps, mitigate the growing discontent that job losses associated with an open economy are causing in Chile.

It is essential to give a word of caution regarding the limitations of this study, which is the absence of a clear distinction of the effects of intermediate inputs. The latter, especially in the case of labour productivity, would add more precision to the analysis, as studies have shown that access to cheaper imported inputs can raise productivity via learning, variety, and quality effects (Mendoza, 2010). Further exploration on the empirical part should take into account possible interactions of the main regressors with dummies proxying low, medium and high tech and R&D expenditure to assess the temporal effects on actual domestic industrial upgrading. Future research should look at how levels of high-technology exports have responded to increased import penetration as well as the role played by the local and regional environment and the improvement of transport infrastructure in order to allow industries to upgrade and capitalize on deeper economic integration.

## Endnotes

[1] Chile was the first South American country to become a member of OECD in 2010. Chile was considered developing during the largest part of our period of analysis.

[2] Key US exports refer to agricultural and construction equipment, autos and auto parts, computers and other information technology products, medical equipment, and paper products. Luxury tax which discriminated against US automobiles has been phased out. The top US exports to Chile are mineral fuel, machinery, vehicles, electrical machinery, and aircraft (UN, COMTRADE).

[3] The relevance of H-O is also contested by Rodrik (2006), who finds China's exports to be more sophisticated than expected for its level of development.

[4] Harmonized System (HS) is the international nomenclature for the classification of products.

[5] Data and coding are available upon request.

[6] Usually knowing the exact error structure is not straightforward, however with aggregated variables clustering at the same level is necessary.

[7] FDI stock as a percentage of GDP stood at 70% in 2014 (OECD, 2015)

[8] A considerable improvement to the current analysis would be a clear distinction of the effect of increases in import penetration in intermediate inputs. Considering that studies have shown that access to cheaper imported inputs can raise productivity via learning, variety and quality effects (Kasahara and Lapham, 2013; Grossman and Helpman, 1991), ideally the analysis should assess this effect separately by distinguishing between intermediate imports (inputs) and final good imports. An even more accurate method would be the use of input-output tables by industry. However, said tables are not available by the National Statistical Office of Chile, while values on intermediate inputs were not consistently reported by product category in the UN Comtrade database. Consequently, jointly exploiting the variation in trade integration by industry and the sectoral level performance indicators at the same industrial category is the best alternative proxy, considering existing data. We thank an anonymous referee for the suggestion and helpful feedback on this point.

[9] For example, consistent annual data on wages to measure the cost of labour were not available.

[10] There are various proxies for labour productivity, including GVA per worker instead of sales per worker. We use sales per worker for the following reasons: Value added will capture more the increase of the value of the produced good (i.e., revenue-cost of inputs) however, in our case, we are not so interested in the value increase but in the actual performance in terms of market shares. This is better reflected in the sales variation over time. We also anticipate that imports will affect more significantly the sales outcome, due to competition effects rather than impact on the value that industries could potentially create, it is worth considering that the cost factor in the formula to calculate value added will not be significantly affected within the period of analysis by imports. Instead, we expect more immediate effects on output sales. We thank an anonymous referee for raising this point.

[11] The difference could be attributed to the fact that capital-intensive industries in the USA are more technologically advanced, productive and resilient to import competition from China compared to capital-intensive industries in Chile.

[12] The vast majority of foreign affiliates in Chile are concentrated in sectors such as food, basic metals, wood, paper, and printing.

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## Appendix 1

Tables A1 and A2 represent the annual growth rate of imports from China and USA for each two digit industrial sector in Chile, the weight each sector accounts for. And the percentage change from the beginning to the end of the study period (2003-2013). The first observation is that the increase in imports from both countries is not evenly distributed across industries. The most exposed sectors in terms of import competition from China (in weight and percentage change) are textiles (17), wearing (18), metals (27), chemicals (24), TV and communication equipment (32).

