Fixed Export Costs and Export Behavior

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Abstract

This paper provides a direct test of how fixed export costs and productivity jointly determine firm-level export behavior. Using Chilean data, we construct indices of fixed export costs for each industry-region-year triplet and match them to domestic firms. Our empirical results show that firms facing higher fixed export costs are less likely to export, while those with higher productivity export more. These outcomes are the foundation of the widely-used sorting mechanism in the trade models with firm heterogeneity. A particular and novel finding is that high-productivity nonexporters face greater fixed export costs than low-productivity exporters. We also find that the substitution between fixed export costs and productivity in determining export decisions is weaker for firms with higher productivity. Finally, both larger fixed export costs and greater within-triplet productivity dispersion raise the export volume of the average exporter.

JEL-Code: F100, F120, F140.

Keywords: sorting, firm heterogeneity, trade costs, exporter premium.

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1 Introduction

A critical addition to trade theory was the introduction of firm-level export decisions (Melitz, 2003). The key idea is that firms are sorted based on productivity and fixed export costs (FECs). Because exporting requires the payment of a fixed cost, only firms that expect sufficiently high profits from exporting choose to pay it (Helpman, Melitz and Yeaple, 2004; Yeaple, 2005). The sorting mechanism has two simple empirical implications. First, for a given level of FECs, firms with high productivity export. Second, for a given productivity, firms with low FECs export. A direct empirical test of these ideas remains absent in the literature, despite extensive empirical evidence that exporters display higher productivity than nonexporters (for instance, Bernard and Jensen, 1999, 2004; Lileeva and Trefler, 2010).

That exporters have a productivity premium is, in itself, insufficient evidence of the sorting mechanism, unless FECs are homogeneous across firms. FECs might be less variable than productivity, though there is no reason to expect them to be identical across firms. FECs are expected to vary by industrial and regional characteristics, which is our point of departure. Without accounting for these differences in costs, the exporter productivity premium could be explained by a number of possibilities. For example, firms with high productivity (i.e., low variable production costs) can perform better at designing, marketing, and distributing new goods across borders or are more likely to be chosen as suppliers of global enterprises. In other words, high productivity may not be the key difference between exporters and nonexporters, but rather one manifestation of some systematic differences between them.

A further observation is that empirical studies using micro data find that some nonexporting firms are more productive than some exporting firms, which is inconsistent with the sorting mechanism. This puzzle has been identified among firms in the United States (Bernard, Eaton, Jensen and Kortum, 2003), Belgium (Mayer and Ottaviano, 2008), and Japan (Wakasugi, 2009). We also observe this phenomenon in the Chilean data.

Our aim in this paper is to provide a direct test of the two implications mentioned above by incorporating measures of FECs faced by firms. We use export expenses reported by firms to the Annual National Industrial Survey of Chile (Encuesta Nacional Industrial Anual, or ENIA) to construct indices of FECs for each industry-region-year triplet in Chile. Then we empirically examine how firms' export decisions vary with both productivity and the FECs of the triplets in which they reside.

Our empirical study reaches three findings. The primary finding is that, with productivity held constant, high FECs are associated with low export propensities. Moving from the

25th to the 75th percentile of the FEC indices, export propensity falls by approximately 6 to 12 percent. Moreover, we find that high-productivity Chilean nonexporters face high FECs. This simple observation helps resolve the puzzle that there are high-productivity nonexporters and low-productivity exporters, and the productivity premium of exporters holds but only in the average sense.

******** Figure 1 about here ********

In Figure 1 we illustrate this fact and our proposed resolution using the two largest industries in the Chilean data. In both industries, the mean of exporters' productivity is larger than that of nonexporters, but there is an overlap between the two distributions. We define high (low) productivity firms as those which are more (less) productive than the 75th-percentile exporter and then compare the FECs between high-productivity nonexporters and low-productivity exporters. High-productivity nonexporters face higher FECs than low-productivity exporters, as shown by the t-statistics in the upper-right corners of the two panels. We report the results using three different indices, explained in Section 3. All differences are significant at least at the five percent level.

Two other findings follow from the primary one. One is that for a given export propensity, high productivity and low FECs are substitutable. As FECs fall, we expect lower-productivity firms to enter exporting. This substitution effect decreases as firm-level productivity increases because covering FECs is a relatively smaller concern for high-productivity firms. The other interesting outcome is that at the industry-region-year triplet level, the export volume of an average exporter is greater where either its FEC or productivity dispersion is larger. The intuition is that, for a given dispersion of firm productivity, higher FECs raise the productivity threshold for exporting, while for given FECs, a larger dispersion of productivity means that more firms move beyond the productivity threshold. In either case, firms that end up exporting are more productive and thus display larger export volumes. In our data, moving from the 25th to the 75th percentile of the FEC indices is associated with an increase in average firm-level export volume of one third to one half in magnitude.

This paper offers the first direct test of the sorting mechanism in firm-level export behavior.[1] Such a test is important because whether sorting occurs determines the extent to which

[1]Fixed costs in international trade have two types: those arising from domestic regional and industrial characteristics (FECs in this paper) and those associated with individual overseas markets (known as marketing costs). Firms pay the former to get sorted into exporters, and pay the latter selectively to enter into different markets. The literature has looked into the marketing costs (e.g., Arkolakis, 2010; Eaton, Kortum, and Kramarz, 2011; Irarrazabal, Moxnes, and Opromolla, 2010), but not as much into FECs. The existing studies infer the existence of FECs from choices about export behavior (Das, Roberts, and Tybout; 2007;

firm heterogeneity generates additional gains from trade. Recent studies show that firm heterogeneity itself does not provide significant additional gains from trade. What may generate large gains is the redistribution effect of firm heterogeneity when firms sort themselves into exporters and nonexporters by productivity.[2] Specifically, social welfare improves when market shares are reallocated from relatively unproductive firms to relatively productive ones. The fact that exporters are more productive than nonexporters is insufficient evidence of this reallocation, because exports may have other advantages. Thus, market shares are not necessarily redistributed to them from nonexporters. In this paper, we find that exporters could be lower-productivity firms with lower FECs than non-exporters, and that with productivity heterogeneity held constant, exporters in triplets with high FECs export more on average. In other words, productivity matters through counteracting FECs, indicating that the relatively larger market shares of exporters stem from sorting and redistribution rather than other advantages of exporters over nonexporters.

The rest of the paper is organized as follows. In Section 2 we build a theoretical model and present its key empirical predictions. In Section 3 we discuss data and the construction of FEC indices. Our empirical findings are presented in Section 4 and we provide conclusions in Section 5.

2 Conceptual framework

In this section we set out a simple theoretical model based on Melitz (2003) to guide our later empirical analysis. Consider two countries, Home and Foreign (rest of the world). Consumers in each country have the same preference over a collection of varieties made in Home:[3]

$$U = \left[\int_{j \in J} x(j)^{\alpha} dj \right]^{\frac{1}{\alpha}},$$

where j is the variety index, J is the set of varieties, and $0 < \alpha < 1$ determines the elasticity of substitution among varieties $\sigma \equiv 1/(1-\alpha) > 1$. In Home, each variety j is produced

Hanson and Xiang, 2011; Roberts and Tybout, 1997a). Helpman, Melitz, and Rubinstein (2008) analyze bilateral aggregate trade statistics, taking FECs as a confounding factor to control for. Since FECs and export behaviors refer to the same variations in the data, these studies cannot separate the impacts of these two factors. Our approach, which is reduced-form and data-driven, is geared to make that separation.

[2]For the recent debate on this, see Arkolakis, Costinot, and Rodríguez-Clare (2012) and Melitz and Redding (2013).

[3]This is only part of the utility function. The utility from consuming varieties made in Foreign is not needed to support the predictions of interest, so we do not write it out.

by a unique firm, also indexed with j. The input demand per unit output of firm j is $a(j)$. Where confusion does not arise, we suppress the index j.

Firms compete in a monopolistic competition fashion in the foreign market. Firm-level export volume is

$$V = (\frac{vc}{\alpha P})^{1-\sigma}\gamma A, \quad (1)$$

where v is an iceberg variable export cost, c is the input price, P is the foreign price index associated with Home varieties J, γ is the foreign expenditure spent on Home varieties, and $A(j) \equiv a(j)^{1-\sigma}$, a decreasing function of a, is used to denote productivity. The potential profit from exporting is

$$\pi = \chi A - f, \quad (2)$$

where $\chi \equiv (1-\alpha)(vc/\alpha P)^{1-\sigma}\gamma$, and f is the fixed export cost.

Next, define X as the export indicator, a binary variable that denotes whether a firm exports, and $\Pr(X = 1)$ as the export propensity. Conditional on its A and f, each firm draws a foreign business opportunity with value u, which follows a standard normal distribution Φ. Random variable u can be considered as the conditional probability of a successful match. This opportunity is realized only if $\pi > u$; otherwise, the firm does not export. The export propensity then depends on the probability of $\pi > u$:

$$\Pr[X = 1|A, f] = \Pr[u < \pi|A, f] = \Phi[\pi|A, f]. \quad (3)$$

Equation (3) has two implications. First, the export propensity of a given firm increases in its potential profit from exporting, but the marginal increase falls as the potential profit rises. The reasoning is as follows. Firms with a nonpositive π chooses not to export regardless of whether $\pi > u$ holds. Firms with a positive π will export if $u < \pi$. A still higher π improves a firm's propensity to export but less than proportionally, because the probability density of u decreases as π increases. Put differently, firms with higher potential profits are more likely to find successful matching opportunities but this benefit decreases with greater profitability. Thus, growing profitability does not make exporting proportionally more likely.[4]

Second, equation (3) can be translated into a probit model for empirical testing, where π is the latent variable determined by a linear function of profit determinants. We discuss the resulting specification in Section 4. At this point, it is noteworthy that from the empirical viewpoint, u only needs to satisfy $E(u|A, f) = 0$ to ensure the consistency of estimation. We have assumed this in the definition of u and impose no stricter assumptions than this. u does

[4]Formally, $\Phi' > 0$ and $\Phi'' < 0$ given $\pi > 0$.

not have to be unconditionally independent of A and f. Also, it does not matter whether the empirical measures of f and A are independent of each other. With either of them being a function of the other, $E(u|A, f) = 0$ applies because of the law of iterated expectations.

Returning to the firm's decision, we define for later usage a threshold productivity A^* such that $\pi = \chi A^* - f = 0$. Clearly, A^* is an increasing function of f. Also, given our focus on the foreign market, we assume for simplicity that all firms serve the home market and the total number of home firms is constant.[5] The timing of the model is as follows. On date 0, firms draw A from a distribution $G(A)$ that ensures $A > 0$ and f from distribution $\Gamma(f)$ that ensures $f > 0$. On date 1, firms draw u from distribution $\Phi(u)$ and make their export decisions.

According to equation (3), a firm's export propensity depends on its realizations A and f. Next we derive three hypotheses for empirical testing.

Prediction 1 (export propensity) *With productivity A held constant, the export propensity of a firm decreases in the fixed export cost f.*

This prediction follows from $\frac{d\Pr(X=1)}{df} = \Phi' \frac{\partial \pi}{\partial f} = -\Phi' \leq 0$; the inequality is strict when $\pi > 0$. Because firms with $\pi \leq 0$ do not export, $E(\pi|X = 1) > E(\pi|X = 0)$.[6] Thus, by equation (2),

$$E(\chi A|X = 1) - E(f|X = 1) > E(\chi A|X = 0) - E(f|X = 0), \tag{4}$$

or

$$E(f|X = 0) - E(f|X = 1) > E(\chi A|X = 0) - E(\chi A|X = 1). \tag{5}$$

This relationship permits an inference about the relative values of f and A of firms based on their export decisions. High-productivity nonexporters correspond to a positive right side of inequality (5). In turn they are expected to have a higher fixed export cost, namely, a positive left side of inequality (5). This inference is an alternative version of Prediction 1 that does not resort to probability:

Prediction 1b (nonexporters) *On average, high-productivity nonexporters have higher fixed export costs than low-productivity exporters.*

In contrast to the impact of fixed export costs, higher productivity raises the firm's

[5] This is similar to Chaney (2008), where the number of firms across countries is assumed to be proportional to country size.

