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Organizational Hierarchies and Export Destinations*

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Abstract

This paper proposes a new link relating export destinations and the organization of the firm. We claim that the production of higher-quality varieties exported to rich destinations induces firms to re-structure their production processes, becoming organizationally more complex. We introduce a theoretical model with these features and we explore the mechanisms using a panel of Chilean manufacturing plants. Our identification strategy relies on falling tariffs on Chilean products across destinations caused by the signature of Free Trade Agreements with high-income countries (the European Union, the United States, and South Korea). We find that Chilean plants that were induced by these tariff reductions to start exporting to high-income destinations increased the number of hierarchical layers and upgraded the quality of their products. This involved the addition of qualified supervisors that facilitated the provision of higher product quality. These effects took place at new high-income exporting firms.

Keywords: Exports, Export destinations, Organizational change, Quality
JEL classification: F14, F16, J24

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1 Introduction

Recent theories of organizational change introduce a novel mechanism linking exports and the hierarchical structure of firms. During output production, workers face problems of varying difficulty, and knowledge-based hierarchies are an optimal way to organize the firm (Garicano, 2000; Garicano and Rossi Hansberg, 2006). Demand shocks, such as export shocks, induce firms to layer-up and thus become more complex organizations (Caliendo and Rossi-Hansberg, 2012; Caliendo, Monte, and Rossi-Hansberg, 2015; Friedrich, 2020; Caliendo, Mion, Opromolla, and Rossi-Hansberg, 2020).

Another strand of literature shows that exporting firms to high-income countries typically sell higher quality goods and hire more skilled workers (Verhoogen, 2008; Bastos and Silva, 2010; Görg, Halpern and Muraközy, 2010; Manova and Zhang, 2012; Brambilla, Lederman and Porto, 2012; Brambilla and Porto, 2016). This happens because, on the one hand, rich countries with richer consumers demand higher quality products and the provision of quality is intensive in skills, and, on the other hand, because exporting to rich countries requires skilled-intensive services, such as logistics and distribution (Verhoogen, 2008; Matsuyama, 2007; Brambilla, Lederman and Porto, 2012).

In this paper, we merge these two strands of literature. We build on the premise that exports to high-income destinations comprise higher quality products. We develop a model to argue that the quality provision mechanism requires knowledge because producing high quality products to sell in rich countries faces more complex production problems. In order to solve these problems, firms need to increase their knowledge and the optimal way to do that is by re-organizing their structure. This re-structuring involves the addition of more complex layers to the hierarchical organization. We advance the notion that the solution of more difficult problems affects the physical production process because high quality products are more sophisticated, harder to assemble, and face inherent complexities in exporting to countries with higher income.

To test these ideas, we use firm-level data from a Chilean manufacturing annual census, the Encuesta Nacional Industrial Anual (ENIA). The ENIA is a panel covering the universe of Chilean plants with ten or more employees. The main module of the survey contains information on employment, wages, hours worked, sales, average unit values, and industry of affiliation. The employment module presents separate information for eight categories of workers which, guided by the literature, we use to construct four hierarchical layers (Caliendo, Monte, and Rossi-Hansberg

2015). We then combine these data with trade data. We merge firms with administrative custom records at the firm-export destination level and with bilateral tariff data from UNCTAD-TRAINS. We therefore build a firm-level dataset with information of firms, the destination of their sales, and the tariff faced in each destination. Due to limitations in customs data, we restrict the analysis to the 2001-2005 period.

We use our data to explore the causal effect of exporting to high-income countries on the organization of the firm. To deal with endogeneity concerns that may arise if more productive firms (with more hierarchies) self-select into export markets or if firm-level shocks simultaneously affect organizational and export decisions, we pursue an instrumental variable estimation procedure. Our identification strategy takes advantage of falling tariffs on Chilean products across different destinations in the context of several Free Trade Agreements that Chile signed with high-income countries during the period of analysis. These include an FTA with the European Union (in effect in 2003), another with the United States (in 2004) and yet another with South Korea (in 2004). These treaties fall in the middle of our sample period. In our strategy, we exploit these breaks in tariff trends across time and across industries. Exogeneity is given by a combination of tariff cuts due to the Chilean FTAs and the initial export composition of industries as in Lileeva and Trefler (2010), Bustos (2011), and Garcia-Marin and Voigtländer (2019).

Our findings are as follows. To take advantage of the FTAs with the European Union, the United States and Korea, Chilean firms gradually enter these markets and begin exporting to high-income destinations. Exporting to high-income countries induce these firms to increase their complexity as they add hierarchical layers. In Chile, this mechanism is inherent to high-income destinations and does not happen at exporters more generally. We also find that firms exporting to high-income countries do sell higher quality products. These two mechanisms are intertwined: high-income destinations demand higher quality products and the provision of higher quality is done more efficiently in organizationally more complex firms.

We also study some of the organizational mechanisms that make firms more complex. In particular, firms increase the layer of skilled production supervisors, which is consistent with the higher skilled labor required to produce higher quality (Verhoogen, 2008; Brambilla, Lederman and Porto, 2012). In addition, these firms tend to add a layer associated with exporting services such as logistics, standards certification and customer care (Matsuyama, 2007; Brambilla, Lederman and Porto, 2012). Moreover, there is evidence of a complementarity between these layers: high-income exporters need to have both layers to be successful. Finally, we show that these phenomena occur at the extensive margin of exporting, rather than at the intensive margin.[1] In the context of models of knowledge-based hierarchies, this is a sensible result because problems related to starting to export are arguably more complex than problems associated with increasing exports at the margin for established exporters.

The mechanism in our paper, which links export destinations and quality via firm re-structuring, is novel in the trade literature. Experimental evidence in Bloom, Eifert, Mahajan, McKenzie, and Roberts (2013) show that better managerial practices increase quality. Textiles plants in India that received managerial training reduced the quality defects of the goods. Both experimental and firm-level data in Bloom, Manova, Van Reenen, Teng Sun, and Yu (2020) show that better managed firms are more likely to export and in particular to export higher quality products. This holds for the Indian firms in Bloom et al. (2013) as well as more generally across the U.S. and Chinese manufacturing sector. There is also some evidence that the mechanisms are related to the destination of exports. Concretely, Mion and Opromolla (2014) show that managers with market-specific export experience facilitate firm entry into those market destinations.

There is also plentiful anecdotal evidence on quality upgrading and high-income exporting from industry and firm case studies. The wine industry in Chile is a nice example (Agosin and Bravo-Ortega, 2012). Chilean exporters transitioned from bulk wine, mostly sold in Latin America, to premium wines sold to various high-income destinations. The process was initiated by pioneering firms, such as Miguel Torres Chile, with several major changes in the organization of the production process. First, the firm switched old wooden vats and concrete tanks by stainless steel and oak vats, which required new layers of qualified supervisors in the assembly and maintenance of the vats. Second, the production of premium wines was supervised by leading oenologists from Spain. Finally, sales and exports were arranged by enhanced layers of distribution and marketing.

The remainder of the paper is organized as follows. In Section 2, we discuss the Chilean Free Trade Agreements and we provide prima-facie evidence in support of our high-income exporting and firm-reorganization hypothesis. In Section 3, we develop a theoretical extension of Caliendo and Rossi-Hansberg (2012) that combines trade, organizational hierarchies and quality. In Section 4, we present our identification strategy and the main results. Section 5 discusses extensions and robustness results. Section 6 concludes the paper with a summary and closing remarks.

[1]Other papers using identification strategies to shock the extensive margin of exports are Lileeva and Trefler (2010), Bustos (2011), Atkin, Khandelwal, and Osman (2017) and Garcia-Marin and Voigtländer (2019).

2 High-Income Export Destinations, Organizational Structure and Quality: Overview

We begin with an exploratory empirical analysis of the link between the destination of Chilean exports, the nature of the firm organization and the provision of quality.

2.1 Chilean Free Trade Agreements with High-Income Countries

The case of Chile provides an interesting natural experiment to investigate the role of export destinations in shaping the reorganization of firms. Chile signed three important Free Trade Agreements with high-income economies: the European Union, implemented in 2003; the United States, in 2004; and South Korea, also in 2004. These FTAs brought sharp tariff cuts and market access privileges to high-income economies starting in 2003 and accentuating in 2004 and 2005. We can quantify this using data from UNCTAD-TRAINS on bilateral tariffs at 4-digits of the Harmonized System. To better display these data, we aggregate the tariffs at the 3-digit of the ISIC Rev. 3 classification and report average tariff cuts between 2001 and 2005, the period spanned by our data, for 46 industries in Table 1. The reduction in tariffs is highly heterogeneous across industries and across destinations. Across all industries, the average tariff cut for products exported to United States is 50.6 percent and the median cut is 100 percent. The reduction of EU tariffs is 64.3 percent, on average, with a median cut of 96.2 percent. The tariff reductions with Korea are lower, with an average cut of 28.8 percent and a median cut of 45.0 percent.

Before these three FTAs with high-income partners, Chile signed a Complementation Agreement with Mercosur in 1996, a Free Trade Agreement with Mexico in 1999, and another with Costa Rica and El Salvador in 2002. While these agreements predate the 2001-2005 period of our study, they implied gradual tariff reductions across time which ended in 2005. This provides additional tariff variation that we can exploit. In fact, the average tariff reduction between 2001 and 2005 due to the Latin American FTAs is 63.7 percent (last column of Table 1).[2]

The trade agreements created incentives to expand exports and also to start exporting. To look at this, we use export data from administrative customs records on the number of Chilean exporting plants from 2001 to 2005.[3] Figure 1 reports the changes in the total number of manufacturing firms

[2]Chile signed FTAs with China and Japan starting in 2006 and 2007. These agreements, which are likely to be more relevant because China and Japan account for about 20 percent of Chilean exports, are not covered by our data.

[3]We have customs data only for the period 2001-2005.

and in the value of exports to the three different high-income FTA destinations, the US, the EU and Korea before and after the signature of the agreements (between 2001 and 2005). Both the value of exports and the number of exporting plants increased considerably. The number of manufacturing plants exporting to United States increased by 31.0 percent between 2001 and 2005. Entry into the EU and Korea was even higher, with increases in exporting firms of 53.6 and 89.9 percent, respectively. This is clear prima facie evidence that the FTAs brought about a large response in the export extensive margin by promoting firms to begin exporting. We see similar trends in the volumes of trade: the value of exports increased by 134.5 percent (to Korea), 84.8 percent (to the US) and 62.7 percent (to the EU). When we look at the changes in the value exported and in the number of exporters to Latin American countries (with FTAs), the increases were also sizeable, though smaller: exporting firms increased by only 12.8 percent and the value of exports by 44.9 percent.

2.2 Firm Data

The Chilean FTAs induced entry and increased exports into preferential markets in high-income countries, and we can use this experiment to explore the firm-level implications that access to high-income exports creates. In order to be able to explore this premise, we need firm-level data. We utilize a plant-level annual census of Chilean manufacturing plants with a panel structure. This survey, the "Encuesta Nacional Industrial Anual" (ENIA), is conducted by the Chilean "Instituto Nacional de Estadísticas" (INE). It covers the universe of Chilean plants with ten or more employees. The main module of the survey includes information on plant characteristics such as the number of workers, wage bill, hours of work, exports, revenue, sales, and gross value of production. Industry affiliation is defined at the four-digit of the International Standard Industrial Classification (ISIC Rev. 3), which totals 113 industries.

The ENIA is well-suited for our purposes for three main reasons. First, the survey includes information on firm production and sales, which allows us to study product quality issues. Second, it includes information on employment categories, which allows us to study organizational hierarchies. Finally, and fundamentally, the ENIA can be merged with the customs administrative records, to study the role of the firm export destinations.

The product module of the ENIA includes data on the value of sales, the total variable cost of production, and the number of units produced and sold at the product level. Products are defined using a Chilean nomenclature system called "Clasificador Único de Productos" (CUP). This classification encompasses 1,272 different products and is similar to the 7-digit ISIC code. We aggregate these data at 4-digits of the ISIC Revision 3 classification and, then, we merge this information with customs records using a standard concordance with the Harmonized System. As a result, we are able to split total sales into sales to the domestic market and to exports to different destinations. In particular, we are able to split destinations into High-income countries, as per the standard definition of the World Bank. In addition, we also know exports to high-income FTA destinations—the USA, the European Union and South Korea.

We also construct proxies of overall product quality at the firm level by computing unit values, the ratio of sales to quantities sold. There are two important caveats in the computation of unit values. First, since we do not have physical production by export destination, the quality proxy given by the unit values are averages across domestic and different export markets. Second, we focus on the core product of the firm, which we define as the best-selling product for each plant. On average the core product represents 84.7 percent of sales during the period under study. We do this so as to avoid estimation procedures commonly used to back out product quality from structural models that depend on implicit assumptions about demand systems, firm's conduct or market structure. In particular, it is not obvious that the empirical methods currently available in the literature are compatible with the firm organization theory in which we build on. Instead, we use a simple measure of product quality and focus on different dimensions related to quality provision that we can actually straightforwardly measure with the available data.

Summary statistics from the ENIA are presented in Table 2. In the panel, exporting firms account for 22.6 percent of total firms, while high-income exporters, for 14.2 percent. Firms typically export 1 product (Panel (a)). The average exporter does so to about 6.35 different destinations, while high-income exporters to 8.9 destinations. High-income exporting firms sell 34 percent of their production abroad, as opposed to about 24 percent for all other exporters. The average unit values across exporters to different countries are roughly similar, but they are higher than the unit values of domestic firms. This is a manifestation of the fact that, in general, exports are of higher quality than domestic goods.

We can also fruitfully use the ENIA to study the firms' organizational hierarchy. The employment module includes information on eight different categories of workers: owners, directors, supervisors, administrative workers, blue-collar workers, production auxiliaries, service workers, and sellers. We use this information from the employment module to construct four hierarchies, Layers 1 to 4. To do this, we build on Caliendo, Monte, and Rossi-Hansberg (2015), Caliendo, Mion, Opromolla and Rossi-Hansberg (2020), and Friedrich (2020). We provide a detailed explanation of the construction of layers in the Appendix.

The composition of the four layers is presented in Table 3. Layer 1, the bottom layer, includes blue-collar, maintenance and services workers in charge of production, storage, transportation, distribution, security and so on. Layer 2 includes accountants, lawyers and desk workers who are in charge of administrative tasks, paperwork, certification, marketing. Layer 3 includes professionals, technicians and skilled workers who control and physically manage the production process. The top hierarchy, Layer 4, comprises directors, who are in charge of planning, organizing, controlling and directing the overall activities of the firm. As pointed out by Caliendo, Monte and Rossi-Hansberg (2015), it is expected to see some discrepancies between the predictions of the theory in terms of hierarchical rankings and the actual organization of the firms. In the case of Chile, for example, Layer 2 supervises some, but not all, of the activities of Layer 1. For instance, an accountant can monitor inventory and storage management more adequately, or a professional may arrange distribution issues more efficiently. In turn, supervisors in Layer 3 can monitor activities in charge of Layer 2, but may also monitor Layer 1 directly. For example, an engineer in Layer 3 may supervise blue-collar workers in Layer 1 (Brambilla, Lederman and Porto, 2019).

We show some descriptive statistic in Panel (b) of Table 2. The average Chilean firm has 2.75 layers. Exporters are typically more complex firms, with 3.56 layers on average. High-income exporters are more complex firms, with 3.65 layers on average. This is a manifestation of the fact that, in general, exporters present a more sophisticated organizational structure (Bloom, Eifert, Mahajan, McKenzie, and Roberts, 2013; Bloom, Manova, Van Reenen, Teng Sun, and Yu, 2020; Mion and Opromolla, 2014). More than 9 out of 10 exporters have layers 1, 2 and 3, while only between 65-77 percent of non-exporting firms do. Around 80 percent of exporters have layer 4, but only 34 of non-exporters do. Exporters employ more workers than the average firm (and therefore than non-exporters) and this holds for both skilled and unskilled workers. Exporters also pay higher wages, on average. Average wages increase with the complexity of the layer, as expected. More interestingly, conditional on a given layer, average wages are higher in exporting firms for all layers.

2.3 Quality and Organizational Hierarchies

After merging the ENIA with customs export destination data, we can now explore, prima facie, the correlation between exporting to high-income countries, the firm provision of quality and its organizational structure. To do this, we first run an OLS regression of the firm unit value on industry-year fixed effects, at 4-digits of the ISIC Rev. 3 classification and recover a proxy for the industry average quality. With these, we compute the change in the average industry quality, before and after the signature of FTAs (that is, before and after 2003). Then, we plot the *change* in the average quality on the *change* in the proportion of firms in each industry that export to high-income countries (irrespective of whether the countries are FTA partners). Note that it only makes sense to compare the changes in these variables rather than their levels. The results are shown in Figure 2. The positive correlation is strong: industries that participated more intensively in exporting to high-income countries are industries that produced higher quality products. This correlation, not shown, also holds if we consider only exporting firms to FTA high-income countries (the US, the EU and Korea).