**Table A1.** Imports from China by sector

| China | | Weight | Growth rate | % Δ '03-'13 |
|---|---|---|---|---|
| ISIC | Total | 100% | 22% | 794% |
| 15 | Food, beverages | 1% | 37% | 3207% |
| 17 | Textiles | 10% | 20% | 657% |
| 18 | Wearing | 11% | 16% | 408% |
| 19 | Leather | 7% | 16% | 420% |
| 20 | Wood | 1% | 24% | 922% |
| 21 | Paper | 0% | 36% | 2913% |
| 24 | Chemicals | 6% | 26% | 1141% |
| 27 | Metals | 7% | 52% | 10265% |
| 28 | Fabricated metal | 5% | 24% | 985% |
| 29 | Machinery | 9% | 26% | 1191% |
| 30 | Computing machinery | 6% | 23% | 893% |
| 31 | Electrical machinery | 5% | 26% | 1165% |
| 32 | TV & comm. equip | 14% | 24% | 991% |
| 33 | Prof. scientific equip. | 1% | 16% | 424% |
| 34 | Automobiles | 4% | 51% | 9411% |
| 35 | Transport equip. | 1% | 22% | 752% |

Source: own calculation using data from INE (National Statistical Office of Chile) and UNcomtrade database

| China | | Weight | Growth rate | % Δ '03-'13 | Import levels | |
|---|---|---|---|---|---|---|
| ISIC | Total | 100% | 22% | 794% | 2003 | 2013 |
| 15 | Food, beverages | 1% | 37% | 3207% | 2.634.400 | 66.713.333 |
| 17 | Textiles | 10% | 20% | 657% | 191.985.370 | 1.318.963.459 |
| 18 | Wearing | 11% | 16% | 408% | 325.451.190 | 1.595.186.901 |
| 19 | Leather | 7% | 16% | 420% | 192.656.042 | 1.023.783.922 |
| 20 | Wood | 1% | 24% | 922% | 8.042.164 | 74.055.308 |
| 21 | Paper | 0% | 36% | 2913% | 2.384.066 | 64.410.377 |
| 24 | Chemicals | 6% | 26% | 1141% | 68.842.368 | 738.089.155 |
| 27 | Metals | 7% | 52% | 10265% | 9.526.071 | 819.685.368 |
| 28 | Fabricated metal | 5% | 24% | 985% | 61.200.907 | 694.992.829 |
| 29 | Machinery | 9% | 26% | 1191% | 102.092.594 | 1.410.008.831 |
| 30 | Computing machinery | 6% | 23% | 893% | 84.744.694 | 1.132.499.864 |
| 31 | Electrical machinery | 5% | 26% | 1165% | 61.528.986 | 708.855.463 |
| 32 | TV & comm. equip | 14% | 24% | 991% | 185.835.221 | 2.554.961.537 |
| 33 | Prof. scientific equip. | 1% | 16% | 424% | 34.342.027 | 186.496.164 |
| 34 | Automobiles | 4% | 51% | 9411% | 5.899.030 | 913.399.122 |
| 35 | Transport equip. | 1% | 22% | 752% | 16.323.987 | 150.141.009 |

Source: own calculation using data from INE (National Statistical Office of Chile) and UNcomtrade database
Notes: values of import levels are in thousands of Chilean pesos

Import penetration from the USA (Table A2), by contrast, is more concentrated in high-skilled, capital-intensive, and high technology industries, such as machinery (29), professional and scientific equipment (33), and automobiles (34). Therefore, the sectoral competition and substitution effects from USA are expected to be less fierce compared to Chinese imports. The higher technological component of USA imports limits the direct competition with domestic manufacturing to a far greater extent than in the case of Chinese imports.

**Table A**Error! Main Document Only.**.** Imports from USA by sector

| | | **Weight** | **Growth rate** | **% Δ '03-'13** |
|---|---|---|---|---|
| **ISIC** | **Total** | **100%** | **11%** | **222%** |
| 15 | Food, beverages | 4% | 20% | 677% |
| 24 | Chemicals | 22% | 13% | 281% |
| 27 | Metals | 1% | 7% | 111% |
| 28 | Fabricated metal | 3% | 9% | 160% |
| 29 | Machinery | 20% | 10% | 181% |
| 30 | Computing machinery | 3% | -1% | -13% |
| 31 | Electrical machinery | 4% | 7% | 118% |
| 32 | TV and comm. equip. | 3% | 5% | 67% |
| 33 | Prof. scientific equip. | 15% | 16% | 412% |
| 34 | Automobiles | 4% | 16% | 420% |
| 35 | Transport equip. | 1% | 7% | 119% |