[6] This expectation is with respect to f and A. If $u \geq 0$, $X = 1$ means $\pi > u$, $X = 0$ means $0 < \pi \leq u$, such that $E(\pi|X = 1) > E(\pi|X = 0)$ follows. If $u < 0$, $X = 1$ means $\pi > 0$ (otherwise, the firm will choose not to export), $X = 0$ means $\pi < 0$, so $E(\pi|X = 1) > E(\pi|X = 0)$.

export propensity: $d\Pr(X=1)/dA > 0$. These two marginal changes interact with each other. For example, the fixed export cost reduces export propensity less if A is high than if A is low. Formally, $\frac{\partial^2 \Pr[X=1]}{\partial f \partial A} = \Phi'' \frac{\partial \pi}{\partial A}\frac{\partial \pi}{\partial f} + \Phi' \frac{\partial^2 \pi}{\partial f \partial A} = -\Phi'' \frac{\partial \pi}{\partial A} \geq 0$, and the inequality is strict when $\pi > 0$. The inequality derives from the fact that $\Phi'' < 0$ if $\pi > 0$, and $\partial^2 \pi / \partial f \partial A = 0$. Thus, we have

Prediction 2 (interaction) *The negative effect of fixed export cost f on the export propensity becomes weaker at higher levels of productivity A.*

Put differently, a given decrease in fixed export costs raises export propensity to a larger magnitude if the productivity is lower. In Figure 2 we demonstrate the intuition underlying Prediction 2. Panel (a) displays the equal-value contours of potential profits from exporting. Recall $\pi = \chi A - f$, meaning that the contours are straight lines. Segments $\Delta f_1 = \Delta f_2$ are two decreases in fixed export costs of the same magnitude, but Δf_2 occurs to a firm with a higher productivity. Therefore, Δf_1 and Δf_2 lead to the same potential profit change ($\Delta \pi_1 = \Delta \pi_2$) but Δf_2 links to higher potential profit levels ($\pi_2 > \pi_1$, $\pi'_2 > \pi'_1$). Panel (b) plots the export propensity against potential profit, a concave function that stems from $\Phi'' < 0$. The profit change $\Delta \pi_2$ generates a smaller increase in export propensity than does $\Delta \pi_1$ ($\Delta \text{Prob}_2 < \Delta \text{Prob}_1$), because its larger profit level limits the marginal export propensity growth.

******** Figure 2 about here ********

The third hypothesis is concerned with an average exporter. Assume that productivity A follows the Pareto distribution $G(A) = 1-(A_{\min}/A)^g$, where the constant $A_{\min}$ is the location parameter (minimum of A) and $g > 2$ is the shape parameter.[7] The larger is g, the smaller is the dispersion of A. The mean of A is $\mu(A) = \frac{gA_{\min}}{g-1}$ and its variance is $\sigma^2(A) = \frac{gA_{\min}^2}{(g-1)^2(g-2)}$. For our empirical work, we need a measure of dispersion that is free from the magnitude of A. Thus, we introduce the coefficient of variation (CV) of A: $\sigma(A)/\mu(A)$, or $[g(g-2)]^{-1/2}$. A smaller g is associated with a larger dispersion of A.

Any truncated distribution of A also follows the Pareto distribution. In particular, the productivity of exporters follows the distribution $G^*(A) = 1 - (A^*/A)^g$. Because firm-level export volume is $(vc/\alpha P)^{1-\sigma}\gamma A$, the average exporter ships an amount equal to the volume of the exporter with the mean productivity, which is $gA^*/(g-1)$. Thus, a larger dispersion of productivity (a smaller g) generates a larger export volume of the average exporter. Also,

[7] We assume $g > 2$ to ensure a finite variance of A, following Helpman, Melitz, and Yeaple (2004).

because A^* is an increasing function of f, a higher FEC also leads to a larger volume of the average exporter. To summarize,

Prediction 3 (average export volume) *The average export volume of exporting firms increases in both the dispersion of firm productivity $\sigma(A)/\mu(A)$ and the fixed export cost f.*

3 Data

3.1 Overview

Our primary dataset is the Encuesta Nacional Industrial Anual (ENIA, translated as "Annual National Industrial Survey") of Chile. The ENIA covers all manufacturing plants with ten or more workers. Since nearly ninety percent of the plants are single-plant firms, we refer to the unit as firm hereafter.[8] The version of ENIA that we access covers the years 2001-2007 and reports firm-level statistics such as industry code (ISIC, Rev.3), location (administrative region), total sales, export volume, and employment.[9] Panel (a) of Table 1 reports annual statistics for our sample of strictly domestic-owned firms.[10] Our data cover 2,896 firms in an average year, of which 18 percent are exporters. All peso values are measured using 2003 prices. Sales and export volume rise over the seven years. Panel (b) reports firm-level statistics. An average exporting firm pays export expenses equal to approximately nine percent of its export volume. We will describe these export expenses in the next subsection. Panel (c) of Table 1 reports statistics at the industry-region-year triplet level, at which we construct fixed export cost (FEC) indices.

******** Table 1 about here ********

The unique geography of Chile provides us the basis for estimating local FECs. As shown in Figure 3, Chile is a narrow and long country located on the west side of the Andes Mountains and the east rim of the Pacific Ocean. As a result, locally made products tend to be exported from within-region ports rather than transported elsewhere and then

[8]The percentage of single-plant firms in all plants varies between 87.5 and 89.8 during the years 2001-2007.

[9]Various versions of this dataset have been used by Levinsohn (1999), Pavcnik (2002), Lopez (2008), Volpe Martincus and Blyde (2013), among others.

[10]We drop multinational subsidiaries and licensees from the sample because their export decisions are heavily influenced by their overseas parent firms. The industries included in the analysis are listed at the bottom of Table 1.

exported. Since the ENIA does not report shipment details on firms' exports, we aggregate the data to the industry-region level and compare them to industry-region level customs statistics.[11] In particular, we compute the share of region r in Chile's total exports in industry i with both the ENIA data and the customs data, denoting the two shares as $S(i,r)$ and $S'(i,r)$, respectively. The correlation between the two shares is 0.79 and there is no statistical difference between their means. Thus, we cannot reject the hypothesis that $S'(i,r)-S(i,r)=0$. This demonstrates that the majority of locally made exported products are shipped through local customs.

********* Figure 3 about here *********

There are three groups of control variables used in our regressions. First, we have firm-level activity measures, including capital/labor ratio (KL) and the ratio of value added to sales (VA). These figures are computed using data reported by the ENIA. Second, we employ measures of regional infrastructure quality obtained from the databases *Estadísticas Vitales* and *Carabineros*: crime rate and infant mortality rate. The crime rate is defined as the ratio of arrests to population and infant mortality rate is the number of deaths per 1,000 births.[12] We also employ average foreign tariff rates as an industrial characteristic that varies over time.[13]

Third, we incorporate, as our productivity measure, the logarithm of total factor productivity (TFP) for each firm and year. For this purpose we use the Ackerberg-Caves-Frazer (ACF, 2006) method, which builds on the earlier approaches of Olley-Pakes (1996) and Levinsohn-Petrin (2003).[14] The ACF method addresses the endogeneity problem that arises from the correlation between unobservable productivity shocks and input levels, as well as the potential collinearity problem in the earlier approaches. For our statistical analysis, we standardize the TFP with industry-year means and standard deviations: $TFP_{jt}^{STAN} = [TFP_{jit} - \mu(TFP)_{it}]/\sigma(TFP)_{it}$, where j, i, and t are firm, industry, and year identifiers, respectively. The standardization ensures the comparability of TFP across industries. In the rest of the paper, standardized TFP is used unless noted otherwise.

[11] Appendix A1 provides details on the customs data.

[12] These data are available at the web address www.ine.cl/canales/chile_estadistico/.

[13] Appendix A2 provides details on the tariff data.

[14] TFP estimates using these methods are widely reported in the trade literature. See, for example, Amiti and Konings (2007), Goldberg, Khandelwal, Pavcnik, and Topalova (2010), and Greenaway, Guariglia and Kneller (2007). In particular, for uses of the ACF method, see Arnold, Javorcik, Lipscomb and Mattoo (2008), Javorcik and Li (2008), and Petrin and Sivadasan (2011). We use skilled labor, unskilled labor and capital stock as our first stage inputs. Electricity consumption is our choice of intermediate input.

3.2 Measurement of fixed export costs (FECs)

Every year exporters in the ENIA report all expenses resulting from export activities, including charges incurred in crating, packing, warehousing, consolidation, storage, loading and shipment.[15] This is a remarkable feature of the data, considering that export costs are rarely reported in firm-level datasets. The limitation of this feature is that export expenses are reported as an aggregate variable. Since for each firm there is just one figure per year, this variable is not directly usable. To make use of the information in it, we assume its generation to follow

$$ExportExpenses = e^{f+\zeta \ln V+\zeta_\tau \ln(1+\tau V)}, \tag{6}$$

where $V > 0$ means export volume and $\tau \geq 0$ refers to the tariff rate levied by importing countries.[16] Notice that the exponential form of equation (6) ensures that the fixed costs are positive. Log-linear trade costs is a standard structure assumed in the trade literature to keep trade costs estimable (Anderson and van Wincoop, 2004, p.710; Anderson and Yotov, 2010; and Limao and Venables, 2001). Using the estimated f, we construct fixed export cost (FEC) indices for each industry-region-year (irt) triplet of Chile. Below, we first discuss the estimation of f and then check the usability of its estimates.

3.2.1 Construction of the FEC indices

The construction of a FEC index consists of two steps. The first step is to regress exporting firms' export expenses on their export volumes and extract the fixed effects associated with each industry, each region, and each year:

$$\begin{aligned} \ln ExportExpenses_{jt} = {} & \delta_i \mathrm{I}_j^i + \delta_r \mathrm{I}_j^r + \delta_t \mathrm{I}_j^t + \zeta_1 \ln V_{jt} + \zeta_{2i} \times \ln V_{jt} \times \mathrm{I}_j^i + \zeta_{2r} \times \ln V_{jt} \times \mathrm{I}_j^r \\ & + \zeta_{2t} \times \ln V_{jt} \times \mathrm{I}_j^t + \zeta_\tau \ln(1+\tau_{it} V_{jt}) + \phi' \mathbf{B}_{jt} + \epsilon_{jt}. \end{aligned} \tag{7}$$

Indicator variable I_j^i refers to firm j's industry: it equals 1 if firm j is in industry i and 0 otherwise. Since each firm is associated with one industry, δ_i captures an industry-specific component of export expenses that is independent of export volume. Indicator variables I_j^r and I_j^t are constructed similarly and their coefficients δ_r and δ_t capture region-specific and year-specific components, respectively. Thus, as we note below, the sum of these three

[15] Roberts and Tybout (1997b) discuss related costs faced by exporters in Colombia, Mexico, and Morocco, but their study focuses on the start-up costs that are sunk after firms break into overseas markets.

[16] Tariff rates faced by Chilean exporters are overall quite low (Pomfret and Sourdin, 2010).

coefficients captures f in equation (6). Because there may be variable-cost components associated with industry, region, and year, we include interactions of export volume with the indicator variables. The coefficients on these interaction terms absorb the part of export expenses that varies with volume, thereby capturing $\ln V$ in equation (6).

The variable $\ln(1+\tau_{it}V_{jt})$ directly captures the corresponding term in equation (6), while $\mathbf{B}_{jt}$ is a vector of additional control variables, including a first-time exporter indicator by firm. The average foreign tariff rate is calculated at the industry-year level and is defined as the weighted tariff-equivalent trade barrier for Chile's five largest export destinations (see Appendix A2 for details). The first-time exporter indicator is included because the few such firms in our sample may need to pay different export expenses.[17]

Note that export volume V_{jt} in regression (7) refers to export value just as defined in equation (1), whereas one might argue that either quantity or weight of exports is more relevant to export expenses than value. Unfortunately, the ENIA does not report quantity or weight exported by firms. We address this possibility by using two alternative specifications of regression (7). First, we add the capital-labor ratio KL_{jt} and the value-added ratio VA_{jt} of firms. If the relevant export measure is quantity, we need to isolate the price variation in the logarithm of export volume. Under reasonable assumptions, these control variables accomplish this task and the remaining variation is the quantity of exports.[18]

Second, we add the weight/value ratio, denoted by WV_{it} for industry i and year t, to regression (7). If the relevant measure is weight, this ratio controls for the unit-weight variation in the logarithm of export volume, and thus the remaining variation comes from the weight of exports.[19] We extract the weight/value ratio of US imports from Chile via ocean shipments reported in Hummels (2007) to proxy for WV_{it}. Hummels' dataset does not cover the years 2005-2007, meaning that we have more missing values when this specification is used. It is important to note that, given the ambiguity in what constitutes the most relevant measure of "true" export volume, we refrain from labeling the coefficients of $\ln V_{jt}$

[17] There are not many such firms and the majority of them frequently switch from one export status to the other (see Table A1 for details).