Next, we inspect the correlation between high-income exports and the firm organization. We plot the change in the average number of layers in each industry before and after the FTA and the change in the intensity of the industry's exports to high-income countries. This correlation, shown in Figure 3, is also positive: exporting to high-income countries entails an increase in the average complexity of the firm. As before, this correlation holds for the subset of exporting firms to the US, the EU or Korea.

Figures 2 and 3 synthesize our hypothesis: firms that export to high-income countries produce higher quality products, because high-income consumers demand more quality; in doing so, they re-organize and become more complex, because producing higher quality products destined to high-income consumers requires solving more complex problems. In what follows, we formally study the link between high-income exports, the organizational hierarchies of the firm, and the provision of quality.

3 A Model of Hierarchies, Quality and Trade

In this section, we present a model to explain how the provision of quality affects the organizational structure of the firm. In Garicano (2000) and Garicano and Rossi-Hansberg (2006), the production of physical output requires solving problems of varying complexity. Workers can solve the simplest problems, while supervisors and managers with higher skills can solve increasingly difficult problems. In this setting, knowledge-based hierarchies are an optimal way to organize production. We extend this model to allow the firm to choose the quality of its product. Quality works as a demand shifter, which is advantageous for the firm. But the provision of higher quality makes firms face more difficult problems, which increases the cost of production. Consequently, firms that choose to provide higher quality may find it optimal to alter their organizational structure, becoming more complex.

This behavior depends on international trade and on the destination of exports. In Caliendo and Rossi-Hansberg (2012) firms with heterogeneous demands use knowledge to produce differentiated products that can be traded internationally across countries with similar preferences. In our model, instead, consumers in rich countries value quality more, as in Verhoogen (2008) and Brambilla, Lederman and Porto (2012). Firms that can access high-income markets thus have an incentive to develop higher quality products and earn higher profits. However, the increase in the complexity of the problems involved in the production of higher quality goods makes firms that decide to enter high-income export markets upgrade their organizational structure. This is not necessarily a scale effect, but rather a consequence of the provision of higher quality output in high-income exports.

3.1 Preferences

There are N agents with CES preferences that include a valuation for quality

$$(1) \quad U(x(\cdot)) = \left[\int_{\Omega} \left(\alpha\theta^{\iota(y_d)}\right)^{\frac{1}{\sigma}} x(\alpha)^{\frac{\sigma-1}{\sigma}} M\mu(\alpha)d\alpha\right]^{\frac{\sigma}{\sigma-1}},$$

where α is an index of variety of goods, $x(\cdot)$ is the consumption each variety, M is the mass of products available to the consumer, $\mu(\cdot)$ is the probability distribution over the available varieties in Ω and $\sigma > 1$ is the elasticity of substitution. These preferences feature two demand shifters. Consumers value a higher α, which is an exogenous shifter. In addition, we allow firms with a given α to choose a quality enhancement θ, which works as an additional demand shifter. To capture the observation that high-income consumers demand higher quality, we assume that the quality shifter θ depends on the valuation of quality ι, which is an increasing function of the per capita GDP (y_d) of the country.

The demand curve is

$$(2) \quad p(\alpha;\theta) = q(\alpha;\theta)^{-\frac{1}{\sigma}}(\alpha\theta^{\iota(y_d)}R)^{\frac{1}{\sigma}}P^{\frac{\sigma-1}{\sigma}},$$

where total quantity is $q(\alpha,\theta) = Nx(\alpha,\theta)$, R is the total revenue in the economy and P is the standard CES price index.

Agents have 1 unit of labor, which accrues a wage w. They can learn how to solve problems in the interval $[0, z]$ at a cost wcz. This cost is received back as wages so that the total income of an agent with knowledge z is $w[cz + 1]$.

3.2 Production

We model production as in Caliendo and Rossi-Hansberg (2012) with an extension to account for the production of quality. An entrepreneur pays a fixed cost F^E to design a product and to get a draw of α from $G(\cdot)$. This parameter α is an exogenous source of firm heterogeneity. Given α, the entrepreneur decides to pay a fixed costs F^E and produce or exit. If α is high enough, the entrepreneur builds an organization, develops the quality θ of its product and produces physical quantities.

An organization with L layers produces quantity and quality with labor and knowledge. Within a firm, an agent can be a worker (employed at layer $\ell = 0$) or a manager (employed at layers $\ell \geq 1$). The number of employees at layer ℓ is n_L^ℓ and their knowledge is z_L^ℓ. Workers use 1 unit of time to produce A units of output of quality θ. To carry out production, the worker needs to solve a problem drawn from the distribution

$$(3) \quad F(z) = 1 - e^{-\lambda(\theta)z},$$

where $\lambda(\theta) > 0$ regulates how common (i.e., difficult) the problems faced in production are: a higher λ means that problems are more common, easier to solve. We assume that λ is a decreasing function of quality θ. This captures the notion that, conditional on a given quantity, the provision of higher quality θ requires solving more difficult problems. We thus think of quality as an attribute of the product that is developed alongside the production of quantity. For example, assembling a high quality car involves paying more careful attention to details as well as operating more complex robots or handling more sophisticated inputs. Producing a higher quality product may also require more complex activities in labelling, logistics or certification. We specify the following relationship between λ and θ

$$(4) \quad \lambda(\theta) = \frac{\lambda_0}{b_0 + b_1\theta^{b_2}},$$

where λ_0 is a baseline parameter and $b_0 > 0$, $b_1 > 0$ and $b_2 > 1$ govern how quality affects the complexity of physical production. This function is general enough and captures the facts that the cost of production is increasing in θ at an increasing rate.[4] With this extension for quality provision, the cost minimization program fits the same structure as in Caliendo and Rossi-Hansberg. A worker with knowledge z_0 can solve the easiest problems in the range $[0, z_0]$. If a worker at layer $\ell = 0$ cannot solve the problem, he goes to a supervisor or manager who invests h units of time in listening to it. The manager at layer $\ell = 1$ can solve problems in the range $[z_0, z_0 + z_1]$. If this manager can solve the problem of the worker, production of output of a product with quality θ is realized. If not, this manager can go to a manager one layer up.

Conditional on quality θ and quantity q, the cost minimization program for an organization with L layers is

$$(5) \quad C_L(q, \theta; w) = \min_{\{n_L^l, z_L^l\}_{l=0}^{L}} \sum_{l=0}^{L} n_L^l w[cz_L^l + 1],$$

subject to

$$(6) \quad A\left[1 - e^{-\lambda(\theta)Z_L^L}\right] n_L^0 = q;$$

$$(7) \quad n_L^l = n_L^0 h e^{-\lambda(\theta)Z_L^{l-1}}, L \geq l > 0;$$

$$(8) \quad n_L^L = 1.$$

where n_L^ℓ is the number of workers in layer ℓ and $Z_L^l = \sum_{\ell=0}^{l} z_L^\ell$ can be interpreted as the cumulative knowledge of the organization. Equation (6) is the production function; output q with quality θ depends on the number of workers in layer 0, n_L^0, and the cumulative knowledge, given the complexity of the problems captured by $\lambda(\theta)$. Restrictions (7)-(8) link the structure of each layer with the supervisory layer above. As in Caliendo and Rossi-Hansberg (2012), the uppermost layer

[4]Note that we restrict the parameters in (4) to satisfy the condition that guarantees that firms choose strictly positive knowledge z in every layer, $c/\lambda(\theta) \leq h/(1-h)$.

has one entrepreneur, $n_L^L = 1$. In the intermediate layers, the number of supervisors n_L^l depends on the number of workers who bring unsolved problems and the cost of communication h. For ease of exposition, the first order conditions for cost minimization are relegated to the Appendix.

For each pair (q, θ) firms choose the optimal number of layers so that the minimum cost function is

$$(9) \quad C(q, \theta; w) = \min_{L \geq 0} C_L(q, \theta; w)$$

Figure 4 (Panel (a)) plots the minimum average cost function for two firms, one producing a low quality product (in gray) and another a higher quality one (in black). We treat θ as a parameter for the moment, but it will be optimally chosen in the profit maximization problem (below).[5] For a given layer, the average cost is U-shaped. As output increases, layering up leads to efficiency gains and lower average costs. Panel (a) plots the minimum cost function $C(q, \theta; w)$, which is the lower envelope of the average cost function of each layer. In Panel (b), we plot the optimal organizational structure (number of layers) as a function of quantity q (in gray for the low-quality firm and in black for the high-quality firm).

The cost function for a firm producing a higher quality good is similar (in black), except that these costs are higher at each level of q. The fundamental observation to highlight in Figure 4 is that a high-quality firm finds it optimal (efficient) to layer-up at lower levels of output (lines in black). This can be seen by comparing the level of output at the discontinuities of the envelope of the average cost curves (panel a), which translates into a shift to the left in the quantity cutoffs at which the high-quality firm changes layers. The intuition is that higher quality increases the likelihood of facing difficult problems and this requires a more complex organization. Consequently, if, for any reason, for example due to a trade shock, a firm decides to upgrade quality it will also become more organizationally complex.

Consider a firm with draw α and the production technology characterized by the cost function $C(q, \theta; w)$ just described. Firms choose price p (or quantity q) and quality θ to maximize profits under monopolistic competition. The profit function is

$$(10) \quad \pi(q, \theta) = q^{\frac{\sigma-1}{\sigma}} (\alpha \theta^{\iota(y_d)} R)^{\frac{1}{\sigma}} P^{\frac{\sigma-1}{\sigma}} - C(q, \theta; w) - wF^E.$$

[5] This graph represents the numerical solution of our problem. Note that, for illustration purposes, we solve the model for firms with up to 4 layers ($L = 0$ to $L = 3$). The parameter set is $A = 5$, $w = 1$, $c = 2$, $\lambda_0 = 1$, $h = 0.8$, $b_0 = 0$, $b_1 = 2$ and $b_2 = 1.5$. The low quality firm produces $\theta = 1$ and the high-quality firm, $\theta = 2.5$.

The first order conditions for profit maximization are

$$(11)\quad p(\alpha;\theta) = \frac{\sigma}{\sigma-1} MC(q(\alpha;\theta);w),$$

and

$$(12)\quad q(\alpha;\theta)^{\frac{\sigma-1}{\sigma}} \left(\alpha\theta^{\iota(y_d)}R\right)^{\frac{1}{\sigma}} \frac{\iota(y_d)}{\sigma\theta} = \frac{\partial C}{\partial \theta}.$$

The optimal price for a good of quality θ is a mark-up over the marginal cost of output MC, which depends on both q and θ. In the margin, firms choose quality to equate the marginal cost of quality (which depends on both q and θ) and the marginal revenue (via higher sales) of increasing θ. In finding the solution to this system of equations, we need to take into account that a given choice of both q and θ affects the marginal costs with respect to both q and θ. Before characterizing this solution, we describe next the role of exports and exports to high-income destinations.

3.3 Exports to High-Income Countries

In our empirical analysis, we compare high-income exporting firms with other firms. To guide the interpretation of this comparison, we examine the theoretical behavior of three types of firms: non-exporters, low-income exporters, and high-income exporters. To do this, we assume that firms face three markets: a domestic market, with income y_D and $\iota(y_D) = \iota_D$; a low-income export market with income y_L and $\iota(y_L) = \iota_L$; and a high-income export market with income y_H and $\iota(y_H) = \iota_H$. We assume $\iota_H > \iota_L$, so that quality valuation is higher in the high-income country. We also assume $\iota_L = \iota_D$ so that the domestic and low-income countries have the same quality valuation. Finally, we set $R_H = R_L$ so that total revenue is the same irrespective of the export market. These assumptions allow us to separate the quality valuation effect and the scale effect of exporting to high-income destinations. Exporting is costly. There are fixed costs of exporting, F_L and F_H, to countries L and H. There are also iceberg costs $\tau_{DL} > 1$ and $\tau_{DH} > 1$. For the baseline solution, we assume these iceberg costs are the same across destinations $\tau_{DL} = \tau_{DH}$. We want to explore how firms that choose different export strategies behave in terms of the choice of quality and its organizational structure. To this end, we describe the profit function for each type of firm and study their profit-maximizing behavior (in partial equilibrium).

Profits for a firm with no exports are

$$\text{(13)} \quad \pi_D(\alpha) = p_D N_D x_D - C(q_D, \theta_D; w_D) - w_D F_E,$$

where the subscript D denotes the domestic economy. Note that total quantity is $q_D = N_D x_D$.

In the case of exporting firms, we assume that they choose the same quality enhancement θ across markets. Thus, firms do not discriminate quality and charge the same price (net of iceberg costs) across destinations.[6] The quantities sold can however be different. In addition, we do not allow firms to serve both export markets in order to better illustrate the behavior of low-income and high-income exporters separately.

Profits for a low-income exporter are

$$\text{(14)} \quad \pi_L(\alpha) = p_D N_D x_D + p_L N_L x_L - C(q_{DL}, \theta_{DL}; w_D) - w_D F_E - w_D F_L,$$

where the total quantity sold is $q_{DL} = N_D x_D + \tau_{LD} N_L x_L$ and θ_{DL} is the optimal quality of a low-income country exporter. Our pricing assumption implies that $p_L = \tau_{DL} p_D$.

The corresponding profits for a high-income exporter are

$$\text{(15)} \quad \pi_H(\alpha) = p_D N_D x_D + p_H N_H x_H - C(q_{DH}, \theta_{DH}; w_D) - w_D F_E - w_D FH,$$

with $q_{DH} = N_D x_D + \tau_{DH} N_H x_H$, $p_H = \tau_{DH} p_D$, and θ_{DH} is the optimal quality of a high-income country exporter.

To proceed, we solve the model for these three types of firms for a set of parameter values. This solution has to be computed numerically. We first solve the cost minimization problem for a matrix of quantity (q) and quality (θ). For each pair (q, θ), we compute the total cost, as well as the average and marginal cost, for different organizational structures from $L = 0$ to $L = 3$ (i.e., for up to 4 layers). We then find the optimal (cost-minimizing) number of layers and the envelope cost function $C(q, \theta; \cdot)$. Second, for a range of values of α, we solve for the profit-maximizing choice of price (quantities), quality and the number of layers for our firm typology—non-exporters,

[6] We adopt the assumption of a common quality enhancement in both markets to keep the model of the technology similar to Caliendo and Rossi-Hansberg (2012). This allows us to capture the role of quality on the organizational structure by assuming that producing higher quality products makes the firm encounter more complex problems (which we formally capture with a lower λ in the cost function). Allowing the firm to choose different qualities would require a model with separate lines of production and organization as in Verhoogen (2008). While this is plausible, it implies a significant departure from Caliendo and Rossi-Hansberg.

low-income exporters and high-income exporters. Next, for each α, we find the profit-maximizing export modality, namely, no exports, low-income exports or high-income exports. Finally, we shock the iceberg costs faced in high-income exporting markets.

The profile of profits for the three types of firms is depicted in Figure 5. Panel (a) plots the solution of the baseline model. Profits increase with α and the profit profiles get steeper as we move from non-exporters to low-income exporters to high-income exporters. We can delimit three cutoffs. The entry cutoff to the domestic market is $\overline{\alpha}_D$. As α increases, profits increase along the light gray curve in the figure. The entry cutoff into the low-income export market is $\overline{\alpha}_L$ and, as α increases, profits increase along the gray curve. Finally, for $\alpha > \overline{\alpha}_H$, firms enter the high-income market and profits increase along the black curve. In Panel (b), we add the profit profile (in purple) under lower trade costs. As the iceberg costs to the high-income country τ_{DH} decline, the cutoff entry declines to α_{H2} and firms with lower consumer appeal find it profitable to enter high-income markets.