Source: own calculation using data from INE (National Statistical Office of Chile) and UNcomtrade database

| **USA** | | **Weight** | **Growth rate** | **% Δ '03-'13** | **Import levels** | |
|---|---|---|---|---|---|---|
| **ISIC** | **Total** | **100%** | **11%** | **222%** | **2003** | **2013** |
| 15 | Food, beverages | 4% | 20% | 677% | 44.542.560 | 327.317.807 |
| 24 | Chemicals | 22% | 13% | 281% | 476.050.068 | 1.939.613.160 |
| 27 | Metals | 1% | 7% | 111% | 30.079.135 | 116.557.602 |
| 28 | Fabricated metal | 3% | 9% | 160% | 86.036.974 | 270.649.168 |
| 29 | Machinery | 20% | 10% | 181% | 582.305.013 | 2.140.827.621 |
| 30 | Comp. machinery | 3% | -1% | -13% | 262.776.015 | 222.296.594 |
| 31 | Electrical machinery | 4% | 7% | 118% | 147.611.593 | 410.731.667 |
| 32 | TV and comm. equip. | 3% | 5% | 67% | 151.122.943 | 251.530.831 |
| 33 | Prof. scientific equip. | 15% | 16% | 412% | 150.560.984 | 347.574.922 |
| 34 | Automobiles | 4% | 16% | 420% | 237.397.505 | 1.537.622.561 |
| 35 | Transport equip. | 1% | 7% | 119% | 65.804.137 | 259.356.219 |

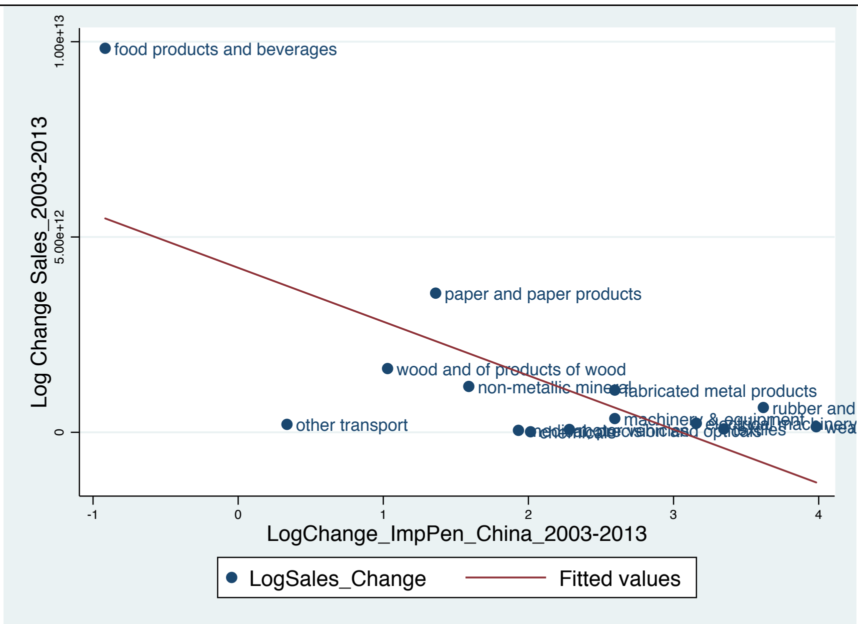
Source: own calculation using data from INE (National Statistical Office of Chile) and UNcomtrade database
Notes: values of import levels are in thousands of Chilean pesos

Considering the patterns observed, the exposure of Chile to China is more prevalent in low-tech, low-skilled products, while competition from the USA is more pronounced in knowledge-intensive sectors and corresponds more to final products. This suggests that the technological development of different trade partners explains the heterogeneity in competition across domestic industries. An expected implication of these patterns of import penetration is a shift in factor utilization out of labour-intensive sectors and a loss of market share. This would be in line with the endowment-based trade model, as a consequence of the fall in the relative price of imported labour-intensive products.

The main take-away of the descriptive analysis on the sectoral composition of imports is to provide insight regarding the varying levels of exposure across industries. This essentially mirrors the import substitution versus efficiency-enhancing dualistic nature of the benefits and losses across import-competing versus import-using industries.