[18] Suppose that quantity q_{jt} is the "true" export volume of firm j in year t. $\ln V_{jt} = \ln(p_{jt}q_{jt}) = \ln p_{jt} + \ln q_{jt}$, where p_{jt} and q_{jt} are the price and quantity, respectively, of firm j's output in year t. Assuming $p_{jt} = p(KL_{jt}, VA_{jt})$, controlling for KL_{jt} and VA_{jt} holds $\ln p_{jt}$ constant and the effective variation in $\ln V_{jt}$ is $\ln q_{jt}$. The association between export prices and capital intensity is widely documented in the literature (Hummels and Klenow, 2005; Hallak, 2006; Manova and Zhang, 2012; Schott, 2004). Prices of firm-level exports may also depend on the production stages (i.e., more similar to final products or intermediate inputs) conducted by the firm, and thus we also control for value-added ratio.

[19] Suppose that weight W_{jt} is the "true" export volume. W_{jt} can be approximated by the product of WV_{it} and firm-level V_{jt}. The variable $WV_{it} \equiv (\frac{W}{V})_{it}$ is available at the industry-year level in trade data. Note that $\ln W_{jt} = \ln[(\frac{W}{V})_{it} \times (V_{jt})] = \ln(\frac{W}{V})_{it} + \ln V_{jt}$, or $\ln V_{jt} = \ln W_{jt} - \ln(\frac{W}{V})_{it}$. It follows that after controlling for $\ln(\frac{W}{V})_{it}$, the effective variation in $\ln V_{jt}$ is from $\ln W_{jt}$.

in regression (7), namely the ζ's, as variable export costs.

The second step is to compile the FEC indices. Recall that in regression (7) exporters pay the export expenses $\delta_i + \delta_r + \delta_t$ regardless of their export volumes. In other words, the sum $\widehat{\delta}_i + \widehat{\delta}_r + \widehat{\delta}_t$ is the counterfactual FEC that nonexporters would necessarily pay if they had exported. Thus, we next assign each triplet (irt) an FEC value $\widehat{\delta}_{irt} = \widehat{\delta}_i + \widehat{\delta}_r + \widehat{\delta}_t$ and transform $\widehat{\delta}_{irt}$ into an index with that ranges between 0 and 1 using $f_{irt} = \frac{\widehat{\delta}_{irt} - \min_{irt}\{\widehat{\delta}_{irt}\}}{\max_{irt}\{\widehat{\delta}_{irt}\} - \min_{irt}\{\widehat{\delta}_{irt}\}}$.[20] Because three different specifications are used to estimate $\{\delta_i, \delta_r, \delta_t\}$, we construct three indices, which we label as *benchmark*, *KL and VA adjusted*, and *WV adjusted*, respectively. In the end, any firm, regardless of its export status, can be linked to its triplet FEC index f_{irt}.

It is noteworthy that, at the irt level, there are six margins of variations in FECs: i, r, t, ir, rt, it, and irt. Clearly, f_{irt} captures the irt margin. In later empirical analysis, we use industry and year fixed effects to absorb the i and t margins, and control for the r and rt margins. Two questions immediately emerge: (1) why not construct FECs using the ir, rt or it margin? and (2) given our focus on the irt margin, why not use a three-way fixed effect rather than the sum of three separate fixed effects? As for (1), the reason is that those margins have too few observations. The median two-way units ir, rt, and it have 10, 11, and 26 exporters, respectively. Considering that the total number of exporters is 3,702, there are not enough variations in the two-way sample to identify FECs. Then the answer to (2) becomes clear: given so little variations along margins ir, rt, and it, there is still less variation at the irt margin, making a three-way fixed effect infeasible. In fact, the median three-way unit irt has only two exporters.

The summary statistics of the FEC indices are provided in Panel (d) of Table 1. We depict in Figure 4 the 25th and 75th percentiles of f_{irt} for each industry, region and year. In panel (a), FECs are shown to be high in wood products, transport equipment, machinery, and basic metals. This is because firms in these industries need special facilities to ship sizable cargos. In contrast, communication equipment and furniture, which can readily be transported using regular facilities, have low FECs. Panel (b) of Figure 4 demonstrates a large dispersion of FECs among Chile's 13 administrative regions, which mainly vary according to geographic characteristics.[21] For example, Tarapaca and Coquimbo have low FECs, because

[20] The sum of fixed effects $\widehat{\delta}_{irt}$ has to be normalized into an index because the magnitude of estimated fixed effects varies across the three specifications. Econometrically, fixed effects estimated using the three specifications are asymptotically equivalent, though their estimated values are different. Also notice that f should not be standardized (i.e., converted into a standard normal distribution) as TFP, because unlike TFP, f is not a firm-level variable.

[21] Chile was divided into 13 administrative regions in 1974. This division was revised in 2007. To maintain consistency throughout the sample, we use the 1974 division.

their large cities, such as Iquique, La Serena, and Coquimbo, are also important seaports and national trade centers. In comparison, the majority of the population in Maule, an area with high FECs, lives in rural areas. Finally, Panel (c) indicates that FECs trended downward between 2001 and 2007, which was likely due to nationwide improvements in trade-related infrastructure.[22]

********* Figure 4 about here *********

Before proceeding, we would like to make two notes on the estimation of regression (7). First, equation (7) is estimated using the sample of exporters, so that the self-selection of high-performing firms to be exporters does not cause endogeneity in regression (7). In essence, we assign FECs estimated using exporters to the nonexporters in their corresponding triplets. A natural concern is whether nonexporters would face either higher or lower FECs than those estimated using exporters, as FECs might be performance-related and export status is part of a firm's performance. In Section 4, we test on this question (Table 8). Second, FECs might be correlated with variable export costs, which also affect exporting behaviors. We are fully aware of this and conduct another specific test (Table 11). We discuss these two issues in detail in Section 4. For now, we focus on checking the usability of the FECs.

3.2.2 Checks on the FEC indices

The first check is concerned with the additive functional form of regression (7), namely the assumption that export expenses consist of both fixed and variable components. Alternatively, we construct an index without accounting for export volume. We would then expect the resulting FEC index to be variable (i.e., correlated with export volume) if having an additive variable component is the right form. To see if this is the case, we run regression (7) without export volume $\ln V_{jt}$ and use the estimated coefficients to construct an experimental FEC index f°_{irt}. We then regress f°_{irt} on triplet-level average exports. This alternative index turns out to rise with exports, as shown in column (1) of Table 2. In contrast, the three FEC indices constructed earlier are shown in columns (2)–(4) to have no correlation with export volume.[23] They together point to the necessity of controlling for export volume in regression (7).

[22]For example, between 1993 and 2006, Chile invested \$5.9 billion in transport infrastructure and built 2,505 kilometers of roads. See OECD (2009, p.70) for details.

[23]Note that the average foreign tariff rate and quality of regional infrastructure have been controlled for in Table 2. This suggests that the correlation between f°_{irt} and $\ln V_{jt}$ cannot be the result of the impacts of foreign tariffs and Chilean infrastructure on those variables.

********* Table 2 about here *********

Second, we investigate how heavily the three FEC indices are influenced by idiosyncratic (firm-specific) export expenses. For example, firms may pay idiosyncratic export expenses to advertise their products. In general, such costs do not contaminate $\{\widehat{\delta}_i, \widehat{\delta}_r, \widehat{\delta}_t\}$. Take $\widehat{\delta}_i$ for example. It does not capture marketing costs paid by only some exporters in industry i. The exception would be a situation in which most exporters in a given industry conduct aggressive marketing and thus incur high idiosyncratic export expenses. In this case, the risk is that the industry's $\widehat{\delta}_i$ is driven up by the heavy marketing of the majority, even though a nonexporter does not necessarily pursue this strategy. The same reasoning holds for $\widehat{\delta}_r$ and $\widehat{\delta}_t$. To address this issue, we examine the correlation between the three FEC indices and an experimental index that reflects firm-level idiosyncratic export expenses.

This empirical exercise has three steps. First, we estimate firm fixed effects in export expenses, using the regression

$$\ln ExportExpenses_{jt} = \delta_j + \widetilde{\zeta} \ln V_{jt} + \widetilde{\zeta}_\tau \ln(1 + \tau_{it} V_{jt}) + \widetilde{\phi}' \mathbf{B}_{jt} + \widetilde{\epsilon}_{jt},$$

where tildes distinguish coefficients from those in regression (7). Second, we extract the firm-level estimates $\{\widehat{\delta}_j\}$ and average them at the industry-region (ir) level, denoted by $\widetilde{f}_{ir}$. Correspondingly, we average the previous FEC indices f_{irt} to the industry-region level: $f_{ir} = \frac{1}{T}\sum_{t=1}^{T} f_{irt}$. Third, we examine the correlation between $\widetilde{f}_{ir}$ and f_{ir} to see whether the FEC indices are influenced by local firms' idiosyncratic expenses. The results are reported in Table 3. There is no correlation between $\widetilde{f}_{ir}$ and f_{ir}, either with or without controlling for the average capital-labor ratio and value-added ratio.[24] This indicates that the FEC indices are not driven by firm-level idiosyncratic export expenses.

********* Table 3 about here *********

A final check of our data is to see whether the FEC indices are consistent with other measures of business costs. Specifically, we link our three indices to the World Bank Enterprise Survey (WBES) of Chile. The WBES evaluates business environments in most developing countries by surveying a representative sample of local firms. The WBES undertook surveys in Chile in 2006 and 2010, but we use only the former because this year is also covered by

[24] Interestingly, higher FECs are positively associated with the capital-labor ratio. One potential explanation is that Chile's transport infrastructure was built to handle exports of minerals and labor-intensive goods (i.e., the country's major exports) rather than capital-intensive products, though we are agnostic on this point.

our ENIA sample. To make this comparison, we average firm-level WBES responses to the industry-region level that can be matched to our 2006 FEC indices. Here, we use only the benchmark and KL- and VA-adjusted indices, because the WV-adjusted index does not cover 2006. We regress the indices on the average responses to each of the relevant survey questions, which are listed in the first column of Table 4. Regression coefficients are summarized in the remaining columns.[25] Note that some of the questions pertain to regional characteristics (e.g., concerns about power outages), perceptions of which may vary across industries in the region. The same holds for questions that concentrate on industrial characteristics. Thus, we run each regression separately with no fixed effects, with region fixed effects, and with industry fixed effects.

********* Table 4 about here *********

As reported in Table 4, FECs are found to be higher where there are more frequent power outages, fewer competitors, more severe informal-sector competition, more licensing and permits requirements, and more restrictive customs and trade regulations. We make three observations. First, not all aspects of the business environment are significant in every specification, because the WBES indicators do not necessarily vary along both industry and region dimensions. For example, frequent power outages affect all industries and regions, making it significantly associated with FECs under all three specifications. In comparison, business licensing and permits, customs and trade regulations are related to nationwide regulations. Because variations in these regulations occur mainly across industries, they lose significance when industry fixed effects are included. Second, FECs are correlated with a mix of business environment indicators, including but not limited to elements of infrastructure. As Table 4 reveals, institutions, regulations, and market structure also matter. As a result, high FECs should not be equated to weak physical infrastructure.[26] Lastly, FECs are lower where there are more competitors, perhaps because they share some costs and thereby realize joint economies.

[25]The averaged firm-level WBES data leave us with 35 industry-region pairs (5 regions and 7 industries). The linear regressions are weighted by the number of firms in each pair to address averaging-induced heteroskedasticity.

[26]The quality of infrastructure is a poor indicator of FECs also because it affects both fixed and variable export costs. Our index construction deliberately expunges variations in export expenses driven by variable export costs, and thus pins down differences in infrastructure that impact FECs.