In Figure 6, we explore the implications for quality (panel a) and the number of layers (panel b) of the exporting status of the firms. The baseline solution is represented by the graphs on the left. As firms enter the domestic market and α increases, product quality improves (panel a). Note that these are the simplest firms, with only 1 or 2 layers, $L = 0$ or $L = 1$ (panel b). When α reaches the low-income export market cutoff, two concurrent things happen. Firms moderately increase quality while, to do that efficiently, they also add a third layer ($L = 2$). We emphasize that this happens simultaneously. In this case, this is a scale effect because we assume that the quality valuation of low-income partners is the same as the domestic quality valuation $\iota_D = \iota_L$. It is not necessarily a scale effect related to exporting, though. At $\overline{\alpha}_3$, a firm with such a product appeal finds it profitable to increase quality (moderately) and add layer $L = 3$. This firms are bigger and more complex without changing export status. It is noteworthy that, even for low-income exporters, there is an interesting and non-trivial theoretical relationship between α and θ. After the cutoff $\overline{\alpha}_L$, further increases in α lead to slightly lower levels of quality. Then, there is the discrete jump in quality at $\overline{\alpha}_3$, and, after that, there are slight decreases in θ as α further increases. This is not a general result. In our formulation, this occurs because firms with higher α enjoy higher demand and sell more output. Increasing quality for this potentially higher output is costly in terms of the complexities of the production process. In the end, the effect of quality on costs dominates the effects of quality as a demand shifter.[7] When α is high enough, though, a discrete quality upgrade can be profitable. More importantly for our premise is that there is an abrupt jump in optimal quality when the firm crosses the high-income export cutoff, $\overline{\alpha}_H$. This is entirely due to the high-quality valuation of these markets, given $\iota_H > \iota_L$ (and, also, given $R_H = R_L$). We emphasize that this is not a scale effect in high-income exporting. To see this, note that we restrict the market size in each export destination to be the same in the numerical solution and we do not allow firms to enter both export markets simultaneously. Firms at the $\overline{\alpha}_H$ cutoff are already complex firms and do not adjust the organization but, for even higher αs (not plotted), they would further upgrade their quality and their structure.

Consider now a decline in the iceberg costs of exporting to high-income destinations (the graphs on the right in Figure 6). As we showed above, as a result, the entry cutoff declines to $\overline{\alpha}_{H2}$. This causes firms to enhance their hierarchical complexity. There is a range of α between $\overline{\alpha}_{H2}$ and $\overline{\alpha}_3$ where firms become high-income exporters and add a layer to the organization. This is accompanied by a discrete increase in quality. In this range of α, this effects are not present in low-income exporters.

These are in the end the two major testable implications of the model. A trade shock that facilitates entry into high-income markets (as the Free Trade Agreement Chile signed with the US, the EU and Korea) induces firms to both upgrade quality and add hierarchial layers to become more efficient and complex. Intuitively, the high-income market becomes profitable because of the reduction in trade costs, but satisfying this market requires selling higher quality products. This in turn increases costs because producing high quality goods raises the likelihood of facing more difficult problems during production. A more complex organization of the firm is an efficient way to do this.[8]

[7] These tensions between the cost effect and the demand effect of quality are studied in Kugler and Verhoogen (2012) and Hallak and Sividasan (2013). They are not, however, relevant, for the case we want to make because, in our model, at the cutoffs of exporting, the demand shifter effect is large enough to illustrate the mechanism.

[8] Note, however, that this layering up does not have immediate efficiency implications in terms of average costs as in Caliendo and Rossi-Hansberg (2012). Because the profitable provision of higher quality is costly, the average costs of high-income exporters can in the end be higher rather than lower. See the Appendix for this and other theoretical results from the model.

4 Regression Analysis

We now turn to the regression analysis to study organizational mechanics. The model is:

$$(16) \quad L_{it} = \gamma_{HI} E_{it}^{HI} + \mathbf{x}_{it}' \beta_2 + \phi_i + \phi_t + \varepsilon_{it},$$

where i is a firm and t is time. The dependent variable, L_{it}, is the number of hierarchical layers (i.e., discrete numbers 1, 2, 3 or 4). Since we want to study the effects of changes in export destinations, we include a dummy variable, E_{it}^{HI}, which is 1 for firms that export to high-income countries (according, as above, to the standard World Bank classification). Our main interest is in the coefficient γ_{HI}. By using an export dummy, we aim to capture the extensive margin of exports.[9]

The regression includes various controls for firm characteristics, ϕ_i is a plant-level fixed effect, ϕ_t is a time fixed effect, and ε_{it} is a mean-zero disturbance. The plant and year fixed effects control for unobserved potential confounders that are fixed over time at the plant-level (e.g., plant location, organizational culture) and time-varying shocks affecting all plants simultaneously (e.g., changes in consumer preferences, technological advance, and macro-shocks). We also control for pre-existing trends in plant-export participation and in firm size (sales). These variables are in the vector $\mathbf{x}$.

Even though our hypothesis is related to the behavior of firms that begin exporting to high-income destinations, we also study an extended model to compare these firms with exporting firm more generally. To do this, we consider the following model with two export dummies

$$(17) \quad L_{it} = \gamma_{HI} E_{it}^{HI} + \gamma_W E_{it}^{W} + \mathbf{x}_{it}' \beta_1 + \phi_i + \phi_t + \varepsilon_{it},$$

where E_{it}^{W} is the export status of firm i at time t, irrespective of the destination of exports. Here, the exporter dummy E^W captures the average effect of exporting to the world and the high-income dummy E^{HI} can be interpreted as a premium for the high-income exporting firms.

The OLS-FE estimation of equations (16) and (17) are reported in Panel (a) of Table 4. These results are analogous to the prima-facie results based on industry data (Figure 2), but using firm-level data. In column (1), we establish a positive (and significant) correlation of exporting to high-income countries and the organization complexity of the firm. In column (2), we show that

[9] In Section 5, we perform robustness analyses to both the classification of countries and the use of export dummies in the regression.

this correlation holds after controlling for the general export status of a firm. Finally, in column (3), we see that the correlation is in fact non-existent (statistically) for the average exporter. As we claim, the organizational mechanism seems to be a phenomenon that applies to high-income exporters.

Clearly, these results may be biased. The exporting status of the firm is endogenous because more productive plants self-select into export markets, and because plant-level shocks might affect export decisions, organizational changes and quality provision simultaneously. There can also be reverse causality, as shown by Bloom, Sadun, and Van Reenen (2012), Bloom, Eifert, Mahajan, McKenzie, and Roberts (2013), Bloom, Manova, Van Reenen, Teng Sun, and Yu (2020) and Bruhn, Karlan, and Schoar (2018). There can also be measurement errors in the construction of the layers because of limitations of the ENIA that impose some restrictions on the number and composition of those layers.[10]

To account for this, we implement several instrumental variable estimations. Our identification strategy exploits the temporal variation in tariffs on Chilean products across the different Free Trade Agreements described in Section 2. Underlying this idea is the notion that the tariffs cuts arising from FTAs can be plausibly considered exogenous to the organizational structure of individual firms. These reductions in tariffs vary both across industries and destinations, and allow us to predict the firm's entry into different export markets, and, then, to explore the attending decisions to alter the firm organization. The use of FTAs as a source of exogenous tariff changes has also been pursued by Lileeva and Trefler (2010), for Canadian plants; Bustos (2011), for Argentine firms; and Garcia-Marin and Voigtländer (2019) for the Chilean firms of this paper.

The instrument is constructed as follows. In Section 2, we aggregated the bilateral tariffs faced by Chile from TRAINS at the 4-digit ISIC Rev. 3, the industry classification in the firm dataset (ENIA). Denote this τ_{jt}^{d} for industry j, destination d, and time t. We then compute the average industry tariffs faced in high-income FTA countries, USA, EU and Korea:

$$\tau_{jt}^{HI-FTA} = \sum_{d \in HI-FTA} s_{j0}^{d} \tau_{jt}^{d}, \tag{18}$$

where s_{j0}^{d} is initial share of exports of industry j to high-income FTA destination country d (USA, EU, and Korea). This variable is in principle a plausible instrument for the high-income exporter

[10] Caliendo, Monte and Rossi-Hansberg (2015), for example, utilize richer administrative data to build the layers of French firms.

dummy. It is very important to note that we use initial industry j export shares, rather than firm i export shares in (18). This is because we want to capture market access or extensive margin effects of the FTAs. In fact, the approach of using initial firm shares as weights can only at most capture the intensive margin effects of firms that were already exporters (to high-income FTAs countries) before the agreements were even signed. By using industry averages, we aim to retrieve potential effects on initially non-exporting firms. This is important because, as shown in Figure 1, a fundamental fact stemming from the FTAs is not only the increase in exports to signing partners but also the increase in the number of exporters. This idea is similar in spirit to Hakobyan and McLaren (2016), who combine the local labor market average tariff with the industry average tariff to investigate labor responses to tariffs in the US. Furthermore, to increase the likelihood of capturing potential new exporters, we interact the average tariff τ_{jt}^{HI-FTA} with both ex-ante firm sales and export status under the premise that larger firms are more likely to profit from the export opportunities of the FTAs. We do this to allow for first-stage heterogeneity, which matters in IV estimation (Angrist and Imbens, 1995). To clarify the rationale of our strategy, we discuss in Section 5 below the differences with more standard strategies using tariff changes weighted by initial *firm* shares. As we will see, the results are quite different.

Recall that Chile also formed FTAs with Mercosur, Mexico, Costa Rica and El Salvador. While these are older agreements, they do have provisions to reduce tariffs during the time span of our sample. To exploit this, we construct the average tariff to *any* FTA destination faced by the average Chilean firm:

$$(19) \quad \tau_{jt}^{FTA} = \sum_{d \in FTA} s_{j0}^{d} \tau_{jt}^{d}.$$

This includes all FTA partners, high-income and Latin America. These overall tariff changes can be used as an additional instrument for the exporter dummy. Note that we use τ_{jt}^{HI-FTA} and τ_{jt}^{FTA} as separate instruments, because the nature of the FTAs from which they are created is different in terms of partners (high-income versus Latin American countries) and timing. Below, we perform robustness tests to this strategy.

The 2SLS results are reported in columns (4)-(6) of Table 4. We find a causal impact of exporting to high-income countries on the firm organizational complexity. The estimated coefficient of the dummy E^{HI} is positive and statistically significant (column 4).[11] Entry into high-income export

[11] In all our regressions, because of the way we construct the instrument, we compute industry-clustered standard

markets (which in our specification is caused by the Free Trade Agreements with the US, the EU and Korea) induces firms to increase the number of hierarchies in their organization by 0.207 layers.[12] This organizational mechanism is a phenomenon that applies to high-income exporters rather than to exporters to the world more generally. We can see this in column (5). When we include both export dummies in the regression (E^{HI} and E^{W}), we keep estimating a positive and significant causal effect of high-income exporting but not of exporting per se. Furthermore, when we only include E^{W}, there is no causal impact for the average exporter. This implies that the effect on high-income exporters gets in fact diluted among all exporters.

In columns (7)-(9), we add log sales as a control for firm size, but this does not affect the results.[13] These specifications are aimed at addressing the role of scale effects. In Caliendo and Rossi-Hansberg (2012), exporting has an organizational effect mainly through a scale effect: the firm adds layers and becomes more complex as it grows because larger firms face a higher probability of facing difficult problems. However, our results in columns (7)-(9) show that the firm re-structuring associated with high-income exporting holds also conditional on firm size. Consequently, the scale effect of exporting is not driving the results entirely. The rationale for this result is the notion that costs increase as quality increases for a given level of output, as the solution of the model in Figure 4 shows.

Before assessing the instrument and our IV strategy in general, we want to establish here the other premise of our claim, namely that exporting to high-income countries requires output quality upgrades. To do this, we run our baseline regression above using a proxy for quality as dependent variable. This proxy, θ_{it}, is the log of the unit value of the firm output, computed as the ratio of sales to quantities sold (for the core product). The causal impacts of high-income exporting

errors (at 4-digit ISIC). Recently, it has become good practice in the shift share literature to account for the presence of correlation in the errors of the regression that may inflate the variance of the estimates (Adao, Kolesar and Morales, 2019; Goldsmith-Pinkham, Sorkin, and Swift, 2020; Borusyak, Hull, and Jaravel, 2022). In the typical trade and local labor market setting, the regressor or the instrument is built by averaging sectoral trade shocks (tariffs or imports) using industry exposure shares as weights. In this case, shocks that are specific to an industry may induce regional correlation in the errors across local labor markets with a similar industry structure. In our setting, this issue does not apply because even though our unit of observation is the Chilean firm and we do use a shift-share instrument based on industry weights, our regressions accommodate industry-level clustered standard errors. Nevertheless, our instrument aggregates FTA tariffs across (high-income) destinations using industry export shares as weights and this may lead to a different type of correlation caused by shocks to the export destinations. Accounting for this following Adao, Kolesar and Morales (2019) leads, however, to (much) smaller standard errors. This is because the clustered correlation caused by industry shocks is stronger in our data than the correlation caused by export destination shocks. As a result, we report our results using the more conservative standard errors based on industry clusters.

[12] Note that the estimated IV coefficient is larger than the OLS coefficient, which is most likely due to measurement error in L_{it}.

[13] It is important to clarify that the inclusion of log sales is not intended to capture a causal coefficient, but the idea is that plant's sales work as a proxy for unobservables such as productivity shocks.

estimated with our 2SLS strategy are reported in Panel (b)) of Table 4. The IV coefficient of the HI exporter dummy is positive and statistically significant (column (4)).[14] The magnitude of the coefficient implies that a firm that starts exporting to a high-income country increases the average quality of its core product by 38 percent. In column (5), we find that new exporters, irrespective of the destination, may increase quality (the coefficient is positive), but this effect is not statistically significant. In we only include the world exporter dummy, then the average quality of those exporters is only marginally higher (column (6)).

To sum up, in Chile, the average exporter to high income countries sells higher quality goods and this, in turn, is accompanied by an increasing complexity of the hierarchies of these firms. Moreover, this is not entirely a scale effect. It is the result of a feature inherent to high-income exporting: selling high-quality goods demanded in high-income destinations makes production mode complex and the re-organization of the firm is an efficient response. To our knowledge the heterogeneous causal effect of export destinations on hierarchical firm organization intertwined with quality upgrading is a completely novel result in the literature.

4.1 Assessing the Instruments

Turning to the evaluation of the instrument, we begin with the first stage results reported in Table 5. Column (1) reports the coefficients pertaining to the model with a high-income export dummy only, column (2), those corresponding to the model which adds the export dummy, and column (3) shows the coefficients of the model with only the export dummy. The instruments are the average tariff by to high-income FTAs countries (18) and to any FTA country (19), as well as interactions with firm characteristics. These estimates imply that lower tariffs to each destination increase the probability of being an exporter to said destination for initially larger non-exporting firms. Intuitively, ceteris paribus, initially larger firms are more likely to benefit from the tariff cuts and this mechanism is stronger for initially non-exporting firms. The first-stage regression has sufficient predictive power for the endogenous regressors. Since the average tariff is constructed at the 4-digit industry classification, we estimate conservative clustered standard errors. We consequently use the clustering-robust Kleibergen and Paap (2006) test statistic for weak instruments. At the bottom of the table, we show that this F-statistic indicates that we can reject the null of weak instruments. Columns (4)-(6) reproduce this layout also controlling for firm size. In all cases, the first stage

[14]The OLS estimates in columns (1) to (3) of Panel (b) are positive but not significant.

results work well. Overall, these first-stage results are reassuring.

Even though the first-stage works well, a potential threat to our identification strategy arises if Chilean manufacturing plants foresee the reduction in tariffs and then modify their optimal decisions before the actual changes in tariffs occur. For example, if firms anticipate free trade agreements, they could increase their capital investment to prepare for exporting in future years, or they could change their main variety produced (and then their industry of affiliation) anticipating relative changes in product tariffs. To address this concern, using data from ENIA for the period 1996-2001 and UNCTAD-TRAINS tariff data for the period 2001-2005, we show in Figure 7 that there is no correlation between the log change of several industry-level outcomes of relevance (sales, employment, capital stock, and number of firms) between 1996-2001 and the subsequent industry-level tariff liberalization between 2001 and 2005. Specifically, Figure 7 shows scatters and linear fit regressions of the log change of an industry-level outcome on the changes in average tariffs in high-income countries (Panel (a)) or Latin American middle-income countries (Panel (b)). In all cases, the estimated coefficients are statistically indistinguishable from zero, in line with the idea that firms are not anticipating and reacting to the subsequent trade liberalization. For instance, firms belonging to industries facing relatively higher tariffs cuts during 2001-2005 did not outperform firms in other industries in terms of capital accumulation, total sales, or labor demand. Also, there is no correlation between the change in the number of firms and future tariff reductions, so that the net effect of firm's entry and exit did not differ significantly across industries in the pre-liberalization period.