The scatterplot below (Figure A1) shows sales change by industrial sector against Chinese import penetration. The negative slope of the line provides evidence that higher values of import penetration are negatively associated with sales. Labour and capital intensive industries also experienced high loses in sales, which suggests price and cost competition effects from Chinese imports.

**Figure A1.** Change in Sales against change in Chinese Import Penetration




*Coef. -1.38e+12 SE: 4.02e+11 t-stat: -3.43 p-value:0.005*

## Appendix 2

**Table A3.** Variable list (definition and sources)

| *Variable* | *Definition* | *Source* | *Geography* | *Time* |
|---|---|---|---|---|
| *Domestic Sales* | Logarithm of firm sales aggregated at the 4 digit ISIC level in constant (2008) prices | Manufacturing census by INE [12] – National Statistic Office of Chile | Chile | 2000-2013 |
| *Employment Change* | Yearly change of the Log of firm-level employment aggregated at the 4 digit ISIC level | Manufacturing census by INE [12] – National Statistic Office of Chile | Chile | 2000-2013 |
| *Labour productivity* | Logarithm of labour productivity (measured as sales per worker) averaged at the 4 digit ISIC level | Manufacturing census by INE [12] – National Statistic Office of Chile | Chile | 2000-2013 |
| *ImPen China* | Import penetration from China in sector j at year t (normalized on apparent consumption in same sector) | United Nations Statistical Division (COMTRADE database) | China | 2000-2013 |
| *ImPen USA* | Import penetration from USA in sector j at year t (normalized on apparent consumption in same sector) | United Nations Statistical Division (COMTRADE database) | USA | 2000-2013 |
| *Size* | Average firm size by industry j in year t | Manufacturing census by INE – National Statistic Office of Chile | Chile | 2000-2013 |
| *Foreign Inv.* | Percentage of foreign ownership by (ISIC) industry | Manufacturing census by INE – National Statistic Office of Chile | Chile | 2000-2013 |
| *Export Intensity* | Export revenue as a percentage of total sales by (ISIC) industry | Manufacturing census by INE – National Statistic Office of Chile | Chile | 2000-2013 |
| *Log (K/L)* | Capital intensity by industry: The ratio of capital (proxied by total assets) over employment | Manufacturing census by INE – National Statistic Office of Chile | Chile | 2000-2013 |
| *Skill ratio* | Ratio of skilled workers over total workers | Manufacturing census by INE – National Statistic Office of Chile | Chile | 2000-2013 |

## Appendix 3

**Table A4.** Descriptive Statistics

| Variables | Mean | Std. Dev. | Min | Max |
|---|---|---|---|---|
| *Domestic Sales (in logs)* | 24.43 | 2.21 | 17.89 | 30.98 |
| *Employment Change (in logs)* | 1.00 | 0.13 | 0.51 | 1.99 |
| *Labour productivity (in logs)* | 17.38 | 1.16 | 12.14 | 21.33 |
| *ImPen China* | 0.11 | 0.19 | 0 | 0.95 |
| *ImPen USA* | 0.10 | 0.19 | 0 | 3.15 |
| *Size* | 4.015 | 8.00 | 0 | 100 |
| *Foreign Investment* | 6.47 | 11.40 | 0 | 100 |
| *Export Intensity* | 0.20 | 1.51 | 0 | 56.99 |
| *Capital Intensity (in logs)* | 13.58 | 2.06 | 3.27 | 20.38 |
| *Skill ratio* | 1.15 | 2.57 | 0 | 35.30 |

**Table A5.** Pairwise correlations

| Variables | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) |
|---|---|---|---|---|---|---|---|---|---|
| *Domestic Sales (1)* | 1 | | | | | | | | |
| *ImPen China (2)* | -0.37 | 1 | | | | | | | |
| *ImPen USA (3)* | -0.26 | -0.00 | 1 | | | | | | |
| *Capital Intensity (4)* | 0.12 | -0.07 | -0.12 | 1 | | | | | |
| *Size (5)* | -0.06 | -0.08 | 0.06 | 0.08 | 1 | | | | |
| *Skill ratio (6)* | -0.17 | 0.12 | 0.05 | 0.08 | 0.02 | 1 | | | |
| *Export Intensity (7)* | 0.01 | -0.04 | -0.01 | -0.04 | -0.00 | -0.02 | 1 | | |
| *Foreign Inv. (8)* | 0.09 | -0.16 | 0.08 | 0.09 | 0.70 | -0.03 | 0.02 | 1 | |
| *Labour productivity (9)* | 0.43 | -0.15 | -0.06 | -0.01 | 0.00 | -0.00 | -0.00 | 0.17 | 1 |