4 Empirical Evidence

This section tests Predictions 1 to 3, with a particular focus on Prediction 1. We start with a reduced-form regression and then discuss four identification issues. The latter work confirms the reliability of the specification, which we then apply to the test of Prediction 2. Lastly, we test Prediction 3, which helps us understand the role FECs play in aggregate trade data.

4.1 Prediction 1

Equation (3) in Section 2 can be transformed into a binary dependent variable regression

$$\Pr[X_{jt} = 1] = \Phi[\beta_f f_{irt} + \beta_{TFP} TFP_{jt} + \lambda' \mathbf{Z}_{firt}], \tag{8}$$

where as before j, i, r, t are identifiers for firms, industries, regions, and years, respectively, TFP is the standardized TFP defined in Section 3.1, and $\mathbf{Z}_{firt}$ is a vector of control variables and fixed effects along various dimensions. The theory predicts $\widehat{\beta}_f < 0$ and $\widehat{\beta}_{TFP} > 0$.

********* Table 5 about here *********

Table 5 reports the results for various specifications. Columns (1) to (3) use the benchmark FEC index. The regression in column (1) excludes control variables, while that in column (2) adds the firm-level capital-labor ratio (KL) and the value-added ratio (VA). Additional control variables are introduced in column (3), including industry-year level average foreign tariff rates, and regional crime rates and infant mortality rates. We also include industry and year fixed effects to control for Chile's industrial comparative advantage and possible macroeconomic shocks.[27] It is evident that the data support Prediction 1 in all three specifications, while including control variables does not affect the regression coefficients. We also respecify the regressions with the benchmark FEC index lagged by one year (column (4)), and with the FEC indices adjusted for KL and VA (column (5)) and for VW (column (6)). These regressions generate similar results.

********* Table 6 about here *********

Panel (a) of Table 6 presents the marginal effects of FECs on export decisions based on the coefficients estimated in columns (3), (5), and (6) of Table 5. Taking the benchmark FEC

[27]Region fixed effects are not used because regional control variables vary little over time. See Section 3.2.1 for discussion on the decomposition of variations in the data.

index as an example, we find that moving from the 25th percentile to the 75th percentile of the index (a rise of 49.7 percent, 1.590/3.198) causes the export propensity of firms to decrease by two percentage points, equivalent to a 12.7 percent change (0.022/0.173). When the KL- and VA-adjusted index is used, a 46.7 percent rise in FEC leads to a 12.7 percent decrease in export propensity. With the WV adjustment applied, the two changes are 43.1 percent and 6.7 percent, respectively.

In comparison with Panel (a), Panel (b) of Table 6 presents the marginal effects of productivity on export decisions. Moving from the 25th percentile to the 75th percentile of standardized TFP causes the export propensity to rise by about six percentage points, or three times the FEC impact in the benchmark. That is, other factors held constant, a 50-percentile increase in FECs leads to about 1/6 to 1/3 as large an effect as a comparable increase in productivity. This is a quantitatively important effect that has not been noted in the prior literature.

The results in Table 5 offer strong evidence of a negative relationship between FECs and export propensity of firms across all industries in Chile. Our next task is to see if this result holds considering identification issues to which the regressions may be vulnerable. First, we check whether the findings from Table 5 hold for the largest individual industries, as opposed to the full sample. In Table 7, we show results from regression (8) for the four largest industries, which together account for 35 percent of the total sample of firms. These individual industry regressions lead to similar findings as above. The industry "publishing, printing and reproduction of recorded media" (labeled "Prints" in the table) has the largest $\widehat{\beta}_f$. This industry relies relatively more heavily than others on design, reputation, and communication, which could explain why its export propensity is more sensitive to FECs.

********* Table 7 about here *********

A second concern is that we may not have captured FECs faced by nonexporters. Our analysis relies on the assumption that estimated FECs of exporters reflect the costs that nonexporters would pay if they actually exported. One potential problem is that exporters, which are known to be more productive than nonexporters, may be more (or less) efficient than nonexporters in managing costs, making the above assignment inappropriate. To address this concern, we construct a FEC index $\widehat{\varepsilon_{irt}}$ using residuals from a regression of FECs on firm performances, including productivity, employment, total sales, and total value added.[28]

[28]This exercise has three steps. First, we standardize the last three firm-level characteristics (for both exporters and nonexporters) to be consistent with TFP and to ensure comparability across industries. Second, we use the sample of exporters to estimate a relationship between the FEC indices and a stan-

If the original index f_{irt} captures just the FECs of high-performing firms, the results in Table 5 will not hold when $\widehat{\widetilde{\varepsilon}_{irt}}$ is used instead. The new results are reported in Table 8, in which each panel uses a different FEC index and each column uses a different dimension of firm performance. The coefficients are close to those in Table 5, in both magnitude and significance levels. In our context, the hypothetical FECs offer similar results, suggesting that the original specification is robust.

********* Table 8 about here *********

A third issue is whether our approach accounts for the possibility that high-productivity nonexporters face high FECs. We test Prediction 1b by examining whether high-productivity nonexporters face elevated FECs. What is a high-productivity nonexporter? Recall that a firm has a high export propensity if it has either a high TFP or a low FEC. That is, exporters may not have high TFP even though they are on average more productive than nonexporters. To be conservative in this matter, we choose as a cutoff, the productivity of the 75th-percentile exporter in a given industry. Thus, a nonexporter is designated to have high productivity if it is no less productive than the 75th-percentile exporter in its industry.

With the high-productivity nonexporters pinpointed, we compare their FECs with those of exporters. A preliminary discussion was presented in Figure 1, which shows the productivity distribution of exporters and nonexporters, respectively, in two industries. Two points were made in that discussion. First, in both industries, there exist high-productivity nonexporters, which are by definition more productive than the 75th-percentile exporter. Second, according to the t-test results, high-productivity nonexporters face higher FECs than lower-productivity exporters.

********* Table 9 about here *********

Now we undertake a more detailed comparison of FECs between high-productivity nonexporters and exporters by dividing the latter into ten productivity deciles. Table 9 examines the "fabricated metal products" industry. In Panels (a) to (c), we compare the FECs of high-productivity nonexporters with those of all exporters (column (1)), those in deciles 1-4 (column (2)), those in deciles 5-8 (column (3)), those in deciles 9-10 (column (4)), and those in decile 10 (column (5)). Clearly, high-productivity nonexporters exhibit higher FECs than

dardized firm characteristic y_{jt} (one among productivity, employment, total sales, and total value added): $f_{irt} = \omega y_{jt}(X_{jt} = 1) + \widetilde{\varepsilon}_{irt}$. Third, we average these first-stage residuals to construct the triplet-level index $\widehat{\widetilde{\varepsilon}_{irt}}$.

all exporters except those in deciles 9 and 10. The same finding is reached when adjusted FEC indices are used. Panels (a) to (c) in Table 10 have results for the "wood and cork" industry, which show still stronger findings: high-productivity nonexporters have higher FECs than nearly all exporters.

********* Table 10 about here *********

For each of these two industries, we also match high-productivity nonexporters with exporters based on their propensities to export. Propensities to export are measured with propensity scores, estimated using a logit regression of the export indicator on firm-level TFP, capital-labor ratio, and value-added ratio.[29] Nonexporting is taken as a treatment on subjects, which are firms with matched firm characteristics TFP, VA, and KL. If nonexporting is caused by factors other than FECs, we would see no association between the treatment and FECs. The results are reported in Panel (d)'s of Tables 9-10, which show that high-productivity nonexporters indeed face higher FECs than comparable exporters.

The fourth identification issue is whether $\widehat{\beta}_f$ in regression (8) is contaminated by the negative effect of variable export costs on $\Pr[X_{jt} = 1]$. Conceivably, FECs are high where variable export costs are also high. This is the reason we control for infrastructure quality in regression (8). To address this further, we examine the correlation between FECs and firm-level export volume using the regression

$$\ln(V_{jt} + 1) = \kappa_f f_{irt} + \kappa_{TFP} TFP_{jt} + \xi' \mathbf{Z}_{jirt} + \eta_{jt}, \tag{9}$$

where $V_{jt} \geq 0$ is the export volume of firm j in year t and other notations are the same as in regression (8). If FECs capture the effect of variable export costs (implying contamination), we would see a negative and significant $\widehat{\kappa}_f$. A noteworthy issue in the estimation of regression (9) is its truncated dependent variable: export volume is truncated at zero and this causes inconsistent estimates of all parameters. The error term in regression (8) is denoted by u. We next estimate regression (9) jointly with regression (8) using a Type II Tobit model that assumes that, conditional on $(f,\, TFP,\, \mathbf{Z})$, $(u, \eta)'$ follows distribution $N((0,0)', \Sigma)$, where

$$\Sigma \equiv \begin{pmatrix} \sigma_N^2 & \rho\sigma_N \\ \rho\sigma_N & \sigma_N^2 \end{pmatrix}.$$

[29] The use of the logit model follows the literature on matching; see, for instance, Rosenbaum and Rubin (1983).

This joint model integrates the estimation of two decisions: whether to export and in what volume.

********* Table 11 about here *********

The results are reported in Panel (a) of Table 11, where the first regression in each pair reflects equation (9) and the second reflects equation (8).[30] As in Table 5, we incorporate all three FEC measures. Coefficients $\widehat{\beta}_f$ and $\widehat{\beta}_{TFP}$ are both significant and of the expected signs, consistent with those in Table 5. This attests again to the effects of FECs and TFP on export propensity. In contrast, in the export-volume regression, the coefficient of fixed export costs $\hat{\kappa}_f$ is not significantly different from zero, while the coefficient of TFP $\hat{\kappa}_{TFP}$ is significantly positive.[31] Thus, our FEC indices are unlikely to be conflated by the negative effect of variable export costs on export decisions.

Panel (b) of Table 11 includes only exporters in the sample and runs an OLS regression with $\ln V_{jt}$ as the dependent variable. The coefficient of FECs is again statistically insignificant, while the coefficient of TFP retains similar significance and magnitude as those in Panel (a). This result is in line with the prediction of the conceptual framework that firm-level export volume, as shown in equation (1), does not have the fixed cost parameter f in it. In other words, FECs do not affect the trade volume of a firm once it chooses to export.

4.2 Predictions 2 and 3

In the previous section we found that the results from regression (8) are robust to a battery of identification issues. With this confidence established, we apply a similar specification to test Prediction 2, which claims that the association between fixed export costs and export propensity becomes weaker for firms with higher productivity. We introduce into regression (8) interaction terms between FECs and dummy variables, labeled $TFPQ$, that classify firm j's productivity in year t to be in the second, third, or fourth quartile:

$$\Pr[X_{jt} = 1] = \Phi[\iota_f f_{irt} + \iota_{TFP} TFP_{jt} + \sum_{q=2}^{4} \theta_q TFPQ_{jtq} \times f_{irt} + \lambda' \mathbf{Z}_{jirt}]. \tag{10}$$

[30] It is difficult to find convincing triplet-level instruments that affect export decisions but not export volumes. Therefore, we use nonlinearity to identify the effect of selection. See Cameron and Trivedi (2009, p.543) for a discussion on the use of nonlinearity in identification.

[31] The $\widehat{\rho}$ estimate is positive and significant, indicating that regression (9) is not independent of regression (8) and thus the sample selection needs to be corrected.

Prediction 2 is then equivalent to $\widehat{\iota}_f < 0$, $\widehat{\iota}_{TFP} > 0$, $\widehat{\theta}_q > 0$, and that the magnitude of $\widehat{\theta}_q$ increases in the quartile q.