To provide further evidence in support of the identification strategy, we perform two additional complementary exercises. The intuition behind our strategy is that, since our sample spans the 2001-2005 period, the Chilean FTAs with the US, the EU and Korea provide a strong before-after experiment to study entry into high-income export markets (and export markets more generally). On top of this, the Latin American FTAs imply gradual tariff reductions which provide additional variability to predict exporting decisions of Chilean firms. In Table 6, we dissect the instruments to show how they operate. In column (1), we run the regression model including only the high-income exporting dummies as an explanatory variable E^{HI} instrumented only with the high-income FTA tariffs, τ^{HI-FTA} in (18). This specification is useful to isolate the role of the high-income FTAs, which is important since we care mostly about high-income exporting. The coefficient in this case is positive and statistically very significant. As expected, the instrument has enough explanatory power to identify the effects. The coefficient, estimated at 0.337, is a bit larger than before, which was 0.216 (see the specification in column (7) of Table 4). While these are not different statistically, the direction of the difference makes sense when we allow for heterogeneous effects of the instrument (Angrist and Imbens, 1995). That is, by using only the tariffs of the high-income FTAs as instruments, we capture the behavior of firms that enter these markets directly, rather than for example the behavior of firms that do not select into high-income markets because of the market access effects of the Latin American FTAs. Arguably, we expect firms that select into high-income markets to react more strongly. If we instead include the world exporter dummy, E^W, using only the high-income FTA tariffs as instruments (column (2)), the instrument works decently in predicting exporting, but the effects on the organization of the firm are not statistically significant. Once again, this is because the organizational change is inherent to high-income exporters and this effects is diluted in the behavior of all exporters.[15] The results in columns (1) and (2) are encouraging.

For the second complementary exercise, we compute the average tariff to Latin American FTAs, τ_{jt}^{LA-FTA}

$$(20)\quad \tau_{jt}^{LA-FTA} = \sum_{d \in LA-FTA} s_{j0}^{d} \tau_{jt}^{d},$$

and we run models that use the high-income FTA tariff τ^{HI-FTA} as before together with the Latin American FTA tariff τ^{LA-FTA} in (20) separately.[16] The results are in columns (3)-(5) of Table 6. In this exercise, we confirm our finding that the re-organization of the firm due to entry into exports is inherent to high-income markets (because of quality considerations). The high-income export dummy is positive and statistically significant when entering the regression model alone (column (3)) and this is preserved when we also include the general exporter dummy (column (4)). In contrast, the exporter dummy, when alone, is never statistically significant (column (5)).

4.2 Organizational Mechanics

We have established that firms increase the average number of hierarchies. We now turn to investigate the mechanics of this organizational change. We begin with decisions concerning the

[15]Note that, in this exercise, we do not run the model with both export dummies, E^{HI} and E^W, together because we only have one instrument set.

[16]That is, we split the average overall tariff τ^{FTA} in (19) and we replace this instrument with the Latin American counterpart.

composition of their layers. To explore this, we run separate regressions, one for each layer, replacing L in (16) and (17) with four different layer-specific binary variables that take the value 1 if a firm employs workers in that specific layer and zero otherwise. These regressions capture the type of worker is involved in the process of firm re-structuring associated with exporting activities. We begin with the results, reported in Table 7, without controlling for firm size (columns 1 to 3). High-income exporters increase layers 2 and 3 (with coefficients that are positive and statistically significant), while there are no changes in either the bottom or the top layer of the organization. These impacts are preserved when we control for the world export dummy (column 2). Also, they are not observed for the average exporter (column 3). These results are robust to controls for firm size (columns (4) to (6)).

To look further into this, we report in Table 8 the impacts of high-income exporting on the average wage paid to workers in the different layers. We find that high-income exporters pay higher average wages to workers in layer 3, but there are no effects on wages at the other three layers. Once again, this is a finding that applies to exporters to high-income destinations rather than to any exporting firm more generally.

Taken together, these results suggest an interesting organizational adjustment of Chilean firms. Exporters to high-income countries upgrade layers 2 and 3. Layer 3 is composed of qualified workers and supervisors who monitor and manage the production process. The re-organization impact on layer 3 involves the addition of this layer for new exporters that did not have this layer to begin with, and, also, an increase in the average wage paid to these workers. This is consistent with a re-structuring within the layer itself, towards more skilled workers. Moreover, firms add layer 2, which includes administrative workers dedicated to accounting and legal activities, logistics, certification of export requirements, customs procedures and international standards. Both layers are needed to satisfy the skill upgrading required to produce the quality of high-income exports, as in Matsuyama (2007), Verhoogen (2008), and Brambilla Lederman and Porto (2012). Our results shed light on the underlying organizational mechanics as the quality upgrades occur via changes in the knowledge-based hierarchies of Caliendo and Rossi-Hansberg (2012).

To further explore this, we construct dummy variables for each pairwise combination of two layers. That is, we build a dummy L_{it}^{12} equal to 1 if a firm i has both layers 1 and 2 at t, a dummy L_{it}^{13} if it has layers 1 and 3 and so on. We run a total of 6 separate regressions for the six dummies (namely, L_{it}^{12}, L_{it}^{13}, L_{it}^{14}, L_{it}^{23}, L_{it}^{24}, L_{it}^{34}). The results are in Table 9. Panel (a) shows the combination of layers involving layer 2, L^{12}, L^{23} and L^{24}. Since we know that exporting firms expand layer 2, we should in principle expect an expansion of these three pairs of layers. However, there is only one specification with positive and statistically significant results: high-income exporting is associated with bundles of Layer 2 and Layer 3. If we look at pairs involving layer 3 (Panel (b)), then on top of the bundling with layer 2, we find marginally significant traces of combinations with layers 1 and 4. There is no bundling of layers 1 and 4 (Panel (c)).

The strong bundling of layers 2 and 3 implies that, as firms begin to export to high-income destinations, they either have layer 2 and add layer 3 or they have layer 3 and add layer 2. It is also possible, though much rarer, to see a firm with neither layer that adds both layers 2 and 3 to become an exporter. Intuitively, firms that have layer 2 are capable of delivering exporting required services (as in Matsuyama, 2007), but need to add the qualified workers of layer 3 to improve quality (as in Verhoogen, 2008). Similarly, firms that have layer 3 are capable of delivering higher quality products, but need to add the qualified workers of layer 2 to add the services required by exporting to high-income countries. Since the addition of layer 3 comes sometimes in bundles with layer 1 or layer 4 (with only marginally significant effects) rather than exclusively with layer 2, this indicates that the incorporation of layer 3 occurs more generally across high-income exporters. Overall, we interpret these results as supportive of the hypothesis of firm re-structuring to provide higher quality.

5 Assessment and Robustness

This section presents an assessment of the identification strategy and the consequent interpretation of the results. We also perform a robustness analysis.

5.1 Imported Inputs

The FTAs signed by Chile with high-income countries can in principle allow firms to access imported inputs of high quality at a lower price. The quality of inputs can for example explain why exporting to high-income countries carries an increase in the quality of the final products (Kugler and Verhoogen, 2012; Bastos, Silva and Verhoogen, 2018; Fieler, Eslava and Xu, 2018). To explore if this mechanism is biasing our results, we run our main regression model with controls for the share of imported inputs at the firm level. The results are reported in Table 10. The columns correspond to specifications without controls for total sales (columns 1 to 3) and with controls for sales (columns 4-6). The main findings of the paper are unchanged, both in terms of firm layering (panel (a)) or firm product quality (panel (b)). Exporting to high-income countries continues to cause firms to re-organize and sell higher quality output, while exporting per se does not. In addition, the magnitudes of the estimated coefficients and their standard errors do not change much.

5.2 Exposure to Free Trade Agreements

This section presents an assessment of the identification strategy and the consequent interpretation of the results. Our regression design has two outstanding features. First, export exposure (to high-income countries) is a dummy variable. Conceptually, this was intended to capture the notion that the organization mechanics that we study are more likely to take place at the extensive margin, rather than at the intensive margin. In other words, an export demand shock is more likely to trigger an organizational change if it induces firms to become exporters rather than perhaps to just expand sales abroad. Second, in order to be able to capture export demand shocks that are capable of making firms switch export status, we built the instruments around the average industry tariff, rather than around the average tariff at the firm level. It is the purpose of this section to assess these two features of our approach. We also perform a robustness analysis.

We begin with the instrument and exposure to the FTAs. A widespread approach in the literature is to follow an IV strategy that combines exogenous tariff changes (like us) or exogenous foreign exchange rate changes with initial, pre-shock, exposure.[17] It seems natural to explore these strategies as an assessment of our regression models. To implement this, we construct two sets of alternative instruments, one using tariffs and another using exchange rates.

Recalling that τ_{jt}^{d} is the tariff faced by industry j at time t in destination d, we compute a firm-level exposure to the tariff changes of high-income FTA countries as:

$$(21)\quad \tau_{it}^{HI-FTA} = \sum_{d \in HI-FTA} s_{i0}^{d} \tau_{jt}^{d},$$

where s_{i0}^{d} is the share of exports of *firm* i to destination d before the changes in tariffs take place

[17]Papers based on exchange rate movement exposure at the firm level include Park, Yang, Shi, and Jiang (2010), Brambilla, Lederman and Porto (2012), Hummels, Jørgensen, Munch, and Xiang (2014), and Bastos, Silva and Verhoogen (2018). The local labor market literature is a typical example where exposure to tariff changes depend on initial shares. See Autor, Dorn and Hanson (2013).

(in 2001) and destination d is the EU, the USA and Korea. Similarly, we construct a firm-level exposure to Latin American FTAs:

$$(22)\quad \tau_{it}^{LA-FTA} = \sum_{d \in LA-FTA} s_{i0}^{d} \tau_{jt}^{d},$$

where d is now Mercosur, Mexico, Costa Rica, and El Salvador.

We explore the implications of using these variables (together with interactions with initial firm characteristics) as instruments for the high-income export dummy and the exporter dummy in Table 11, columns (1)-(3). We focus on impacts on organizational changes and quality and we summarize the first stage results with the Kleibergen and Paap F test for weak instruments. As we can see, there is no discernable impact on the firm organization or in quality, either for high-income exporters or for exporters more generally. Technically, this is because the instruments have low explanatory power for the export exposure dummy—the instruments are not significant and are weak overall with a low corresponding F-value (reported at the bottom of the table). Intuitively, the reason for this is that the instruments (21) and (22) use initial firm exposure as weights. These take a value of 0 for initial non-exporters and, as a result, have low power to explain switches in export status. This fails to account for the extensive margin of exports and the strategy is incapable of identifying impacts on the organization of the firm or on quality. Arguably, the organizational mechanics operate for firms that become exporters. Firms that expand exports may have already re-structured before the formation of the FTAs. We interpret these results as an additional justification for the use of the instruments in our preferred specifications above (based on industry exposure).

To study exchange rate instruments, we compute a firm-level exposure variable as:

$$(23)\quad e_{it} = \sum_{d} s_{i0}^{d} e_{t}^{d},$$

where e_t^d is the bilateral exchange rate between Chile and partner d. As before, this is interacted with initial conditions at the firm level to enhance the predictive power of the exchange rate movements. The results are in columns (4)-(6) of Table 11. It is not surprising to see that the same conclusions emerge since the exchange rate instrument has little explanatory power as well and therefore none of the estimated impacts on the intensive margin are statistically significant.

5.3 Alternative Definition of High-Income Destinations

In the main analysis of the paper, we used the standard World Bank classification of high-income countries. Recall that the idea of distinguishing export destinations is because of differences in quality valuation that stem from differences in incomes. Here, we investigate the robustness of the results to the exclusion of some countries in the World Bank list, namely OPEC countries as well as a few countries that are islands in the Caribbean. We summarize the results in Table 12. Panel (a) shows positive and significant effects on quality of exporting to countries in the alternative definition of high-income countries; Panel (b), in turn, shows that only exporting firms to these destinations re-organize their hierarchies; and Panels (c) to (f) show that this re-organization takes place in terms of layers 2 and 3. Robustness to the set of high-income countries becomes apparent.

6 Conclusion

Firms that face export demand shocks re-organize and expand their hierarchical structures. Firms that export to high-income destinations sell higher quality products. In this paper, we ask if there is a connection between these two strands of literature. Using Chilean firm-level data, we find support for such a link: exporting firms to high-income countries sell higher quality goods and, in order to so, they increase their overall organizational complexity.

We set up an instrumental variables strategy that exploits plausibly exogenous variation in tariffs arising from the Free Trade Agreements signed by Chile with the United States, the European Union and Korea, as well as with Mercosur, Mexico, Costa Rica and El Salvador. These FTAs with countries with varying income levels allow us to predict the decision of Chilean firms to export goods to those different destinations. These firm-level decisions, exogenously caused by the tariff changes, identify causal effects of exporting to high-income countries.

Our results are consistent with Caliendo and Rossi-Hansberg (2012) and the recent models of firm organization and trade. Our intuition behind these links is the idea that producing higher quality products to sell in high-income exports confront firms with more complex problems in design, assembly, distribution, marketing, logistics. These problems can in principle be solved more efficiently in more complex firms with more layers of production. In particular, our study of the organizational mechanics of Chilean firms indicates that they add intermediate layers of supervisors of the general production process. These mechanics are consistent with the theories of knowledge-based organizations.

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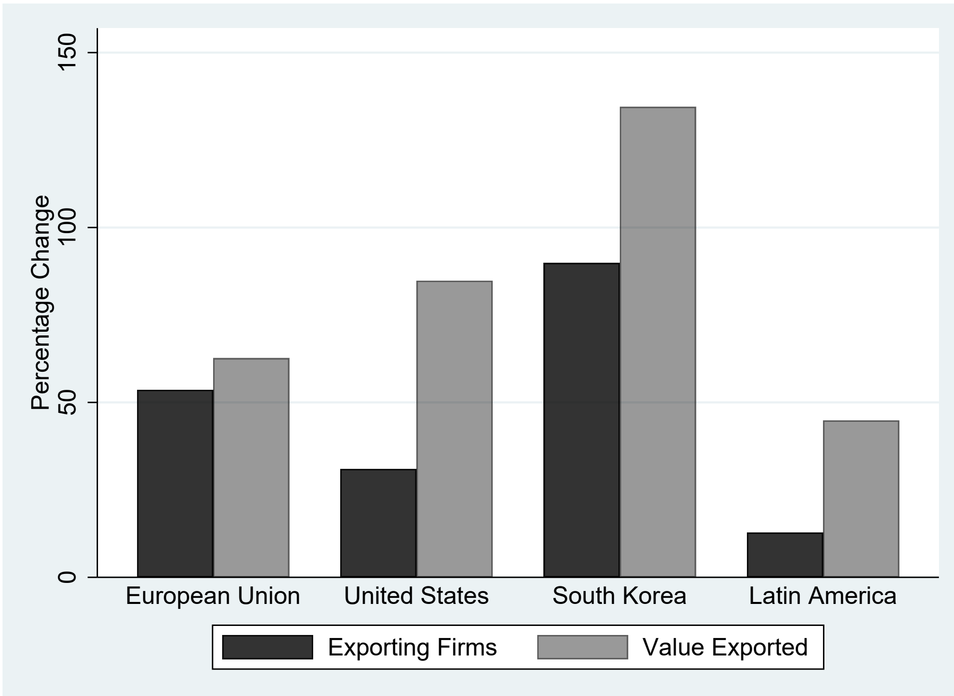
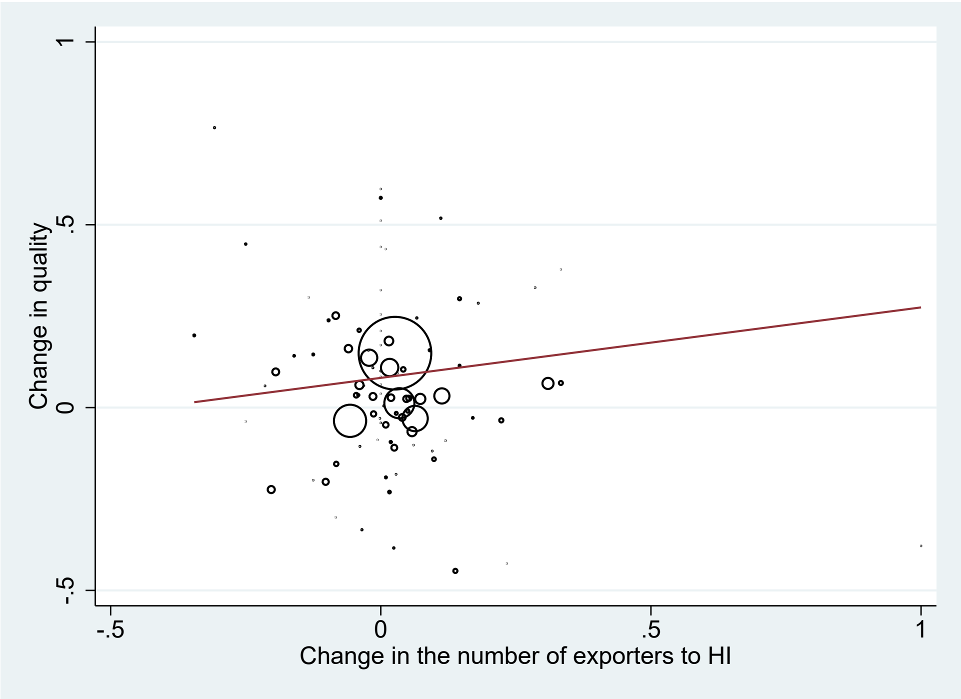
Figure 1
Changes in Exporting Firms and in Exports by Destination
2001 - 2005



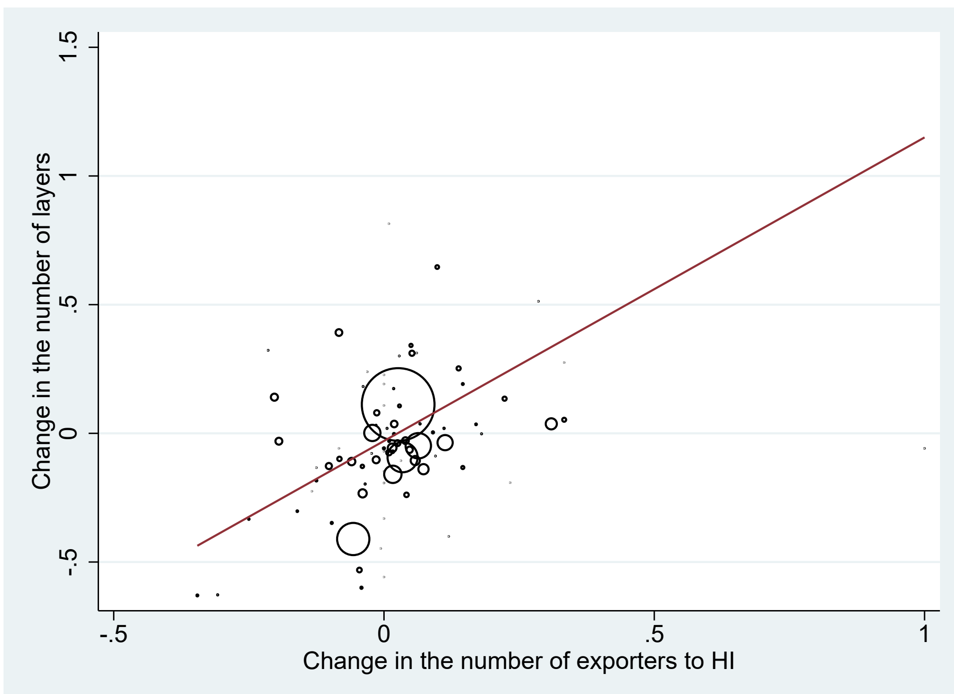
Notes: The bars show that changes in the number of exporting firms (in black) and in the value of exports (in grey) for FTA countries, namely the European Union, the United States, South Korea and Latin American countries (Mercosur, Mexico, Costa Rica and El Salvador). Chilean customs records 2001-2005.