## 1.1 Robustness checks

A major problem in micro econometric analysis is the possibility of inconsistent parameter estimation, due to endogenous regressors. In order to ensure that the estimates measure not only the magnitude of association, but the magnitude and direction of causation, which is needed for policy analysis, we have applied an instrumental variable strategy. To minimize the endogeneity problem associated with omitted variables, we have included a rich set of controls as well as industry and year fixed effects to control for unobservable industry characteristics. However, given that potential bias may still be present stemming from additional omitted variables and reverse causality concerns, we implement an instrumental variable strategy (which is described in detail in the next section).

The potential endogeneity of Chinese and USA imports could emanate from unobserved industry-specific demand shocks affecting both the outcome variables (i.e. sales) and the key regressor (import penetration variable). Among the possible causes is a negative productivity shock that results in a decrease in sales, which will induce a higher import rate. Such concerns have been addressed in the literature instrumenting the import penetration variable with a) time lags of the import penetration variable (Álvarez and Claro, 2009), b) product quotas and tariffs or transport costs (Bernard et al., 2006), c) export shares of the trade partner in other countries excluding the study-country (Autor et al. 2013), and d) the production growth or evolution of the production cost in the trade partner's domestic sector (i.e. China).

Due to data limitations, we cannot resort to options b) and d) and we address the endogeneity concern, following Autor et al. (2013), based on option c) using Chinese sectoral exports to the world as an instrument. Specifically, we instrument for import penetration from China into the Chilean economy with the contemporaneous composition and growth of Chinese exports to the rest of the world (excl. Chile). The proposed IV is correlated with Chinese exports into Chile, but uncorrelated with Chilean domestic sales and employment growth satisfying the relevance and exogeneity requirements of a valid IV.

The exogeneity of the proposed instrument is justifiable on the grounds that Chinese exports to the rest of the world (excluding Chile) capture changes in China's comparative advantage that are not related to Chile's domestic industrial production. Additionally, the variation in Chinese exports proxies for both Chinese productivity in each sector $j$ and the decrease in transportation costs/tariffs[12] which are exogenous to the Chilean domestic production but are correlated with Chinese imports into Chile (relevance requirement), as Chile was one of the first countries to complete a FTA with China and heavily imports from China.

The first-stage estimate reported in Table A6 confirms the reliability of our instrument, which is positively and significantly correlated with our main regressor (Chinese import penetration) in all specifications. In addition to that and in compliance with the econometric literature on weak instruments (Staiger and Stock, 1997; Stock and Yogo, 2005), the F-statistic for the first-stage as reported in Table A6 shows values well above the conventional thresholds of ten (Stock and Yogo, 2005). The second stage confirms that domestic sales and labour productivity are lower in response to Chinese competition re-confirming the OLS estimates.

The same does not hold for employment growth, the estimate retains the negative sign, but is not statistically significant. A possible explanation of the effect on employment growth is that perhaps the OLS estimate suffers from an upward bias and that the effect may be conditional on the scale of the industry, assuming that larger scale industries producing closer substitutes to Chinese import in labour intensive sectors or sectors of a lower technological level are disproportionately affected. To test whether there is a heterogeneous effect stemming from the scale of the industry, we stratify the sample into two categories: industries with employment above and below the mean. The results are presented in Table A7 and confirm that larger scale industries (above the mean of 50%, which is 3697 employees) suffer disproportionately in terms of employment contraction from increases in import competitions pressures from China. The asymmetric effect stemming from the scale of the industry is seen as the other side of the coin elaborating on the results of the capital intensity's interaction effect. The negative coefficient of the interaction between capital intensity and Chinese import penetration may suggest that larger scale, low technology and capital-intensive sectors are more negatively affected. When taking a closer look (in the dataset) at which sectors are actually above the mean (in terms of labour size), the low and medium tech sectors (basic metals, plastic, electrical machinery) stand out, followed by labour intensive (textiles and apparel). Studies stress that these trends are in fact wider, covering many Latin American countries. To this end, Artuç et al. 2015 argue that China's competition in manufacturing has significant effects on countries exporting textiles like Honduras, El Salvador and Haiti as well as countries exporting a more diverse set of manufacturing products such as Mexico. Furthermore, another possible explanation is that industries with larger average firm size may be more flexible in hiring and firing and respond to pressures faster that smaller firms or family businesses.