********* Table 12 about here *********

Results from regression (10), reported in Table 12, are in line with Prediction 2. Quartile 1 is the reference group. Take column (1) for example. $\widehat{\iota}_f = -1.345$ reflects the negative effect of FECs on the export decision in that group. The same effect in the higher quartiles 2, 3, and 4 can be calculated as $\widehat{\iota}_f + \widehat{\theta}_2$, $\widehat{\iota}_f + \widehat{\theta}_3$, and $\widehat{\iota}_f + \widehat{\theta}_4$, respectively. Since $\widehat{\theta}_4 > \widehat{\theta}_3 > \widehat{\theta}_2 > 0$, the negative effect of FECs on the export decision decreases as TFP rises. Thus, as predicted, low FECs substitute for high productivity, and the substitution effect is weaker for firms with higher TFP. These findings hold in columns (2) through (5), when control variables are added and different FEC indices are used.[32]

The substitution effect in Prediction 2 should be symmetric in the sense that high productivity substitutes for low FECs, and the substitution becomes weaker when those costs are lower. This symmetric effect is tested in column (6) of Table 12, which establishes interactions between TFP and quartiles of fixed trade costs:

$$\Pr[X_{jt} = 1] = \Phi[\widetilde{\iota}_f f_{irt} + \widetilde{\iota}_{TFP} TFP_{jt} + \sum_{q=2}^{4} \varphi_q FQ_{jtq} \times TFP_{jt} + \widetilde{\lambda}' \mathbf{Z}_{jirt}], \qquad (11)$$

where FQ_{jtq} is a dummy variable denoting firm j's FECs by quartile.[33] Quartile 1, with the lowest FECs, is used as the reference group. As expected, $\widehat{\widetilde{\iota}}_f < 0$, $\widehat{\widetilde{\iota}}_{TFP} > 0$, $\widehat{\varphi}_q > 0$, and $\widehat{\varphi}_q$ increases as q increases.

One may wonder about the practice of dividing firms by their f_{irt} quartiles and TFP_{jt} quartiles, because f_{irt} is not a firm-level variable and the comparability of TFP across industries relies on standardization. In this regard, in column (7), we interact triplet-level FECs directly with firm-level TFP. In column (8), we replace TFP with the productivity percentile of a firm within its industry-year group. The interaction terms in both columns are positive, in line with Prediction 2. We also use the residual-based FEC indices $\widehat{\widetilde{\varepsilon}_{irt}}$ calculated earlier to examine the interaction, which leads to the same findings (reported in Table A2).

The relationship between Table 12 and Tables 9-10 deserves elaboration. The findings from Tables 9 and 10 are stronger still if the findings from Table 12 are taken into account.

[32] In column (5), $\widehat{\iota}_f + \widehat{\theta}_4$ seems positive but is not significantly different from zero.

[33] We experimented with quartiles of FECs at both the triplet level and the firm level and reached the same findings.

Table 12 shows that high-productivity firms, compared to low-productivity ones, are less sensitive to FECs. However, according to Tables 9 and 10, high-productivity nonexporters are still blocked from exporting by FECs, which reinforces the negative effect of such costs on trade.

Turn next to Prediction 3, which claims that firms on average export a larger volume if either FECs are higher or dispersion of productivity is greater. Intuitively, with FECs held constant, a larger dispersion of productivity leads to more firms that are beyond the productivity threshold to export. Conversely, for a given dispersion, higher FECs raise the threshold. To investigate this idea, we compute the coefficient of variation (CV) of TFP at the triplet level. We include this CV in a regression where the dependent variable is the logarithm of total exports divided by the number of exporters at the triplet level.[34] Since this variable is an average, we weight the regression using the number of exporters at the same level.

********* Table 13 about here *********

The results are reported in Table 13. Column (1) includes the CV of productivity but not the FEC index. Triplets with larger dispersion of productivity are shown to have larger average export volumes. Column (2) includes the benchmark FEC index but not the productivity dispersion. It is clear that higher FECs are associated with larger average export volumes. Column (3) includes both variables. The initial findings remain intact, while their magnitudes shrink.

These coefficients constitute evidence of "survival of the fittest"—a Darwinian phrase used here to characterize a Melitz-style redistribution effect—in the exporting business.[35] Recall from Table 6 that the benchmark FEC index, when moving from the 25th percentile to the 75th percentile, would rise by 46.7 percent and lower export propensity by 12.7 percent. For firms that do export, however, this rise in FECs translates into a nearly 50-percent increase in the export volume of an average exporter if the dispersion of productivity is held constant.[36] We repeat this exercise using the adjusted FEC indices in columns (4)–(7) and reach similar findings. Overall, moving from the 25th percentile to the 75th percentile of FECs causes average export volume to increase by one third to one half. The coefficients of the control variables remain consistent with expectations.

[34]Since CV is an industry-specific measure, it is constructed using non-standardized TFP.

[35]Zingales (1998) uses this term in a corporate finance study.

[36]This calculation is the product of the rise in fixed costs (0.177, see Table 6) and the coefficient on FECs (2.655 in column (3) of Table 13).

The linkage between Table 13 and Table 11 is also noteworthy. Higher FECs affect export volume of average exporters by selecting firms with higher productivity to be exporters. However, this mechanism does not affect firm-level export volume conditional on productivity. As theoretically illustrated in Section 2, the FEC, once paid, does not further affect export behavior. This notion holds empirically in both panels of Table 11, where productivity is controlled for. If productivity is not controlled for, the selection effect in Table 13 should present itself in regressions of firm-level export volume. We undertake this experiment and report the results in Table A3, where exporters in triplets with higher FECs are found to export larger volumes when productivity is not held constant.

5 Conclusions

Firm-level export decisions mainly depend on two cost parameters: average variable costs of production (i.e., productivity) and the fixed costs of selling products abroad (i.e., fixed export costs, FECs). This is a standard assumption in the trade literature, whereas corresponding empirical evidence remains absent. Our paper closes this gap by documenting the following three findings. First, both productivity and FECs affect export propensities of firms, whereas only productivity affects export volume. In particular, there are high-productivity nonexporters and low-productivity exporters, the former of which face higher FECs than the latter. Second, these two factors interact with each other, in that the effect of reducing FECs on export propensity is weaker for firms with higher productivity. Third, the average export volume of exporters is larger where the dispersion of productivity is greater or FECs are higher. These findings as a whole indicate that the productivity premium of exporters stems from a sorting mechanism based on productivity and FECs.

This analysis offers both theoretical and empirical avenues for future research. First, it will be interesting to incorporate heterogeneous FECs into a general equilibrium framework. Recent trade models have taken productivity heterogeneity into account, but not different FECs across firms. We speculate that the gains from trade through market share redistribution also vary by fixed export costs. Second, FEC is widely used in theoretical modeling due to its tractability and importance, but largely unstudied empirically due to difficulties in measurement. The FEC indices developed in this paper can be applied to other datasets in which micro-level export expenses are available. Additional empirical efforts in this direction should help deepen our understanding of FEC and its role in theoretical modeling. Finally, this paper contributes to new thinking on policies that could expand exports. The conventional wisdom is that productivity improvement is the key to achieving this outcome.

However, it may be easier, in policy terms, to reduce local FECs and, as our results suggest, there would be significant impacts on export propensity and volume.

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Appendix

A1. Data from the customs of Chile

Customs data were taken from the Chilean National Customs Service (for more information, see www.aduana.cl). The National Customs Service collects information regarding imports and exports from Chile at 90 points of entry/exit, including ports, airports and controlled border crossings. They provide statistics of exports from Chile to the rest of the world, using the 2002 Harmonized System (HS) Classification at the eight-digit level. Statistics are reported in current US Dollars (FOB values). To combine these data with the ENIA data, we matched the HS classifications with the two-digit ISIC (rev.3) codes.

A2. Data on tariff charges

The tariff data are available from the website of the World Integrated Trade Solution (WITS, wits.worldbank.org/wits/) maintained by the World Bank. The WITS website provides access to the database Trade Analysis and Information System (TRAINS), the data of which are collected by the United Nations Conference on Trade and Development (UNCTAD). Since Chile's exports concentrate on five trade partners (China, the European Union, Japan, South Korea, and United States, denoted by b below), we compute their industry-level annual average tariff rates weighted by trade volume. Specifically, we construct the average tariff rate,

$$\tau_{it} = \sum_b \varsigma_{bit} \times TARIFF_{bit}$$

where

$$\varsigma_{bit} = \frac{EXPORTS_{bit}}{\sum_b EXPORTS_{bit}},$$

i is the two-digit ISIC (rev.3) code, t is year, $EXPORTS$ is export volume, and $TARIFF_{bit}$ is the average effectively applied rate at the country-industry-year (bit) level.

Table 1: Descriptive statistics

Panel (a): by year*

	(1)	(2)	(3)	(4)	(5)	(6)
Year	No. of firms	No. of exporters	Total sales (tn pesos)	Total export volume (tn pesos)	Average export intensity	Share of exporters
2001	2739	498	9.62	3.49	0.25	0.18
2002	2987	513	10.40	3.15	0.27	0.17
2003	2987	546	11.36	2.90	0.27	0.18
2004	3070	524	14.49	4.79	0.28	0.17
2005	2985	512	16.83	4.46	0.28	0.17
2006	2846	500	18.87	5.89	0.28	0.18
2007	2660	481	21.49	7.51	0.28	0.18
Average	2896	511	14.72	4.60	0.27	0.18

* Column (3) aggregates the sales of all firms. Column (4) aggregates the export volumes of all exporters. Column (5) is the export volume/total sales ratio averaged across exporters. Column (6) is the ratio of column (2) to column (1).

Panel (b): by firm

Variable	Obs	Mean	Std. Dev.
Sales (mn pesos)	20274	5.08	59.67
Capital (mn pesos)	20274	2.17	22.37
Value added (mn pesos)	20274	3.45	51.81
Skilled labor (persons)	20274	38.21	117.00
Unskilled labor (persons)	20274	26.63	62.35
Export volume (mn pesos)	3702	8.70	54.14
Export expenses/export volume	3702	0.09	0.50

Table 1: Descriptive statistics (cont'd)

Panel (c): by triplet (industry-region-year)**

Variable	Obs	Mean	Std. Dev.
No. of firms	594	34.13	54.24
No. of exporters	594	6.02	10.58
Average-exporter's sales (mn pesos)	594	17.90	107.44
Average-exporter's volume (mn pesos)	594	4.53	18.41

Panel (d): statistics on fixed export costs, by triplet

Fixed export cost index (0 to 9)	Obs	Mean	Sd.
Benchmark	593	0.51	0.21
Adjusted for KL & VA	593	0.52	0.21
Adjusted for WV	347	0.58	0.24

Notes: Peso in the above table means Chilean peso. All peso values are measured using 2003 prices. During the 2001-2007 period, the average exchange rate is 1 US dollar = 606.3687 Chilean pesos.

(**) Industries in this study refer to the following two-digit (ISIC, Rev.3) industries: 17 (Manufacture of textiles); 18 (Manufacture of wearing apparel; dressing and dyeing of fur); 19 (Tanning and dressing of leather; manufacture of luggage, handbags, saddlery, harness and footwear); 20 (Manufacture of wood and of products of wood and cork, except furniture; manufacture of articles of straw and plaiting materials); 21 (Manufacture of paper and paper products); 22 (Publishing, printing and reproduction of recorded media); 24 (Manufacture of chemicals and chemical products); 25 (Manufacture of rubber and plastics products); 26 (Manufacture of other non-metallic mineral products); 27 (Manufacture of basic metals); 28 (Manufacture of fabricated metal products, except machinery and equipment); 29 (Manufacture of machinery and equipment n.e.c.); 30 (Manufacture of office, accounting and computing machinery); 31 (Manufacture of electrical machinery and apparatus n.e.c.); 32 (Manufacture of radio, television and communication equipment and apparatus); 33 (Manufacture of medical, precision and optical instruments, watches and clocks); 34 (Manufacture of motor vehicles, trailers and semi-trailers); 35 (Manufacture of other transport equipment); and 36 (Manufacture of furniture; manufacturing n.e.c.). Regions in this study can be found in Figure 3. Years are 2001-2007.

Table 2: Functional form

Dependent variable: fixed export cost indices				
	(1)	(2)	(3)	(4)
The fixed export cost index used:	Constructed without export volume	Constructed with export volume		
		Benchmark	Adjusted for KL & VA	Adjusted for WV
ln(Export volume)	0.121**	0.022	0.025	-0.002
	(0.050)	(0.050)	(0.049)	(0.084)
Averaged capital-labor ratio (KL)	1.154	0.115**	0.116**	0.348***
	(0.818)	(0.051)	(0.050)	(0.119)
Averaged value-added ratio (VA)	-0.594	0.016	0.020	0.187
	(0.752)	(0.121)	(0.117)	(0.174)
Control variables	Yes	Yes	Yes	Yes
Observations	593	593	593	347
R-squared	0.082	0.697	0.707	0.124

Notes: Regressions are undertaken at the industry-region-year level. Control variables are tariff rate, infant mortality rate, and crime rate. Robust standard errors are in parentheses. *** $p<0.01$, ** $p<0.05$.