Figure 2
Cross-Industry Changes in Quality and Exports to High-Income Countries
2001 - 2005



Notes: Cross-Industry scatterplot between changes in quality (log unit values) from 2005 and 2001 and changes in the number of exporters firm to high-income countries (World Bank definition). Industries are at 4-digit ISIC Rev. 3. ENIA combined with Chilean Customs data.

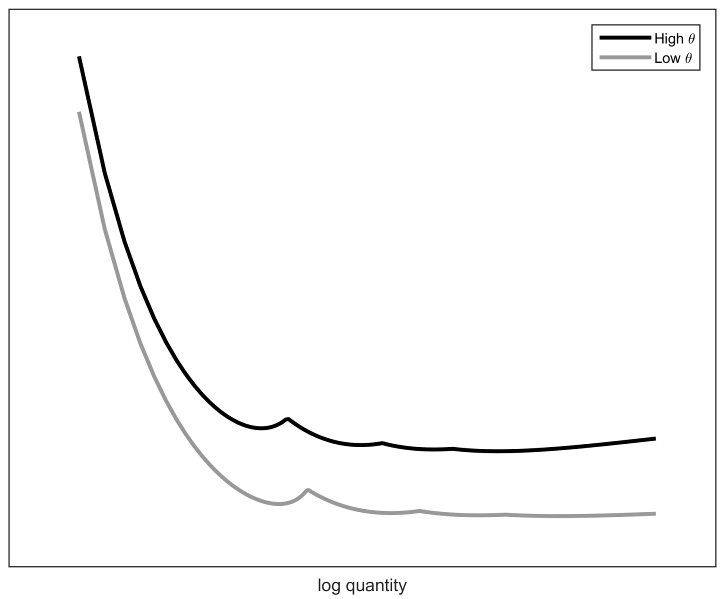
Figure 3
Cross-Industry Changes in Layers and Exports to High-Income Countries
2001 - 2005



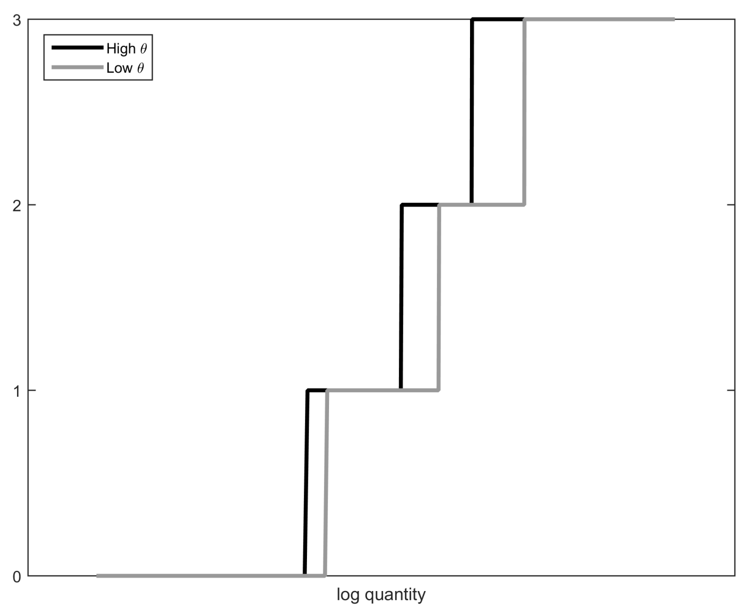
Notes: Cross-Industry scatterplot between changes in the number of organizational layers from 2005 and 2001 and changes in the number of exporters firm to high-income countries (World Bank definition). Industries are at 4-digit ISIC Rev. 3. ENIA combined with Chilean Customs data.

Figure 4
Low- and High-Quality Firms
Average Costs and Number of Layers

(a) Envelope of Average Cost



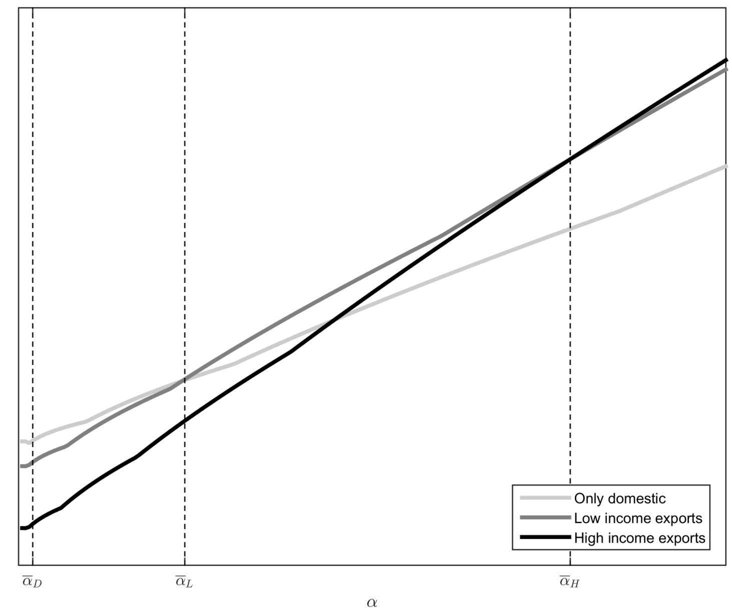
(b) Number of Layers



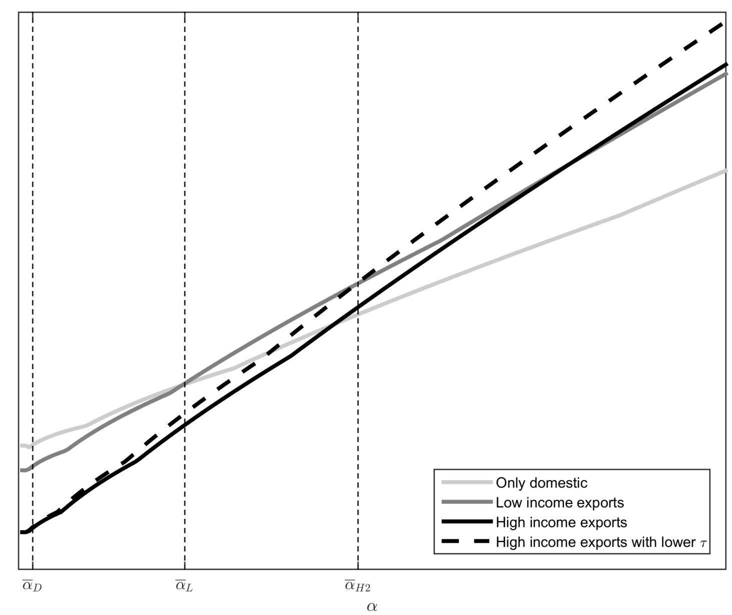
Numerical solution of the cost minimization problem. Panel (a) plots the envelope of the average cost curves for $L = 0, 1, 2, 3$. The gray envelope corresponds to a low-quality firm ($\theta = 1$) and the black curve, to a high-quality firm ($\theta = 2.5$). Panel (b) plots the optimal numbers of layers for each firm at different levels of output. The parameter set is: $A = 5$, $w = 1$, $c = 2$, $\lambda_0 = 1$, $h = 0.8$, $b_0 = 0$, $b_1 = 1$, $b_2 = 1.5$.

Figure 5
Profits

(a) Baseline



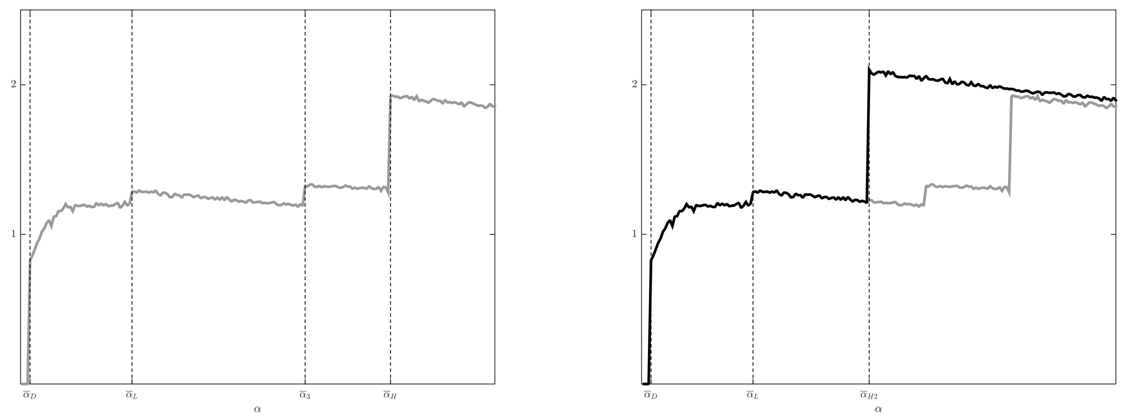
(b) Lower Trade Costs to High-Income Destinations



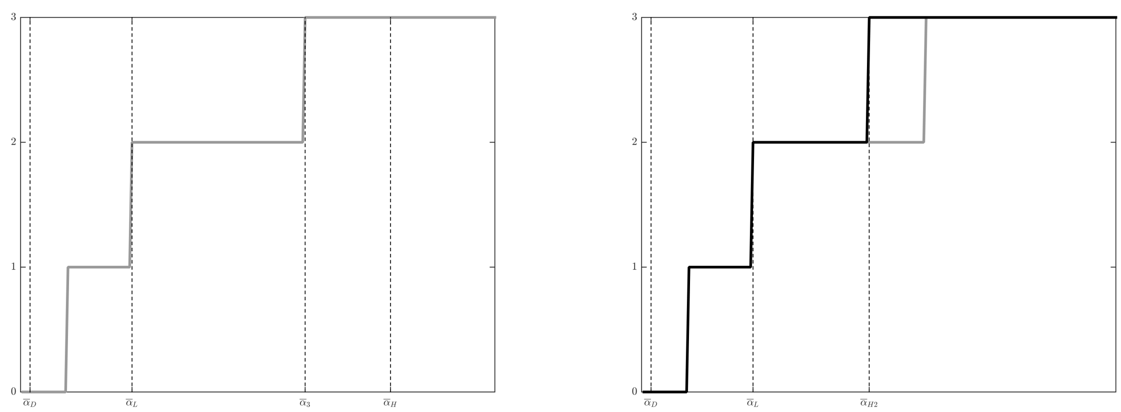
Numerical solution of the profit maximization problem in the baseline model (Panel (a)) and in the lower trade cost model (Panel (b)). The profit profiles are: in light gray for a non-exporter; in gray, for a low-income exporter; in black, for a high-income exporter in the baseline; in dashed black, for a high-income exporter under lower trade costs. The parameter set is: $A = 5$, $w = 1$, $c =$, $\lambda_0 = 1$, $h = 0.8$, $b_0 = 0$, $b_1 = 2$, $b_2 = 1.5$; $\sigma = 5$, $\iota_D = \iota_L = 3.3$, $\iota_H = 4.3$, $R_D = 25$; $R_L = R_H = 70$, $F_L = 2$, $F_H = 7$. Baseline trade costs, $\tau_{DL} = \tau_{DH} = 1.2$; shocked trade costs to high-income countries $\tau'_{DH} = 1.1$.

Figure 6
High-Income Exporting Firms
Product Quality and Number of Layers

(a) Quality



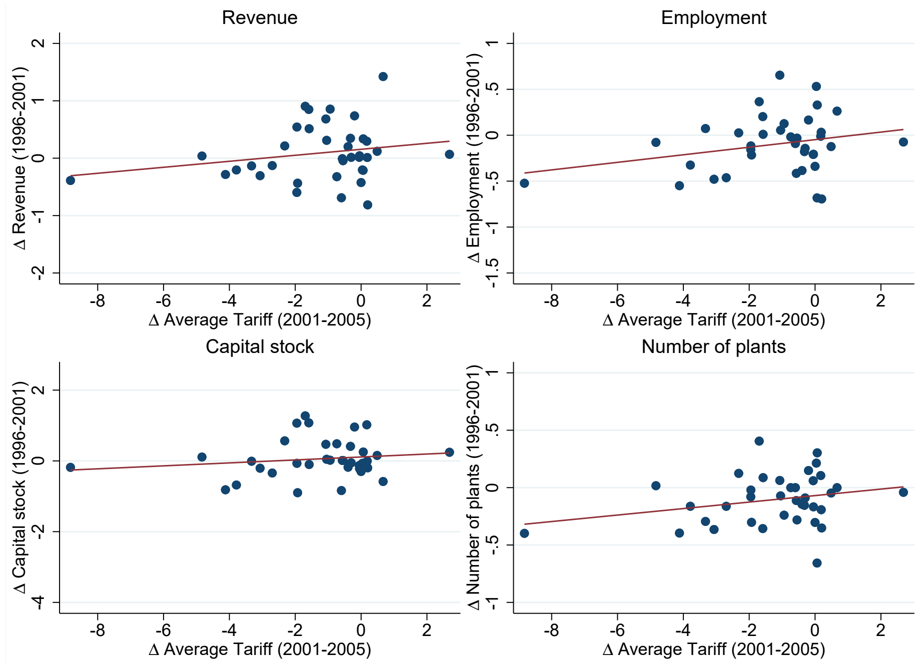
(b) Number of Layers



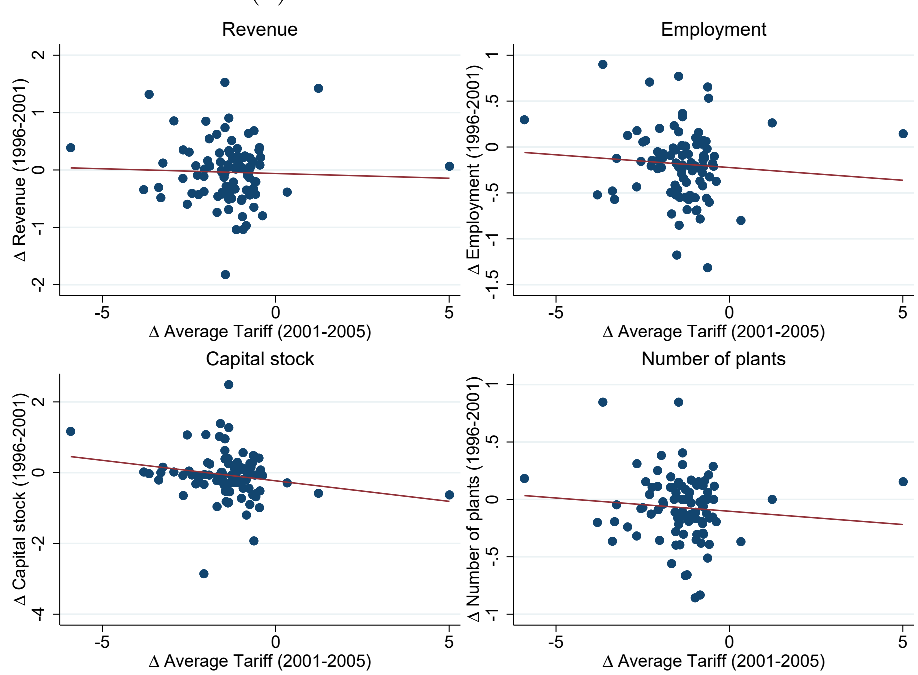
Numerical solution for quality θ (Panel (a)) and the number of layers (Panel (b)). Left panel: baseline results (in gray); Right panel: lower trade cost model (in black). The parameter set is: $A = 5$, $w = 1$, $c = 2$, $\lambda_0 = 1$, $h = 0.8$, $b_0 = 0$, $b_1 = 2$, $b_2 = 1.5$; $\sigma = 5$, $\iota_D = \iota_L = 3.3$, $\iota_H = 4.3$, $R_D = 25$; $R_L = R_H = 70$, $F_L = 2$, $F_H = 7$. Baseline trade costs, $\tau_{DL} = \tau_{DH} = 1.2$; shocked trade costs to high-income countries $\tau'_{DH} = 1.1$.