**Table A**Error! Main Document Only.**.** IV estimation (China Import penetration)

| **IV 2SLS estimation – second stage**<br><br>*Instrumented*: ImPen China | (1)<br><br>**Dependent variable**: Domestic Sales | (2)<br><br>**Dependent variable**: Δ Log Employment$_{t,t+1}$ | (3)<br><br>**Dependent variable**: *Log* Labour productivity |
|---|---|---|---|
| *ImPen China* | -1.806*** | -0.047 | -0.974*** |
| | (0.282) | (0.034) | (0.306) |
| *First Stage* | 0.049*** | 0.050*** | 0.053*** |
| | (0.002) | (0.002) | (0.002) |
| F statistic First Stage | 387 | 377 | 379 |
| Industry level controls | YES | YES | YES |
| Industry FE | YES | YES | YES |
| Year FE | YES | YES | YES |
| Observations | 1321 | 1205 | 1321 |

Notes: A constant is included but not reported; Standard errors are clustered at the four-digit ISIC level; Robust standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

**Table A**Error! Main Document Only.**.** IV estimates for Employment growth — scale effects

| **IV 2SLS – second stage**<br>**Dependent variable**:<br><br>*Instrumented*: ImPen China | (1)<br><br>Employment growth<br><br>(Employees < 50%) | (2)<br><br>Employment growth<br><br>(Employees > 50%) |
|---|---|---|
| *ImPen China* | -0.013 | -0.127** |
| | (0.034) | (0.063) |
| *First Stage* | 0.056*** | 0.041*** |
| | (0.003) | (0.004) |
| F statistic First Stage | 301 | 91 |
| Industry level controls | YES | YES |
| Industry FE | YES | YES |
| Year FE | YES | YES |
| Observations | 816 | 372 |

Notes: A constant is included but not reported; Standard errors are clustered at the four-digit ISIC level; Robust standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

The proposed instrumental variable for China does not apply for the USA import penetration variable and we resort to using three-year time lags of USA imports penetration, following Álvarez and Claro (2009). The reason behind the unsuitability of overall USA exports as an instrument for US import penetration into Chile is that USA (manufacturing) exports are much more diversified than China's and not a good proxy for Chile's import trade profile, given that Chile imports specific products that do not cover the broad spectrum of USA's exports. The latter is justifiable on the grounds that Chile, by having a relatively lower income level compared to that of USA's traditional trade partners, such as the EU and other advanced economies, does not have a similar import pattern. As reported in Table A8, the relevance requirement is confirmed given that the three year time lag of USA import penetration is positively and significantly correlated with our main regressor and the F-statistic is high and above the conventional thresholds of 10 (Stock and Yogo, 2005). Considering that the effect from USA in the majority of cases is found to have a non-significant impact in the baseline model we conclude that the IV confirms the insignificance of the OLS parameters. The second stage confirms our initial results, which are relatively stable across the three specifications (Columns 1-3).

**Table A**Error! Main Document Only.. IV estimation (USA Import penetration)

| **IV 2SLS estimation – second stage** | (1)<br>**Dependent variable**: Log Domestic Sales | (2)<br>**Dependent variable**: Δ Log Employment$_{t,t+1}$ | (3)<br>**Dependent variable**: Log Labour productivity |
|---|---|---|---|
| *Imp Pen USA* | -0.291<br>(0.580) | 0.059<br>(0.043) | -0.363<br>(0.619) |
| *First Stage* | 0.355***<br>(0.036) | 0.374***<br>(0.038) | 0.374***<br>(0.038) |
| F statistic First Stage | 96 | 94 | 91 |
| Industry level controls | YES | YES | YES |
| Industry FE | YES | YES | YES |
| Year FE | YES | YES | YES |
| Observations | 1321 | 1205 | 1321 |

Notes: A constant is included but not reported; Standard errors are clustered at the four-digit ISIC level; Robust standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1