Table 3: Firm idiosyncrasy ridden index and fixed export cost indices

Dependent variable: fixed export cost indices averaged to the industry-region level						
	(1)	(2)	(3)	(4)	(5)	(6)
The fixed export cost index used:	Benchmark		Adjusted for KL & VA		Adjusted for WV	
Firm idiosyncrasy ridden index	-0.024	-0.019	-0.030	-0.022	-0.129	-0.087
	(0.126)	(0.104)	(0.128)	(0.104)	(0.132)	(0.134)
Capital-labor ratio (KL)		0.234		0.247*		0.320*
		(0.149)		(0.148)		(0.163)
Value-added ratio (VA)		0.062		0.050		0.322
		(0.262)		(0.264)		(0.301)
Observations	105	105	105	105	99	99
R-squared	0.000	0.326	0.001	0.343	0.010	0.193

Notes: Regressions are undertaken at the industry-region level. Firm-idiosyncrasy ridden index and fixed export cost indices are averaged to the industry-region level. See Section 3 of the text for details. Control variables are tariff rate, infant mortality rate, and crime rate. Robust standard errors are in parentheses. * p<0.1.

Table 4: Consistency check using the World Bank Enterprise Surveys

Dependent variable: fixed export cost indices						
The fixed export cost index used:	Benchmark			Adjusted for KL & VA		
	No FE	Industry FE	Region FE	No FE	Industry FE	Region FE
Power outage(s) in the past year? (Yes=0, No=1)	-**	-**	-*	-**	-*	-*
Number of competitors	-***	-***	-	-***	-***	-
Practices of competitors in the informal sector as an obstacle (0-no obstacle to 4-very severe obstacle)	+	+***	+	+	+***	-
Business licensing and permits as the most severe problem (1 if reported as a firm's top 3 most severe problems, 0 otherwise)	+**	-	+***	+**	-	+***
Customs and trade regulations as the most severe problem (1 if reported as a firm's top 3 most severe problems, 0 otherwise)	+**	-	+***	+**	-	+***
Transportation as the most severe problem (1 if reported as a firm's top 3 most severe problems, 0 otherwise)	+*	-**	+***	+	-**	+***

Notes: This table checks the consistency of the fixed export cost indices with the responses reported in the World Bank Enterprise Survey (WBES). The relevant WBES wave was done in Chile in 2006. We chose the indices for the year 2006, and matched them to the firms in the WBES using industry and region information. Regressions are undertaken at the industry-region level. The fixed export cost index adjusted for WV is not included because it does not cover the year 2006. See Section 3 of the text for details. Robust standard errors are in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Table 5: Export decisions, fixed export costs, and productivity

Dependent variable: export indicator (0 or 1)						
	(1)	(2)	(3)	(4)	(5)	(6)
Fixed export cost index	Benchmark			Lagged benchmark	Adjusted for KL & VA	Adjusted for WV
Fixed export costs	-0.575***	-0.512***	-0.586***	-0.552***	-0.602***	-0.345**
	(0.144)	(0.133)	(0.154)	(0.176)	(0.158)	(0.160)
TFP	0.246***	0.263***	0.264***	0.238***	0.264***	0.320***
	(0.022)	(0.021)	(0.022)	(0.024)	(0.022)	(0.034)
Capital-Labor ratio (KL)		0.039	0.045	-0.002	0.046	0.114
		(0.074)	(0.074)	(0.073)	(0.075)	(0.151)
Value-added ratio (VA)		-0.834***	-0.832***	-0.860***	-0.833***	-0.681***
		(0.075)	(0.076)	(0.088)	(0.076)	(0.098)
Tariff rate			-0.009	-0.010	-0.009	-0.007
			(0.008)	(0.010)	(0.008)	(0.012)
Crime rate			-0.003*	-0.003	-0.003*	-0.002
			(0.002)	(0.002)	(0.002)	(0.003)
Infant mortality rate			0.005	0.007	0.009	0.052
			(0.022)	(0.025)	(0.022)	(0.034)
Observations	20,271	20,271	20,271	15,184	20,271	11,783

Notes: Industry and year fixed effects are included. Robust standard errors are in parentheses. *** p<0.01, ** p<0.05.

Table 6: Marginal effects of fixed export costs on export propensity

Panel (a) marginal effects of fixed export costs on export propensity

Fixed export cost index	Benchmark			Adjusted for KL & VA			Adjusted for WV		
	P(X=1)	dP(X=1)/df	f	P(X=1)	dP(X=1)/df	f	P(X=1)	dP(X=1)/df	f
25th percentile	0.173	-0.130	0.355	0.173	-0.133	0.367	0.163	-0.065	0.405
Median	0.162	-0.124	0.444	0.161	-0.127	0.456	0.157	-0.064	0.498
75th percentile	0.151	-0.119	0.532	0.151	-0.122	0.539	0.152	-0.062	0.580
75th percentile - 25th percent	-0.022	0.011	0.177	-0.022	0.011	0.172	-0.011	0.003	0.175

Panel (b) marginal effects of productivity on export propensity

Fixed export cost index	Benchmark			Adjusted for KL & VA			Adjusted for WV		
	P(X=1)	dP(X=1)/dA	A	P(X=1)	dP(X=1)/dA	A	P(X=1)	dP(X=1)/dA	A
25th percentile	0.132	0.049	-0.540	0.132	0.049	(as in the	0.128	0.051	(as in the
Median	0.161	0.056	0.002	0.161	0.056	benchmark	0.158	0.059	benchmark
75th percentile	0.194	0.063	0.558	0.194	0.063	case)	0.193	0.067	case)
75th percentile - 25th percent	0.061	0.014	1.098	0.061	0.014		0.065	0.016	

Notes: The three groups correspond to, respectively, columns (3), (5), and (6) in Table 5.

Table 7: Export decisions, fixed export costs, and productivity, by industry

Dependent variable: export indicator (0 or 1)

Panel (a): benchmark fixed export cost index				
	(1)	(2)	(3)	(4)
	Fab. Metal	Wood&Cork	Chemicals	Prints
Fixed export costs	-1.147**	-0.927***	-0.879***	-2.004**
	(0.495)	(0.220)	(0.339)	(0.829)
TFP	0.246***	0.455***	0.127***	0.244***
	(0.052)	(0.102)	(0.029)	(0.056)
Observations	2,263	2,164	1,505	1,164
Panel (b): fixed export cost index adjusted for KL & VA				
	(5)	(6)	(7)	(8)
	Fab. Metal	Wood&Cork	Chemicals	Prints
Fixed export costs	-1.209**	-0.888***	-0.926***	-2.042**
	(0.495)	(0.221)	(0.342)	(0.837)
TFP	0.246***	0.461***	0.126***	0.247***
	(0.052)	(0.104)	(0.029)	(0.057)
Observations	2,263	2,164	1,505	1,164
Panel (c): fixed export cost index adjusted for WV				
	(9)	(10)	(11)	(12)
	Fab. Metal	Wood&Cork	Chemicals	Prints
Fixed export costs	-0.922**	-0.966***	-0.548*	-1.536***
	(0.446)	(0.318)	(0.333)	(0.569)
TFP	0.213***	0.679***	0.133***	0.210***
	(0.060)	(0.183)	(0.042)	(0.059)
Observations	1,280	1,288	832	642

Notes: The same specification as Table 5 is used, but with different individual industries. Short names Fab. Metal, Wood&Cork, Chemicals, and Prints in the table refer to, respectively, "manufacture of fabricated metal products, except machinery and equipment," "manufacture of wood and of products of wood and cork, except furniture as well as manufacture of articles of straw and plaiting materials," "manufacture of chemicals and chemical products," and "publishing, printing and reproduction of recorded media." Robust standard errors are in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Table 8: Export decisions and residual-based fixed export costs

Dependent variable: export indicator (0 or 1)

Panel (a): residual-based fixed export costs, benchmark				
	(1)	(2)	(3)	(4)
The chosen firm-level performance variable:	TFP	Employment	Total sales	Total Value added
$\widehat{\tilde{\varepsilon}_{irt}}$	-0.540***	-0.597***	-0.647***	-0.604***
	(0.152)	(0.154)	(0.152)	(0.153)
TFP	0.262***	0.264***	0.263***	0.264***
	(0.021)	(0.021)	(0.021)	(0.021)
Observations	20,271	20,271	20,271	20,271

Panel (b): residual-based fixed export costs, adjusted for KL and VA				
	(1)	(2)	(3)	(4)
The chosen firm-level performance variable:	TFP	Employment	Total sales	Total Value added
$\widehat{\tilde{\varepsilon}_{irt}}$	-0.555***	-0.616***	-0.667***	-0.621***
	(0.156)	(0.158)	(0.155)	(0.157)
TFP	0.263***	0.264***	0.263***	0.264***
	(0.022)	(0.022)	(0.021)	(0.021)
Observations	20,271	20,271	20,271	20,271

Panel (c): residual-based fixed export costs, adjusted for WV				
	(1)	(2)	(3)	(4)
The chosen firm-level performance variable:	TFP	Employment	Total sales	Total Value added
$\widehat{\tilde{\varepsilon}_{irt}}$	-0.282*	-0.349**	-0.358**	-0.343**
	(0.157)	(0.160)	(0.158)	(0.159)
TFP	0.319***	0.320***	0.319***	0.320***
	(0.035)	(0.034)	(0.034)	(0.034)
Observations	11,783	11,783	11,783	11,783

Notes: Control variables are capital-labor ratio, value-added ratio, tariff rate, infant mortality rate, and crime rate. Industry and year fixed effects are included. Each panel uses a different fixed export cost index and each column uses a different firm-level performance variable. See Section 4 of the text for details. Robust standard errors are in parentheses. *** p<0.01, ** p<0.05,

Table 9: Productivity and fixed export costs of high-productivity nonexporters (industry 28)

"Manufacture of fabricated metal products, except machinery and equipment"

	(1)	(2)	(3)	(4)	(5)
	Reference group				
	All exporters	Decile 1-4 exporters	Decile 5-8 exporters	Decile 9-10 exporters	Decile 10 exporters
Panel (a): dependent variable: benchmark fixed export cost index					
High-productivity nonexporter dummy	0.020**	0.034**	0.038***	-0.010	-0.007
	(0.009)	(0.013)	(0.011)	(0.013)	(0.014)
Observations	497	286	326	313	276
R-squared	0.010	0.022	0.034	0.002	0.001
Panel (b): dependent variable: fixed export cost index adjusted for KL and VA					
High-productivity nonexporter dummy	0.021**	0.034**	0.039***	-0.010	-0.008
	(0.009)	(0.013)	(0.011)	(0.013)	(0.014)
Observations	497	286	326	313	276
R-squared	0.011	0.023	0.037	0.002	0.001
Panel (c): dependent variable: fixed export cost index adjusted for WV					
High-productivity nonexporter dummy	0.017	0.042**	0.046***	-0.038	-0.033
	(0.015)	(0.020)	(0.018)	(0.023)	(0.029)
Observations	278	153	180	165	141
R-squared	0.005	0.027	0.036	0.019	0.012
Panel (d): propensity score estimates: the fixed export cost premium of high-productivity nonexporters					
	Estimates			No. treated	No. control
	Difference	Std. Error	t-statistic		
Nearest Neighbor Matching	0.020	0.009	2.269	214	283
Radius Matching	0.020	0.009	2.271	214	283
Kernel Matching	0.020	0.009	2.227	214	283

Notes: Panels (a)-(c): "High-productivity" nonexporters are defined as nonexporters that are more productive than the 75th-percentile exporters. Robust standard errors are in parentheses. *** p<0.01, ** p<0.05. Panel (d): The benchmark fixed export cost index is used. Common support is required. Bootstrap standard errors for the matching estimates are based on 2000 replications.