Figure 7
Correlation between tariff liberalization (2001-2005) and industry performance (1996-2001)

(a) High-Income FTA countries



(b) Latin America FTA countries



Scatterplots of changes in various outcomes (revenue, employment, capital stock and number of firms) from 1996 to 2001 and changes in tariff from 2001 and 2005. The sample is split into high-income FTA partners (the EU, the US, South Korea) in panel (a) and Latin American FTA partners (Mercosur and Mexico) in panel (b). Data from ENIA and bilateral trade data from UNCTAD-TRAINS.

Table 1
Free Trade Agreement and Tariff Cuts
(in percentage)

	European Union	United States	South Korea	LAC
Production of meat, fish, fruit, veg., oils and fats	-24.7	-35.0	-9.9	-74.2
Manufacture of dairy products	-74.3	-28.7	-9.4	-69.0
Manufacture of grain mill products	15.8	-63.5	-10.2	-76.6
Manufacture of other food products	-8.5	-21.0	22.4	-56.9
Manufacture of beverages	-20.1	-24.5	0.9	-55.0
Spinning, weaving and finishing of textiles	-96.4	-100.0	-49.7	-70.1
Manufacture of other textiles	-98.3	-100.0	39.3	-75.6
Manufacture of knitted fabrics	-100.0	-100.0	-38.1	-33.6
Manufacture of wearing apparel, exc. fur	-98.9	-98.4	16.8	-69.2
Tanning and dressing of leather; luggage	-94.4	-73.1	-46.6	-65.9
Manufacture of footwear	-100.0	-100.0	-69.2	-48.6
Sawmilling and planing of wood	0.0	-100.0	-19.9	-91.5
Manufacture of products of wood	-93.9	-100.0	-21.5	-84.1
Manufacture of paper and paper products	0.0	0.0	-100.0	-58.6
Publishing	-100.0	0.0	-46.7	-69.3
Printing	-100.0	0.0	0.0	-67.5
Reproduction of recorded media	0.0	0.0	0.0	0.0
Manufacture of basic chemicals	-90.5	-100.0	-37.7	-63.3
Manufacture of other chemical products	-93.1	-94.4	26.5	-59.1
Manufacture of man-made fibres	-100.0	0.0	0.0	-61.9
Manufacture of rubber products	-94.3	122.2	0.0	-67.6
Manufacture of plastics products	-73.5	-100.0	-54.6	-58.0
Manufacture of glass and glass products	-81.4	58.5	-50.0	-74.8
Manufacture of non-metallic products n.e.c.	-91.4	6.5	0.0	-62.9

Notes: Own calculation based on UNCTAD-TRAINS. Bilateral tariffs are available at 4-digit of the Harmonized System, which are aggregated at 4-digit ISIC Rev 3. in the analysis. The tables shows average at a further level of aggregation, 3-digit ISIC Rev. 3.

Table 1
Free Trade Agreement and Tariff Cuts
(in percentage)

	European Union	United States	South Korea	LAC
Manufacture of basic iron and steel	-100.0	-100.0	-37.5	-63.3
Manufacture of basic precious and non-ferrous metals	-78.3	-80.0	-76.6	-61.7
Manufacture of structural metal products	-42.1	-100.0	0.0	-66.7
Manufacture of other fabricated metal products	-87.0	-98.2	-50.0	-49.8
Manufacture of general purpose machinery	-100.0	-100.0	-31.2	-66.5
Manufacture of special purpose machinery	-100.0	0.0	-43.7	-83.6
Manufacture of domestic appliances n.e.c.	-100.0	-100.0	-50.0	-67.4
Manufacture of electric motors, generators	-100.0	0.0	-50.0	-44.8
Manufacture of electric control apparatus	-100.0	0.0	-26.7	-65.5
Manufacture of insulated wire and cable	-100.0	0.0	0.0	-55.8
Manufacture of accumulators and primary batteries	0.0	0.0	0.0	-5.4
Manufacture of electric lamps and lighting equipment	-100.0	0.0	0.0	-58.3
Manufacture of other electrical equipment n.e.c.	-100.0	0.0	-64.1	-71.5
Manufacture of electronic valves and tubes	-100.0	0.0	0.0	-82.3
Manufacture of medical appliances and instruments	-100.0	0.0	-49.4	-61.4
Manufacture of optical instruments	-91.0	0.0	0.0	-93.0
Manufacture of watches and clocks	-100.0	-98.4	0.0	-50.2
Manufacture of motor vehicles	-75.4	-100.0	0.0	-91.1
Manufacture of motor vehicles parts & accessories	-100.0	0.0	-50.0	-27.0
Manufacture of transport equipment n.e.c.	0.0	0.0	0.0	0.0
Manufacture of furniture	0.0	-100.0	0.0	-55.9
Manufacturing n.e.c.	-77.8	37.5	-65.5	-65.1
Average	-50.6	-64.3	-28.8	-65.0

Notes: Own calculation based on UNCTAD-TRAINS. Bilateral tariffs are available at 4-digit of the Harmonized System, which are aggregated at 4-digit ISIC Rev 3. in the analysis. The tables shows average at a further level of aggregation, 3-digit ISIC Rev. 3.

Table 2
Descriptive Statistics

	All Firms	Non Exporters	Exporters	High-Income Exporters
a) Exports				
Proportion of firms		0.774	0.226	0.142
Number of destinations	6.35	–	6.35	8.91
Number of exported products	0.25	0.02	1.02	1.22
Exports/sales	0.06	0.00	0.24	0.34
Unit Values	0.46	0.44	0.53	0.53
Observations	13112	10148	2964	1856
b) Organizational Structure				
Number of Layers	2.75	2.52	3.56	3.64
Layer 1	0.80	0.77	0.92	0.93
Layer 2	0.79	0.75	0.95	0.96
Layer 3	0.71	0.65	0.91	0.93
Layer 4	0.44	0.34	0.78	0.82
Share Layer 1	0.43	0.42	0.49	0.51
Share Layer 2	0.15	0.14	0.19	0.19
Share Layer 3	0.21	0.23	0.15	0.14
Share Layer 4	0.03	0.02	0.03	0.03
Log Workers	3.19	2.81	4.47	4.71
Log Wage	8.09	7.95	8.57	8.58
Log Wage Layer 1	7.99	7.89	8.25	8.24
Log Wage Layer 2	8.24	8.08	8.68	8.72
Log Wage Layer 3	8.47	8.26	8.98	9.04
Log Wage Layer 4	9.53	9.12	10.14	10.23

Notes: Own calculation based on ENIA (Encuesta Nacional Industrial Anual) merged with administrative custom records. The layers of the firm are described in Table 3 following Caliendo, Monte and Rossi-Hansberg (2015).

Table 3
Four Layers of Organizational Hierarchies

Layer	Worker Type	Description of Tasks
Layer 1	Blue-Collars Production Auxiliaries Services	Workers in charge of executing productive tasks directly linked to production. Workers indirectly linked to production, responsible for maintenance, storage,transportation, security and cleaning
Layer 2	Accountants Lawyers Administrative	Workers in charge of accounting and statistical registration, data entry and processing, certification, paperwork, and marketing
Layer 3	Supervisors	Professionals, technicians and skilled workers directly linked to production, who work controlling and physically managing the production process
Layer 4	Directors	Managers whose function is to plan, organize, control and direct the activities of the establishment

Notes: The layers are constructed based on ENIA (Encuesta Nacional Industrial Anual) following Caliendo, Monte and Rossi-Hansberg (2015).

Table 4
High-Income Exports, Organizational Change and Quality

	OLS			2SLS					
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
a) Layers									
High-Income Exporter	0.053^{**}	0.062^{***}		0.207^{**}	0.266^{**}		0.216^{**}	0.274^{**}	
	(0.021)	(0.024)		(0.101)	(0.135)		(0.099)	(0.130)	
Exporter		−0.019	0.007		−0.186	−0.146		−0.177	−0.135
		(0.028)	(0.025)		(0.191)	(0.183)		(0.191)	(0.184)
b) Quality									
High-Income Exporter	0.001	−0.007		0.382^{***}	0.358^{***}		0.378^{***}	0.354^{***}	
	(0.016)	(0.017)		(0.129)	(0.132)		(0.126)	(0.129)	
Exporter		0.017	0.014		0.075	0.129^{*}		0.073	0.128^{*}
		(0.014)	(0.013)		(0.082)	(0.072)		(0.081)	(0.071)
Weak IV F-stat				14.3	11.1	18.2	15.1	11.8	18.2
N	13080	13080	13080	13049	13049	13049	13049	13049	13049
Firm Fixed-Effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Initial Conditions*Year	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Log(sales)	No	No	No	No	No	No	Yes	Yes	Yes

Notes: Columns (1)-(3): OLS-FE regressions. Columns (4)-(9): IV-FE regressions. Dependent variables in second stage: Total number of Organization layers (Panel a); log unit values (sales over quantity (Panel b). All regressions include firm and year fixed effects, initial conditions (indicator variable for exporting status in 2001) interacted with year effects. Columns (7)-(9) also include log sales as a control for firm size. Standard errors are clustered at 4-digit ISIC Rev. 3. The F-statistic corresponds to the Kleibergen and Paap (2006) test for weak instruments. Significance: * p<0.01, ** p<0.05, * p<0.1.

Table 5
First Stage Results

	(1)	(2)	(3)	(4)	(5)	(6)
a) High-Income Exporter						
Tariff HI-FTA	0.009	0.009		0.009	0.009	
	(0.009)	(0.009)		(0.009)	(0.009)	
Tariff HI-FTA*Log(sales)	−0.001	−0.001		−0.001	−0.001	
	(0.001)	(0.001)		(0.001)	(0.001)	
Tariff HI-FTA*Exporter	−0.011***	−0.011***		−0.012***	−0.012***	
	(0.004)	(0.004)		(0.004)	(0.004)	
Tariff HI-FTA*Exporter High	0.032***	0.032***		0.033***	0.033***	
	(0.006)	(0.006)		(0.006)	(0.006)	
Tariff FTAs	0.016**	0.016**		0.016**	0.016**	
	(0.006)	(0.006)		(0.006)	(0.006)	
Tariff FTAs*Log(sales)	−0.001**	−0.001**		−0.001**	−0.001**	
	(0.001)	(0.001)		(0.001)	(0.001)	
Tariff FTAs*Exporter	−0.004	−0.004		−0.003	−0.003	
	(0.011)	(0.011)		(0.011)	(0.011)	
Tariff FTAs*Exporter FTA	0.008	0.008		0.008	0.008	
	(0.011)	(0.011)		(0.011)	(0.011)	
b) Exporter						
Tariff HI-FTA		0.010*	0.010*		0.010*	0.010*
		(0.005)	(0.005)		(0.005)	(0.005)
Tariff HI-FTA*Log(sales)		−0.001*	−0.001*		−0.001*	−0.001*
		(0.000)	(0.000)		(0.000)	(0.000)
Tariff HI-FTA*Exporter		0.012**	0.012**		0.012**	0.012**
		(0.005)	(0.005)		(0.005)	(0.005)
Tariff HI-FTA*Exporter High		−0.005	−0.005		−0.005	−0.005
		(0.004)	(0.004)		(0.004)	(0.004)
Tariff FTAs		0.032***	0.032***		0.032***	0.032***
		(0.006)	(0.006)		(0.005)	(0.005)
Tariff FTAs*Log(sales)		−0.003***	−0.003***		−0.003***	−0.003***
		(0.000)	(0.000)		(0.000)	(0.000)
Tariff FTAs*Exporter		0.055***	0.055***		0.056***	0.056***
		(0.008)	(0.008)		(0.009)	(0.009)
Tariff FTAs*Exporter FTAs		−0.039***	−0.039***		−0.039***	−0.039***
		(0.008)	(0.008)		(0.009)	(0.009)
Weak IV F-stat	14.3	11.1	18.2	15.1	11.8	18.4
N	13049	13049	13049	13049	13049	13049
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Initial Conditions*Year	Yes	Yes	Yes	Yes	Yes	Yes
Log(sales) Control	No	No	No	Yes	Yes	Yes

Notes: First stage results from IV-FE regressions. Instruments are the average high-income FTA tariff (to the US, the EU and Korea) and the average FTA tariff (to the US, the EU and Korea and Latin America). All regressions include firm and year fixed effects, initial conditions (indicator variable for exporting status in 2001) interacted with year effects. Columns (4)-(6) also include log sales as a control for firm size. Standard errors are clustered at 4-digit ISIC Rev. 3. The F-statistic corresponds to the Kleibergen and Paap (2006) test for weak instruments. Significance: * p<0.01, ** p<0.05, * p<0.1.

Table 6
High-Income Exports, Organizational Change and Quality
Additional Specifications

	(1)	(2)	(3)	(4)	(5)
a) Layers					
High-Income Exporter	0.337***		0.287**	0.284**	
	(0.121)		(0.121)	(0.125)	
Exporter		0.183		0.034	0.047
		(0.164)		(0.145)	(0.140)
b) Quality					
High-Income Exporter	0.400**		0.326***	0.314**	
	(0.161)		(0.123)	(0.127)	
Exporter		0.273***		0.165**	0.179***
		(0.080)		(0.077)	(0.065)
Weak IV F-stat	12.8	9.9	17.2	13.8	14.3
N	13049	13049	13049	13049	13049
Firm FE	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes
Initial Conditions*Year	Yes	Yes	Yes	Yes	Yes
Log(sales)	Yes	Yes	Yes	Yes	Yes

Notes: Columns (1)-(5): IV-FE regressions. Dependent variables in second stage: Total number of Organization layers (Panel a); log unit values (sales over quantity (Panel b). The instrument in columns (1) and (2) is the high-income FTA tariff only. The instruments in columns (3)-(5) are the high-income and the Latin America FTA average tariff, included separately. All regressions include firm and year fixed effects, initial conditions (indicator variable for exporting status in 2001) interacted with year effects. All regressions include log sales as a control for firm size. Standard errors are clustered at 4-digit ISIC Rev. 3. The F-statistic corresponds to the Kleibergen and Paap (2006) test for weak instruments. Significance: * p<0.01, ** p<0.05, * p<0.1.

Table 7
High-Income Exports and Firm Organizational Change
Composition of Layers

	(1)	(2)	(3)	(4)	(5)	(6)
a) Layer 1						
High-Income Exporter	−0.140	−0.127		−0.135	−0.123	
	(0.100)	(0.084)		(0.099)	(0.084)	
Exporter		−0.042	−0.061		−0.038	−0.057
		(0.082)	(0.087)		(0.080)	(0.085)
b) Layer 2						
High-Income Exporter	0.144^{***}	0.147^{***}		0.144^{***}	0.147^{***}	
	(0.047)	(0.040)		(0.047)	(0.039)	
Exporter		−0.008	0.014		−0.007	0.015
		(0.045)	(0.046)		(0.046)	(0.048)
c) Layer 3						
High-Income Exporter	0.232^{***}	0.257^{***}		0.231^{***}	0.258^{***}	
	(0.081)	(0.096)		(0.080)	(0.094)	
Exporter		−0.081	−0.043		−0.081	−0.041
		(0.080)	(0.081)		(0.080)	(0.081)
d) Layer 4						
High-Income Exporter	−0.029	−0.012		−0.024	−0.008	
	(0.050)	(0.064)		(0.048)	(0.062)	
Exporter		−0.055	−0.057		−0.051	−0.052
		(0.097)	(0.092)		(0.098)	(0.093)
Weak IV F-stat	14.3	11.1	18.2	15.1	11.8	18.4
N	13049	13049	13049	13049	13049	13049
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Initial Conditions*Year	Yes	Yes	Yes	Yes	Yes	Yes
Log(sales)	No	No	No	Yes	Yes	Yes

Notes: Columns (1)-(6): IV-FE regressions. Dependent variables in second stage: dummy indicator if the firm has Layer 1 (Panel a) to Layer 4 (Panel d). All regressions include firm and year fixed effects, initial conditions (indicator variable for exporting status in 2001) interacted with year effects. Columns (4)-(6) also include log sales as a control for firm size. Standard errors are clustered at 4-digit ISIC Rev. 3. The *F*-statistic corresponds to the Kleibergen and Paap (2006) test for weak instruments. Significance: * p<0.01, ** p<0.05, * p<0.1.