Table 10: Productivity and fixed export costs of high-productivity nonexporters (industry 20)

"Manufacture of wood and of products of wood and cork, except furniture; manufacture of articles of straw and plaiting materials"

	(1)	(2)	(3)	(4)	(5)
	Reference group				
Compared with:	All exporters	Decile 1-4 exporters	Decile 5-8 exporters	Decile 9-10 exporters	Decile 10 exporters
Panel (a): dependent variable: benchmark fixed export cost index					
High-productivity nonexporter dummy	0.100***	0.121***	0.104***	0.084***	0.073***
	(0.021)	(0.024)	(0.023)	(0.023)	(0.024)
Observations	627	186	285	294	211
R-squared	0.043	0.137	0.079	0.052	0.046
Panel (b): dependent variable: fixed export cost index adjusted for KL and VA					
High-productivity nonexporter dummy	0.096***	0.117***	0.101***	0.080***	0.069***
	(0.021)	(0.023)	(0.022)	(0.022)	(0.023)
Observations	627	186	285	294	211
R-squared	0.041	0.133	0.077	0.051	0.044
Panel (c): dependent variable: fixed export cost index adjusted for WV					
High-productivity nonexporter dummy	0.070**	0.083**	0.075**	0.061*	0.045
	(0.030)	(0.035)	(0.032)	(0.031)	(0.033)
Observations	356	98	157	169	123
R-squared	0.017	0.057	0.035	0.023	0.015
Panel (d): propensity score estimates: the fixed export cost premium of high-productivity nonexporters					
	Estimates			No. treated	No. control
	Difference	Std. Error	t-statistic		
Nearest Neighbor Matching	0.100	0.022	4.613	69	558
Radius Matching	0.100	0.021	4.770	69	558
Kernel Matching	0.100	0.022	4.630	69	558

Notes: Panels (a)-(c): "High-productivity" nonexporters are defined as nonexporters that are more productive than the 75th-percentile exporters. Robust standard errors are in parentheses. *** p<0.01, ** p<0.05, * p<0.1. Panel (d): The benchmark fixed export cost index is used. Common support is required. Bootstrap standard errors for the matching estimates are based on 2000 replications.

Table 11: Fixed export costs and export volume

Dependent variable: firm-level export volume

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Measure of fixed export costs	Benchmark				Lagged benchmark		Adjusted for KL & VA		Adjusted for WV	
Panel (a): Type II Tobit model, exporters and nonexporters										
Dependent variable	ln(V+1)	Pr(X=1)	ln(V+1)	Pr(X=1)	ln(V+1)	Pr(X=1)	ln(V+1)	Pr(X=1)	ln(V+1)	Pr(X=1)
Fixed export costs	0.479	-0.437***	0.375	-0.481***	0.295	-0.471***	0.407	-0.494***	-0.253	-0.255*
	(0.596)	(0.133)	(0.553)	(0.158)	(0.612)	(0.179)	(0.560)	(0.162)	(0.555)	(0.153)
TFP	0.749***	0.192***	0.840***	0.230***	0.787***	0.215***	0.840***	0.230***	0.911***	0.249***
	(0.073)	(0.018)	(0.065)	(0.020)	(0.073)	(0.023)	(0.065)	(0.020)	(0.085)	(0.027)
ρ (the selection coefficient)#	0.298***		0.192***		0.224***		0.193***		0.230***	
	(0.056)		(0.043)		(0.046)		(0.043)		(0.069)	
ln(σ_N)#	0.888***		0.793***		0.784***		0.793***		0.817***	
	(0.020)		(0.016)		(0.019)		(0.016)		(0.020)	
Control variables	No	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	20,271	20,271	20,271	20,271	15,184	15,184	20,271	20,271	11,783	11,783
Panel (b): OLS, exporters only										
Dependent variable				ln(V)		ln(V)		ln(V)		ln(V)
Fixed export costs				0.530		0.466		0.566		-0.150
				(0.405)		(0.455)		(0.411)		(0.435)
TFP				0.765***		0.708***		0.765***		0.814***
				(0.047)		(0.051)		(0.047)		(0.060)
Control variables				Yes		Yes		Yes		Yes
Observations				3,573		2,804		3,573		2,081
R-squared				0.338		0.354		0.338		0.300

Notes: Control variables are capital-labor ratio, value-added ratio, tariff rate, infant mortality rate, and crime rate. Industry and year fixed effects are included. Robust standard errors are in parentheses. #See Section 4 of the text for the meanings of ρ and σ_N in the Typy II Tobit model. *** p<0.01, * p<0.1.

Table 12: Interaction between fixed export costs and productivity

Dependent variable: export indicator (0 or 1)	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Different fixed export cost indices						Single interaction	
	Benchmark		Lagged benchmark	Adjusted for KL & VA	Adjusted for WV	Symmetric effects	Using lnTFP	Using lnTFP percentile
Fixed export costs	-1.345***	-1.323***	-1.189***	-1.312***	-1.154***	-0.783***	-0.785***	-1.873***
	(0.189)	(0.201)	(0.223)	(0.202)	(0.222)	(0.187)	(0.185)	(0.246)
TFP	0.039	0.084***	0.072***	0.085***	0.103***	0.101***	-0.083	-0.019
	(0.026)	(0.023)	(0.026)	(0.023)	(0.034)	(0.030)	(0.051)	(0.027)
Fixed export costs x	0.508***	0.518***	0.471***	0.503***	0.589***			
productivity quartile 2	(0.099)	(0.092)	(0.098)	(0.090)	(0.125)			
Fixed export costs x	1.028***	0.976***	0.831***	0.948***	1.106***			
productivity quartile 3	(0.124)	(0.116)	(0.122)	(0.114)	(0.160)			
Fixed export costs x	1.317***	1.198***	1.054***	1.163***	1.300***			
productivity quartile 4	(0.168)	(0.152)	(0.158)	(0.149)	(0.203)			
Fixed export costs quartile 2 x						0.107**		
productivity						(0.045)		
Fixed export costs quartile 3 x						0.284***		
productivity						(0.062)		
Fixed export costs quartile 4 x						0.403***		
productivity						(0.071)		
Fixed export costs (benchmark) x							0.794***	
productivity							(0.132)	
Fixed export costs (benchmark) x								2.300***
productivity percentile within industry-year								(0.250)
Control variables	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	20,271	20,271	15,184	20,271	11,783	20,271	20,271	20,271

Notes: Control variables are capital-labor ratio, value-added ratio, tariff rate, infant mortality rate, and crime rate. Industry and year fixed effects are included. Robust standard errors are in parentheses. *** p<0.01, ** p<0.05.

Table 13: Average export volume of exporters

Dependent variable: export volume of an average exporter							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Fixed export cost index	NA	Benchmark		Adjusted for KL & VA		Adjusted for WV	
TFP coefficient of variation (CV)	13.674***		11.390***		11.313***		7.772*
	(3.607)		(3.595)		(3.587)		(4.175)
Fixed export costs		3.270***	2.655***	3.409***	2.781***	2.134***	1.664***
		(0.524)	(0.534)	(0.535)	(0.545)	(0.557)	(0.537)
Capital-Labor ratio (KL)	0.315	0.274	-0.437	0.200	-0.490	2.236	2.909
	(1.973)	(1.825)	(1.880)	(1.821)	(1.876)	(2.205)	(2.397)
Value-added ratio (VA)	-5.329***	-5.828***	-5.427***	-5.720***	-5.345***	-3.099	-2.445
	(1.662)	(1.722)	(1.635)	(1.719)	(1.631)	(1.965)	(1.901)
Tariff rate	-0.116***	-0.109***	-0.115***	-0.108***	-0.114***	-0.106***	-0.109***
	(0.041)	(0.038)	(0.039)	(0.038)	(0.039)	(0.038)	(0.039)
Crime rate	0.012	0.028***	0.021**	0.029***	0.021**	0.017	0.011
	(0.010)	(0.011)	(0.010)	(0.011)	(0.010)	(0.019)	(0.018)
Infant mortality rate	-0.010	-0.168	-0.191	-0.188	-0.209	-0.122	-0.124
	(0.139)	(0.160)	(0.149)	(0.160)	(0.149)	(0.203)	(0.189)
Observations	583	593	582	593	582	347	342
R-squared	0.074	0.061	0.093	0.063	0.095	0.045	0.070

Notes: Since the dependent variable is an averaged value, regressions are weighted by the number of exporters in the triplet to address heteroskedasticity. When the TFP coefficient of variation is included in a regression, sample size shrinks because the sample standard deviation of TFP is not well-defined when there is only one firm in the triplet. Robust standard errors are in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Table A1: New exporters and quitters

Years	Total No. of firms	No. of new exporters	Share of new exporters	No. of new quitters	Share of new quitters	No. of new exporters who are also quitters	Share of new exporters who are also quitters
2001	2,739	NA	NA	96	3.50%	NA	NA
2002	2,987	47	1.57%	49	1.64%	27	0.90%
2003	2,987	44	1.47%	61	2.04%	38	1.27%
2004	3,070	33	1.07%	39	1.27%	35	1.14%
2005	2,985	38	1.27%	37	1.24%	43	1.44%
2006	2,846	24	0.84%	40	1.41%	32	1.12%
2007	2,660	19	0.71%	NA	NA	NA	NA
Average	2,896	34.17	1.16%	54	1.85%	35	1.21%

Notes: This table summaries number and share of new exporters, which are defined as firms that export in the current year but not the previous year. As a comparison, it also reports counterpart statistics of quitters, defined as firms that export in the current year but not the next year. Since our data cover years 2001—2007, information on new exporters in 2001 and quitters in 2007 are unavailable.

Table A2: Interaction between fixed export costs and residual-based productivity

Dependent variable: export indicator (0 or 1)	(1)	(2)	(3)
	Different fixed export cost indices		
	Benchmark	Adjusted for KL & VA	Adjusted for WV
Residual-based fixed export costs ($\widehat{\tilde{\varepsilon}_{irt}}$)	-1.843***	-1.819***	-1.199***
	(0.307)	(0.305)	(0.299)
lnTFP	0.282***	0.281***	0.319***
	(0.021)	(0.021)	(0.033)
Residual-based fixed export costs x	0.655**	0.630**	0.306
productivity quarter 2	(0.263)	(0.262)	(0.287)
Residual-based fixed export costs x	1.609***	1.563***	1.251***
productivity quarter 3	(0.306)	(0.303)	(0.355)
Residual-based fixed export costs x	2.246***	2.212***	1.790***
productivity quarter 4	(0.332)	(0.328)	(0.358)
Control variables	Yes	Yes	Yes
Observations	20,271	20,271	11,783

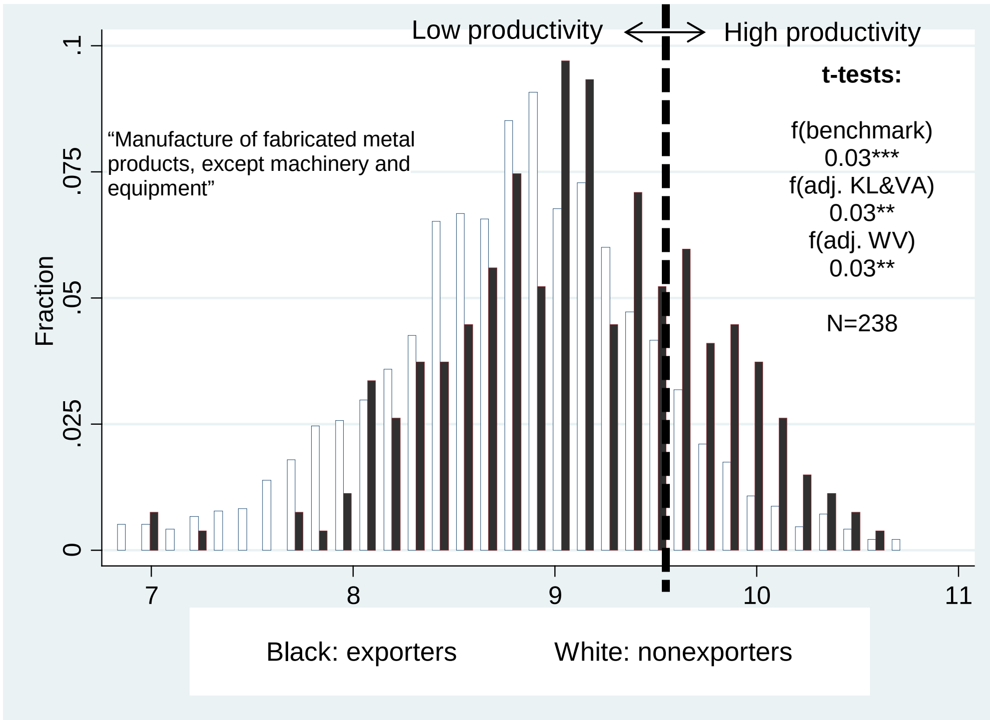
Notes: The residual-based fixed export costs are calculated based on productivity. See text for details. Control variables are capital-labor ratio, value-added ratio, tariff rate, infant mortality rate, and crime rate. Industry and year fixed effects are included. Robust standard errors are in parentheses. *** p<0.01, ** p<0.05.