Table 8
High-Income Exports and Firm Organizational Change
Wages by Layers

	(1)	(2)	(3)	(4)	(5)	(6)
a) Wage Layer 1						
High-Income Exporter	0.050	0.021		0.058	0.027	
	(0.140)	(0.150)		(0.139)	(0.148)	
Exporter		0.083	0.087		0.087	0.092
		(0.072)	(0.065)		(0.070)	(0.063)
Weak IV F-stat	13.4	10.5	21.6	14.3	11.3	20.4
N	10290	10290	10290	10290	10290	10290
b) Wage Layer 2						
High-Income Exporter	−0.176	−0.147		−0.174	−0.145	
	(0.130)	(0.128)		(0.126)	(0.124)	
Exporter		−0.078	−0.099		−0.078	−0.098
		(0.071)	(0.077)		(0.073)	(0.078)
Weak IV F-stat	6.8	5.1	19.4	6.9	5.1	18.8
N	10168	10168	10168	10168	10168	10168
c) Wage Layer 3						
High-Income Exporter	0.423**	0.476***		0.420**	0.475***	
	(0.175)	(0.165)		(0.175)	(0.163)	
Exporter		−0.203	−0.154		−0.203	−0.153
		(0.173)	(0.170)		(0.171)	(0.168)
Weak IV F-stat	12.0	13.0	14.0	12.6	13.8	13.9
N	8996	8996	8996	8996	8996	8996
d) Wage Layer 4						
High-Income Exporter	0.156	0.207		0.169	0.211	
	(0.186)	(0.227)		(0.184)	(0.226)	
Exporter		−0.085	−0.018		−0.068	0.002
		(0.136)	(0.113)		(0.131)	(0.108)
Weak IV F-stat	7.9	8.0	17.4	7.8	8.2	17.2
N	5508	5508	5508	5508	5508	5508
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Initial Conditions*Year	Yes	Yes	Yes	Yes	Yes	Yes
Log(sales)	No	No	No	Yes	Yes	Yes

Notes: Columns (1)-(6): IV-FE regressions. Dependent variables in second stage: average wage in Layer 1 (Panel a) to Layer 4 (Panel d). All regressions include firm and year fixed effects, initial conditions (indicator variable for exporting status in 2001) interacted with year effects. Columns (4)-(6) also include log sales as a control for firm size. Standard errors are clustered at 4-digit ISIC Rev. 3. The *F*-statistic corresponds to the Kleibergen and Paap (2006) test for weak instruments. Significance: * p<0.01, ** p<0.05, * p<0.1.

Table 9
High-Income Exports and Firm Organizational Change
Bundles of Layers

	(1)	(2)	(3)	(4)	(5)	(6)
a) Bundles of Layer 2						
a1) With Layer 1						
High-Income Exporter	0.001	0.008		0.003	0.010	
	(0.084)	(0.078)		(0.085)	(0.078)	
Exporter		−0.024	−0.023		−0.022	−0.021
		(0.077)	(0.079)		(0.076)	(0.078)
a2) With Layer 3						
High-Income Exporter	0.346^{***}	0.360^{***}		0.347^{***}	0.360^{***}	
	(0.082)	(0.090)		(0.080)	(0.088)	
Exporter		−0.041	0.012		−0.041	0.015
		(0.072)	(0.065)		(0.071)	(0.064)
a3) With Layer 4						
High-Income Exporter	0.054	0.049		0.054	0.049	
	(0.066)	(0.069)		(0.067)	(0.069)	
Exporter		0.015	0.022		0.016	0.023
		(0.077)	(0.074)		(0.077)	(0.075)
b) Bundles of Layer 3						
b1) With Layer 1						
High-Income Exporter	0.095	0.137^{*}		0.099	0.142^{*}	
	(0.069)	(0.080)		(0.067)	(0.079)	
Exporter		−0.133	−0.113		−0.129	−0.107
		(0.113)	(0.109)		(0.111)	(0.108)
b2) With Layer 4						
High-Income Exporter	0.197^{*}	0.232^{*}		0.197^{*}	0.233^{*}	
	(0.113)	(0.135)		(0.111)	(0.132)	
Exporter		−0.112	−0.078		−0.111	−0.075
		(0.114)	(0.110)		(0.114)	(0.111)
c) Layer 1 + 4						
High-Income Exporter	−0.014	0.024		−0.010	0.027	
	(0.080)	(0.066)		(0.078)	(0.064)	
Exporter		−0.118	−0.115		−0.115	−0.110
		(0.102)	(0.102)		(0.099)	(0.099)
Weak IV F-stat	14.3	11.1	18.2	15.1	11.8	18.4
N	13049	13049	13049	13049	13049	13049
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Initial Conditions*Year	Yes	Yes	Yes	Yes	Yes	Yes
Log(sales)	No	No	No	Yes	Yes	Yes

Notes: Columns (1)-(6): IV-FE regressions. Dependent variables in second stage: dummy indicators for firm with different combinations of two layers. All regressions include firm and year fixed effects, initial conditions (indicator variable for exporting status in 2001) interacted with year effects. Columns (4)-(6) also include log sales as a control for firm size. Standard errors are clustered at 4-digit ISIC Rev. 3. The F-statistic corresponds to the Kleibergen and Paap (2006) test for weak instruments. Significance: * p<0.01, ** p<0.05, * p<0.1.

Table 10
High-Income Exports, Organizational Change and Quality
Robustness to Use of Imported Inputs

	(1)	(2)	(3)	(4)	(5)	(6)
a) Layers						
High-Income Exporter	0.216**	0.275**		0.223**	0.281**	
	(0.098)	(0.133)		(0.096)	(0.128)	
Exporter		-0.184	-0.143		-0.176	-0.133
		(0.189)	(0.181)		(0.189)	(0.183)
b) Quality						
High-Income Exporter	0.385***	0.360***		0.380***	0.356***	
	(0.130)	(0.132)		(0.126)	(0.129)	
Exporter		0.076	0.130*		0.074	0.129*
		(0.082)	(0.072)		(0.081)	(0.071)
Weak IV F-stat	14.4	11.2	18.0	15.2	11.9	18.2
N	13049	13049	13049	13049	13049	13049
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Initial Conditions*Year	Yes	Yes	Yes	Yes	Yes	Yes
Share of imported inputs	Yes	Yes	Yes	Yes	Yes	Yes
Log(sales)	No	No	No	Yes	Yes	Yes

Notes: IV-FE regressions. Dependent variables in second stage: Total number of Organization layers (Panel a); log unit values (sales over quantity (Panel b). These regressions control for the share of imported inputs. All regressions include firm and year fixed effects, initial conditions (indicator variable for exporting status in 2001) interacted with year effects. Columns (4)-(6) also include log sales as a control for firm size. Standard errors are clustered at 4-digit ISIC Rev. 3. The F-statistic corresponds to the Kleibergen and Paap (2006) test for weak instruments. Significance: * p<0.01, ** p<0.05, * p<0.1.

Table 11
High-Income Exports and Firm Organizational Change
Alternative Instruments

	Firm-level Tariff IV			Firm-level RER IV		
	(1)	(2)	(3)	(4)	(5)	(6)
a) Number of Layers						
High-Income Exporter	0.123	−0.064		0.853	0.769	
	(0.348)	(0.237)		(0.926)	(0.892)	
Exporter		−0.151	−0.130		−0.152	−0.325
		(0.231)	(0.236)		(0.566)	(0.504)
b) Layer 1						
High-Income Exporter	−0.095	0.224		−0.622	−0.461	
	(0.194)	(0.282)		(0.456)	(0.348)	
Exporter		0.258	0.185		0.294	0.398
		(0.164)	(0.125)		(0.311)	(0.351)
c) Layer 2						
High-Income Exporter	0.106	−0.110		1.199	1.063	
	(0.125)	(0.142)		(0.849)	(0.763)	
Exporter		−0.175	−0.139		−0.249	−0.488
		(0.116)	(0.096)		(0.546)	(0.408)
d) Layer 3						
High-Income Exporter	0.214	0.030		0.385	0.359	
	(0.174)	(0.105)		(0.361)	(0.350)	
Exporter		−0.149	−0.159		−0.047	−0.128
		(0.099)	(0.105)		(0.197)	(0.123)
e) Layer 4						
High-Income Exporter	−0.101	−0.207		−0.110	−0.192	
	(0.228)	(0.234)		(0.442)	(0.428)	
Exporter		−0.086	−0.018		−0.150	−0.107
		(0.171)	(0.152)		(0.394)	(0.365)
f) Quality						
High-Income Exporter	−0.082	−0.217		0.307	0.266	
	(0.250)	(0.326)		(0.710)	(0.761)	
Exporter		−0.110	−0.039		−0.075	−0.135
		(0.177)	(0.141)		(0.347)	(0.306)
Weak IV F-stat	1.8	0.5	5.8	1.0	0.6	1.4
N	13049	13049	13049	13049	13049	13049
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Initial Conditions*Year	Yes	Yes	Yes	Yes	Yes	Yes
Log(sales)	No	No	No	Yes	Yes	Yes

Notes: IV-FE regressions. Dependent variables in second stage: total number of layers (a), dummy indicator for each specific layer (b-e) and quality proxied by unit values (f). Columns (1)-(3): instruments based on tariff changes due to FTAs and firm initial export exposure to each destination. Columns (4)-(6): instruments based on exchange rates and firm initial export exposure. All regressions include firm and year fixed effects, initial conditions (indicator variable for exporting status in 2001) interacted with year effects and log sales as a control for firm size. Standard errors are clustered at 4-digit ISIC Rev. 3. The F-statistic corresponds to the Kleibergen and Paap (2006) test for weak instruments. Significance: * p<0.01, ** p<0.05, * p<0.1.

Table 12
High-Income Exports and Firm Organizational Change
Alternative High-Income Country Definition

	(1)	(2)	(3)	(4)	(5)	(6)
a) Number of Layers						
High-Income Exporter	0.195^{**}	0.251^{*}		0.211^{**}	0.266^{**}	
	(0.095)	(0.131)		(0.093)	(0.130)	
Exporter		−0.164	−0.119		−0.157	−0.108
		(0.191)	(0.176)		(0.191)	(0.177)
b) Layer 1						
High-Income Exporter	−0.130	−0.113		−0.124	−0.107	
	(0.096)	(0.077)		(0.095)	(0.077)	
Exporter		−0.049	−0.069		−0.046	−0.066
		(0.084)	(0.089)		(0.082)	(0.087)
c) Layer 2						
High-Income Exporter	0.130^{***}	0.132^{***}		0.132^{***}	0.134^{***}	
	(0.044)	(0.037)		(0.045)	(0.037)	
Exporter		−0.006	0.017		−0.006	0.019
		(0.049)	(0.049)		(0.049)	(0.050)
d) Layer 3						
High-Income Exporter	0.221^{***}	0.246^{**}		0.221^{***}	0.246^{***}	
	(0.079)	(0.096)		(0.078)	(0.094)	
Exporter		−0.071	−0.027		−0.071	−0.025
		(0.080)	(0.075)		(0.080)	(0.076)
e) Layer 4						
High-Income Exporter	−0.027	−0.015		−0.019	−0.007	
	(0.047)	(0.059)		(0.046)	(0.059)	
Exporter		−0.037	−0.040		−0.034	−0.035
		(0.091)	(0.086)		(0.092)	(0.086)
f) Quality						
High-Income Exporter	0.383^{***}	0.349^{***}		0.381^{***}	0.346^{***}	
	(0.129)	(0.127)		(0.126)	(0.125)	
Exporter		0.100	0.162^{**}		0.097	0.161^{**}
		(0.085)	(0.070)		(0.084)	(0.069)
Weak IV F-stat	9.9	10.0	10.6	10.6	10.6	11.6
N	13049	13049	13049	13049	13049	13049
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Initial Conditions*Year	Yes	Yes	Yes	Yes	Yes	Yes
Log(sales)	No	No	No	Yes	Yes	Yes

Notes: IV-FE regressions. Dependent variables in second stage: quality proxied by unit values (a), total number of layers (b), dummy indicator for each specific layer (c-f). The Alternative Definition of High-Income includes all countries in the World Bank classification except OPEC countries and the islands of the Caribbean. The instruments are the FTA tariffs as in the main specification. All regressions include firm and year fixed effects, initial conditions (indicator variable for exporting status in 2001) interacted with year effects; columns (4)-(6) add log sales as a control for firm size. Standard errors are clustered at 4-digit ISIC Rev. The F-statistic corresponds to the Kleibergen and Paap (2006) test for weak instruments. Significance: 3. * p<0.01, ** p<0.05, * p<0.1.

Appendix

A1. Construction of Layers

The employment module of the ENIA survey presents separate information for different types of workers that have different roles in the plant: owners, directors, supervisors, administrative workers, blue-collars, production auxiliaries, services, and sellers. For each category we know the number of workers, the wage bill and hours of work. We follow Caliendo, Monte, and Rossi-Hansberg (2015) and construct four hierarchical layers.

Based on the theory of knowledge-based hierarchies, layers should be constructed according to the knowledge/span of control of different types of workers, the wages earned, and the total number of hours worked. In order to classify each worker's category into specific hierarchical layers, we calculate the firm log average hourly wage for each type of worker, and we plot the cumulative distribution functions in Figure A1. Then, we group types of workers into hierarchies according to similarities in those cumulative distribution functions. As a result, Layer 1 includes blue-collar workers, production auxiliaries, and maintenance services' workers. Layer 2 comprises administrative workers dedicated to accounting, statistical activities, legal issues, design and marketing and so on. The third layer of management is conformed by supervisors, who control and manage the production process. Directors and owners who receive a wage are the highest hierarchical level within the organization. Sellers are not included in any layer, because they are outside the production process and their CDF spans all worker types.[18]

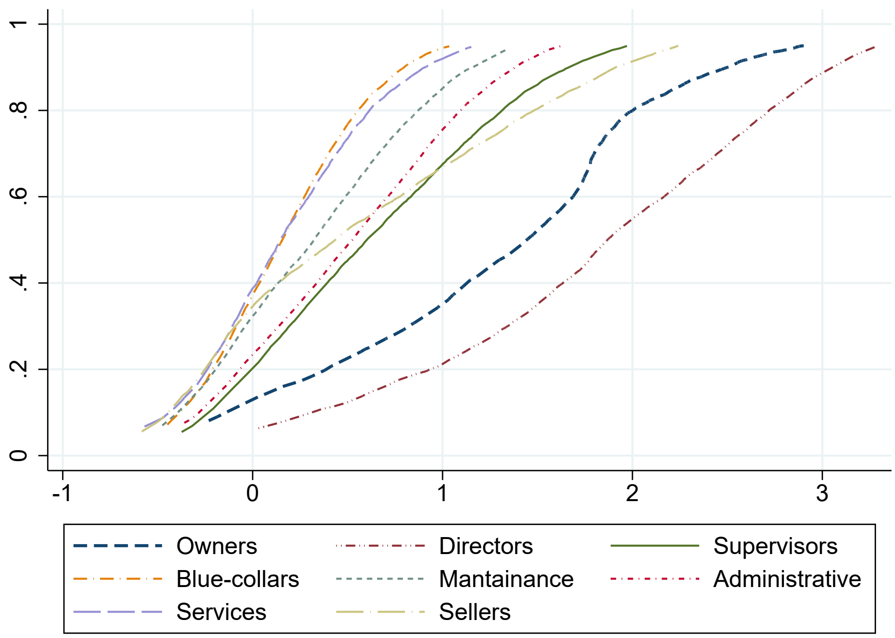
A2. Some Facts About Chilean Firms Organizational Hierarchies

Figure A2 plots cumulative distribution functions of firm average hourly wages and firm total hours worked (both in logs) for each hierarchical layer. The left panel shows that these CDFs are consistent with knowledge-based theory, that is, lower/higher layers earn less/more, which follows from the criterion used to construct the layers. The theory also points out that the typical firm should use less/more hours of work in higher/lower layers (Caliendo et al., 2015). This pattern is

[18] We assume firms have workers in a given category if the firm reports a positive wage bill for that class of worker. This point is particularly relevant in the case of owners, given that there are many of them (24 percent of observations) that actively participate in firm activities but do not receive a wage. Given that our main criterion to classify workers in different layers is based on the hourly wage distributions of different workers' categories, we decide not to include owners that do not receive a fixed remuneration in any layer. However, main results remain virtually unchanged if we include owners with no wage in layer 4, and also, if we exclude all owners (waged and unwaged) from layer 4. In the last case, layer 4 is formed only by directors.

FIGURE A1

Cumulative distribution functions of log hourly wages by worker's category

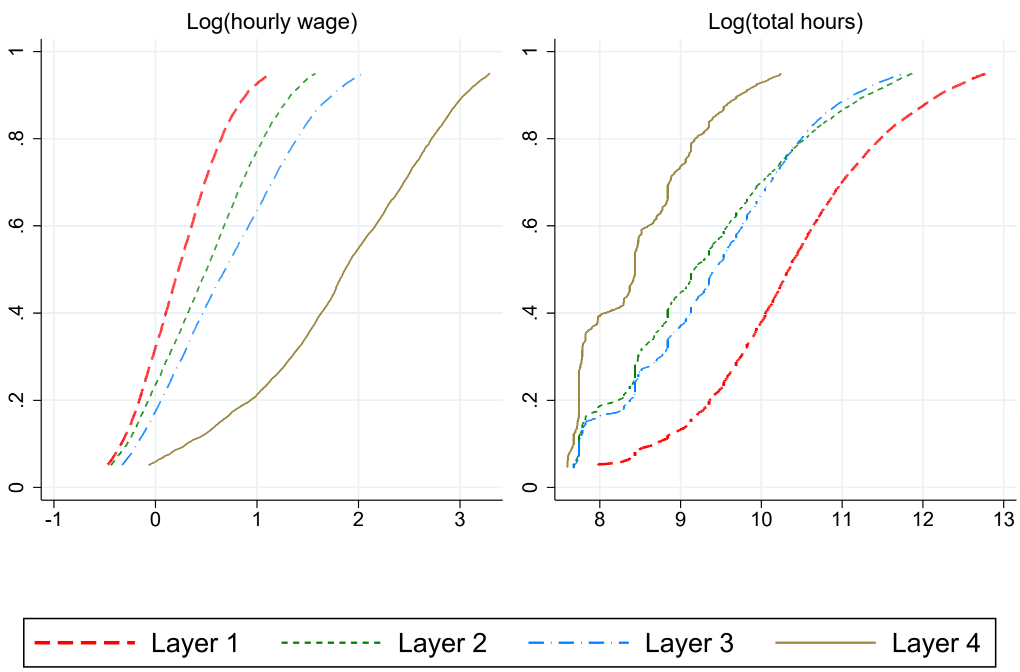


Notes. This figure plots the cumulative distribution functions of firm average hourly wages (in logs) for each type of worker category reported in ENIA survey.

very clear for layers 1, 2, 4 or 1, 3, 4. Although the ordering between layers 2 and 3 predicted by theory is satisfied in terms of hourly wages, it is not in terms of total hours of work. This means that the typical firm hires more workers in layer 3 (supervisors) than in layer 2 (administratives). This seems to be driven by the fact that among Chilean manufacturing firms that have just one hierarchical level, a significant fraction (40.84 percent) has layer 3 as their only hierarchy.

FIGURE A2

CDFs of Hourly Wages and Total Hours of Work for Each Layer



Notes. This figure plots the cumulative distribution functions of firm average hourly wages and firm total hours of work (both in logs) for each hierarchical layer. Sources. ENIA-INE.

Table A2 shows the conditional distribution of firms by number of layers. One-layer firms have either layer 1 (57.6 percent) or layer 3 (40.84 percent) as their only organizational hierarchy. Firms starting with layer 1 are more likely to add layer 2 when they re-structure, and then layers 3 and 4, following the idea of having a consecutive order of layers, as described in Caliendo et al. (2015). Firms starting with layer 3 are also more likely to add layer 2 as their second organizational hierarchy, then layer 1, and finally layer 4.

TABLE A2

Structure of firms conditional on the number of layers

		Share of firm-years with			
	N	Layer 1	Layer 2	Layer 3	Layer 4
A. Firm-years with 1 Layer	1,653	59.41	4.05	34.79	1.75
B. Firm-years with 2 Layers	3,944				
and Layer 2		48.38	-	-	-
and Layer 3		13.06	27.64	-	-
and Layer 4		4.89	0.81	5.22	-
C. Firm-years with 3 Layers	3,522				
and Layers 2 and 3		61.39	-	-	-
and Layers 2 and 4		17.06	-	-	-
and Layers 3 and 4		5.54	16.01	-	-
D. Firm-years with 4 Layers	3,992	*Have all hierarchical layers*			

Notes. This table reports the distribution of layer-combinations for firms with different number of layers (1,2,3 and 4). Each cell reports the fraction of firm-years with the given structure, conditional on the number of layers. Numbers in each block (A, B, and C) sum to 100. Firms with 4 layers have all hierarchical layers. Sources. ENIA-INE.

Table A3 reports firms' organizational transitions from one year to the next, conditional on the number of layers in the initial year. Three facts emerge from this table: most firms maintain their structure (around 70 percent of 1, 2, and 3 layers firms); smaller firms are more likely to exit the market; firms tend to re-structure by adding/droping one layer at a time. All these facts are consistent with previous theory and empirical findings in Caliendo et al. (2015).

TABLE A3

Layers transitions

Number of layers at t	Number of layers at t+1					
	Exit	1	2	3	4	
1	14.7	70.4	11.3	2.7	0.9	100
2	11.0	6.3	70.8	9.7	2.1	100
3	9.9	1.5	8.2	68.8	11.5	100
4	8.2	0.4	1.4	7.5	82.5	100

Notes. This table reports the distribution of the number of layers at time t+1 conditional on the number of layers at time t (1,2,3 and 4). Note that firms can exit the market at t+1. Numbers in each row sum to 100. Sources. ENIA-INE.

Figure A3 shows that constructing layers in this way has a meaningful economic interpretation. Firm's organizational structure (number of hierarchical layers) is positively correlated with firm's total sales, hourly wages, total hours of work, and labor productivity. These findings are in line with previous works for France (Caliendo et al., 2015), Sweden (Tag, 2013), Brazil (Cruz et al., 2016), and Denmark (Friedrich, 2018).

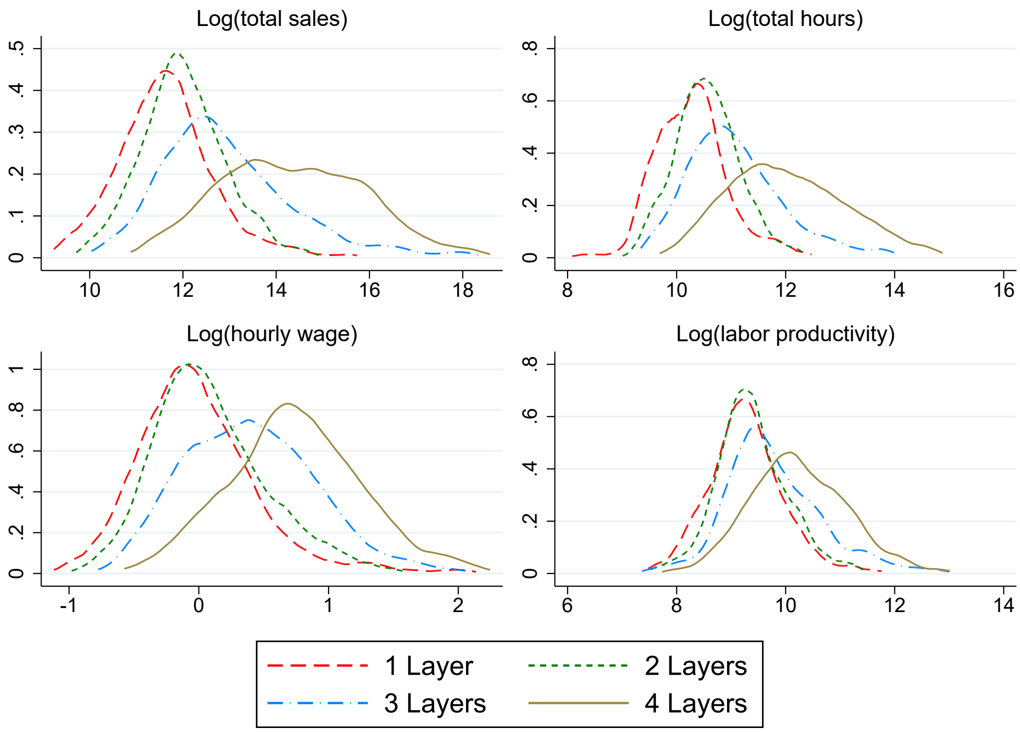
A3. Cost Minimization

Conditional of both quantity q and quality θ, the cost minimization problem is the same as in Caliendo and Rossi-Hansberg (2012). The first order condition with respect to z_L^0 is

$$c + \lambda(\theta)(cz_L^0 + 1) - \phi\frac{\lambda(\theta)A}{w} = 0, \tag{24}$$

FIGURE A3

Kernel distributions for firms with different number of layers



Notes. This figure plots the kernel distribution functions of firm total sales, total hours, average hourly wage, and labor productivity (all in logs) for firms with different number of layers (1,2,3 and 4). Sources. ENIA-INE.

where ϕ is the lagrange multiplier of the output restriction and is thus the marginal cost. The first order conditions with respect to z_L^l, for $0 < l < L$ are

$$(25)\quad he^{-\lambda(\theta)Z_L^{l-1}}c + \lambda(\theta)(cz_L^0 + 1) + \lambda(\theta)h\sum_{k=0}^{l-1} e^{-\lambda(\theta)Z_L^k}(cz_L^{k+1} + 1) - \phi\frac{\lambda(\theta)A}{w} = 0.$$

Finally, the first order conditions with respect to z_L^L (the knowledge of the entrepreneur) is

$$(26)\quad c - \phi\frac{\lambda(\theta)A}{wh}e^{-\lambda(\theta)z_L^L} = 0.$$

The restrictions (6)-(8) also hold.

A4. Additional Results: Average Costs and Efficiency

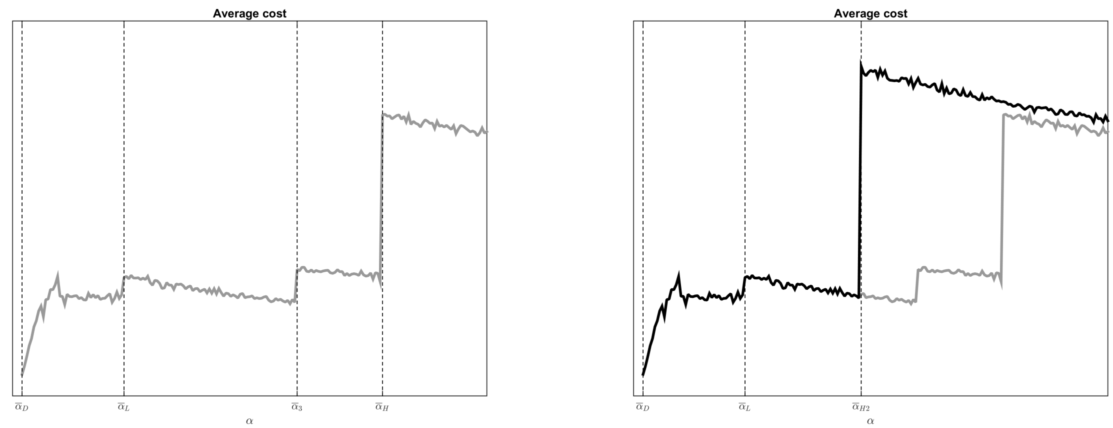
This appendix includes additional results on average costs and efficiency. In a model without quality considerations, exporting increases the scale of the firm. As a response to this, firms add layers, the average cost typically declines with sales, and the firm becomes more efficient. The average cost is thus a good measure of the productivity of the firm. In our model, this is not necessarily the case because exporting, and in particular exporting to high income countries, implies a quality upgrade that is costly. We can see this more clearly in the theoretical model. Panel (a) of Figure A4 shows the average cost as a function of α, the exogenous parameter that characterizes each firm. In the graph, we see that the average cost does not necessarily decline as the firms layer up, especially when this layering up occurs jointly with the provision of higher quality. Average costs do not necessarily capture the efficiency effects of re-organization.

This can also be seen in the data. Firms report total costs and quantities and the variable cost is the ratio between these two variables. Table A4 shows the results from regressions of average costs on export status (both to high-income countries and of exporting more generally) as in the main specification of the paper. The impact of exporting on average costs is never statistically significant, in both models without or with firm size as a control. This reflects the tensions between the negative productivity effect of re-organization on costs and the positive effect of quality upgrading.

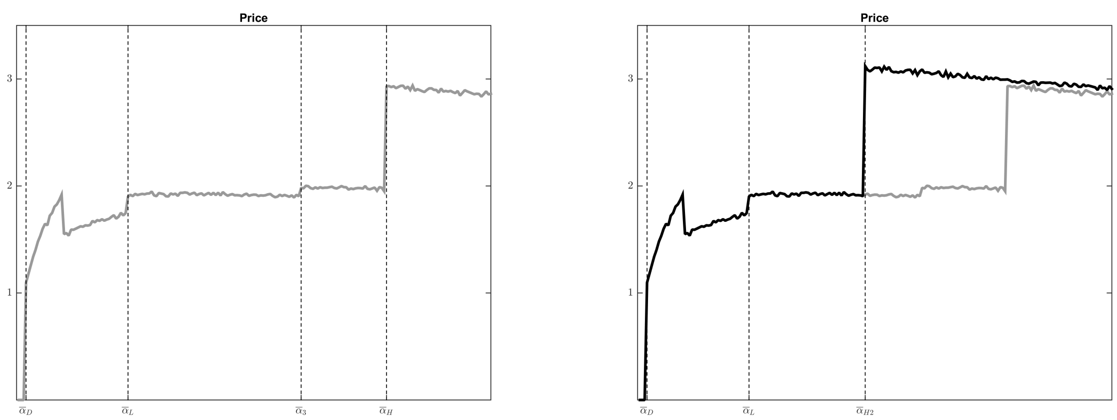
Another manifestation of these phenomena is the profile of prices. In Panel (b) of Figure A4, we depict the optimal prices that firms with different α charge. This price is increasing in α and it shows discrete jumps as the quality of the product increases with exports.

Figure A4
High-Income Exporting Firms
Prices and Average Costs

(a) Average Cost



(b) Prices



Numerical solution for quality θ (Panel a) and the number of layers (Panel b). Left panel: baseline results (in gray); Right panel: lower trade cost model (in black). The parameter set is: $A = 5$, $w = 2$, $\lambda_0 = 1$, $h = 0.8$, $b_0 = 0$, $b_1 = 2$, $b_2 = 1.5$; $\sigma = 5$, $\iota_D = \iota_L = 3$, $\iota_H = 3.8$, $R_D = 25$; $R_L = R_H = 70$, $F_L = 2$, $F_H = 7$. Baseline trade costs, $\tau_{DL} = \tau_{DH} = 1.2$; shocked trade costs to high-income countries $\tau'_{DH} = 1.1$.

Table A4
High-Income Exports and Average Costs

	OLS			2SLS					
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Log(Average Cost)									
High-Income Exporter	0.041	0.035		-0.262	-0.324		-0.245	-0.312	
	(0.033)	(0.033)		(0.204)	(0.228)		(0.204)	(0.230)	
Exporter		0.012	0.027		0.197	0.148		0.206	0.158
		(0.039)	(0.038)		(0.167)	(0.154)		(0.167)	(0.152)
Weak IV F-stat				14.3	11.1	18.2	15.1	11.8	18.2
N	13080	13080	13080	13049	13049	13049	13049	13049	13049
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Initial Conditions*Year	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Log(sales)	No	No	No	No	No	No	Yes	Yes	Yes

Notes: IV-FE regressions. Dependent variables in second stage: log average cost (total cost over quantity). The instruments are the FTA tariffs as in the main specification. All regressions include firm and year fixed effects, initial conditions (indicator variable for exporting status in 2001) interacted with year effects; columns (4)-(6) add log sales as a control for firm size. Standard errors are clustered at 4-digit ISIC Rev. The F-statistic corresponds to the Kleibergen and Paap (2006) test for weak instruments. Significance: 3. * p<0.01, ** p<0.05, * p<0.1.