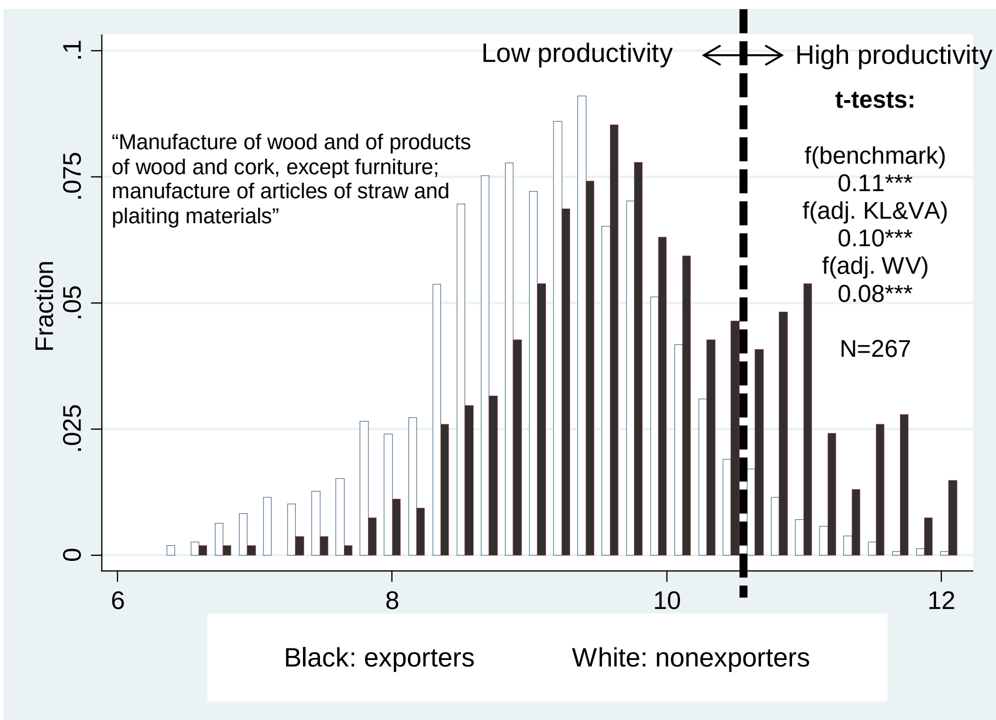
Table A3: Fixed export costs and export volume, without controlling for productivity

The dependent variable: firm-level export volume			
	(1)	(2)	(3)
Estimation method	OLS	Tobit II	
Dependent variable	ln(V)	ln(V+1)	Pr(X=1)
Fixed export costs	1.589***	1.930***	-0.411***
	(0.423)	(0.514)	(0.128)
ρ (the selection coefficient)#		-1.260***	
		(0.067)	
ln(σ_N)#		1.280***	
		(0.033)	
Control variables	Yes	Yes	Yes
Observations	3,701	20,271	20,271

Notes: Column (1) includes only exporters. Columns (2) and (3) include all firms, and are jointly estimated to correct the truncation in firm-level export volume. Control variables are capital-labor ratio, value-added ratio, tariff rate, crime rate, and infant mortality rate. Industry and year fixed effects are included. Robust standard errors are in parentheses. #See Section 4 of the text for the meanings of ρ and σ_N in the Typy II Tobit model. *** p<0.01.

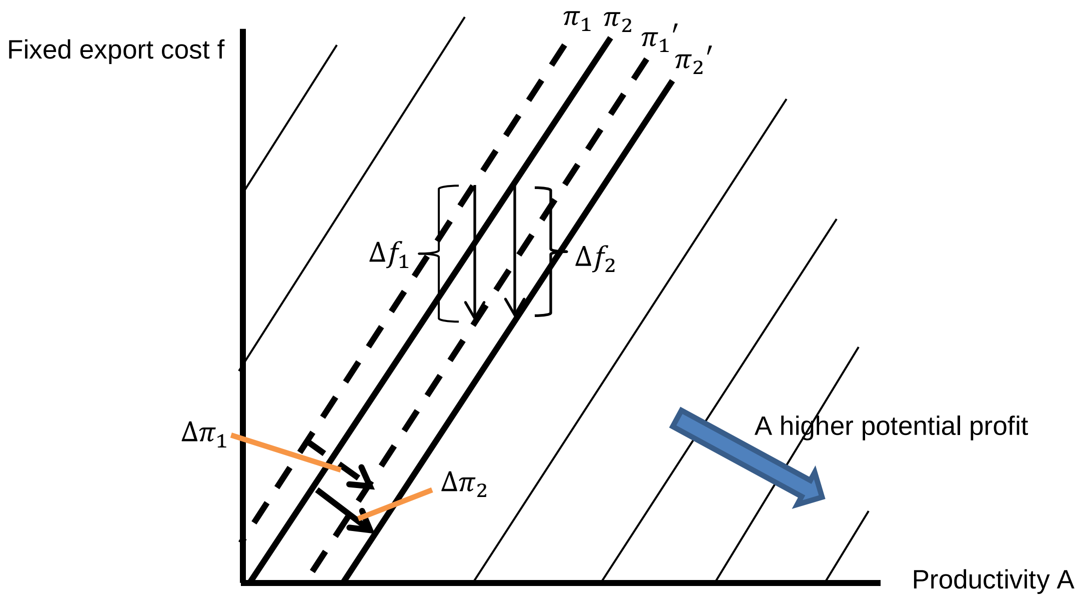
Figure 1: Productivity overlap between exporters and nonexporters



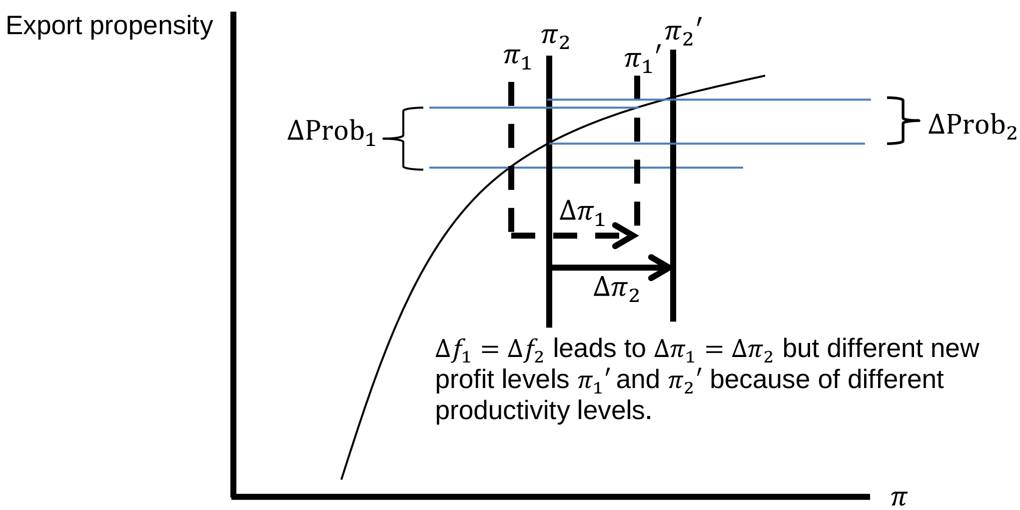


Notes: Productivity is estimated using the Ackerberg-Caves-Frazer (2006) method. The vertical dashed line is the 75th-percentile productivity of exporters and we define productivity above (below) this level as high (low) productivity. Then we compare the fixed export costs between high-productivity nonexporters and low-productivity exporters. The differences measured with three distinct indices (see the text of Section 3) are reported in the the upper-right corners, together with t-test results (*** p<0.01, ** p<0.05).

Figure 2: Interaction between fixed export costs and productivity

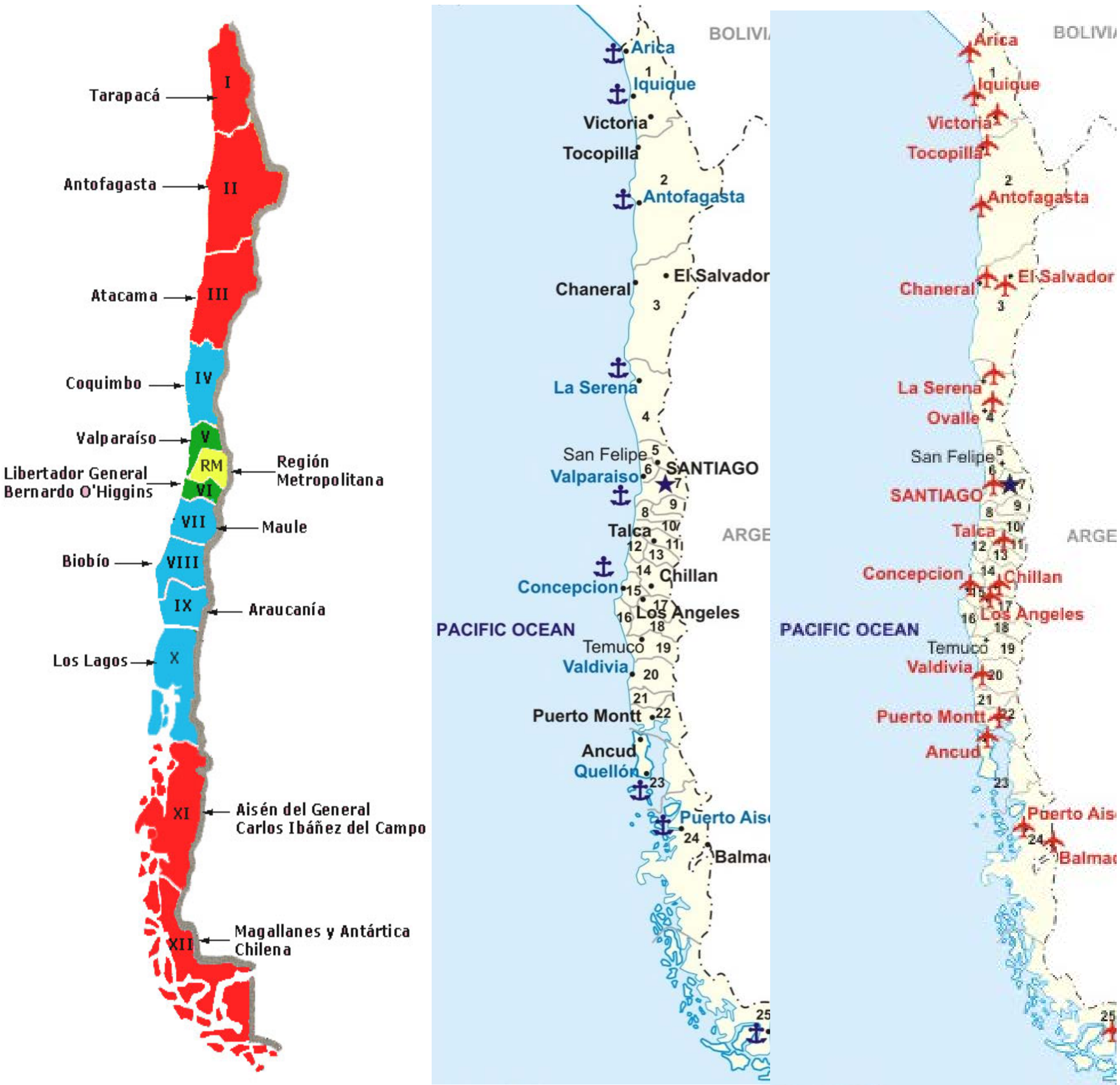


Panel (a): Contours of potential profit π from exporting
Note: only the contours of exporters are shown.



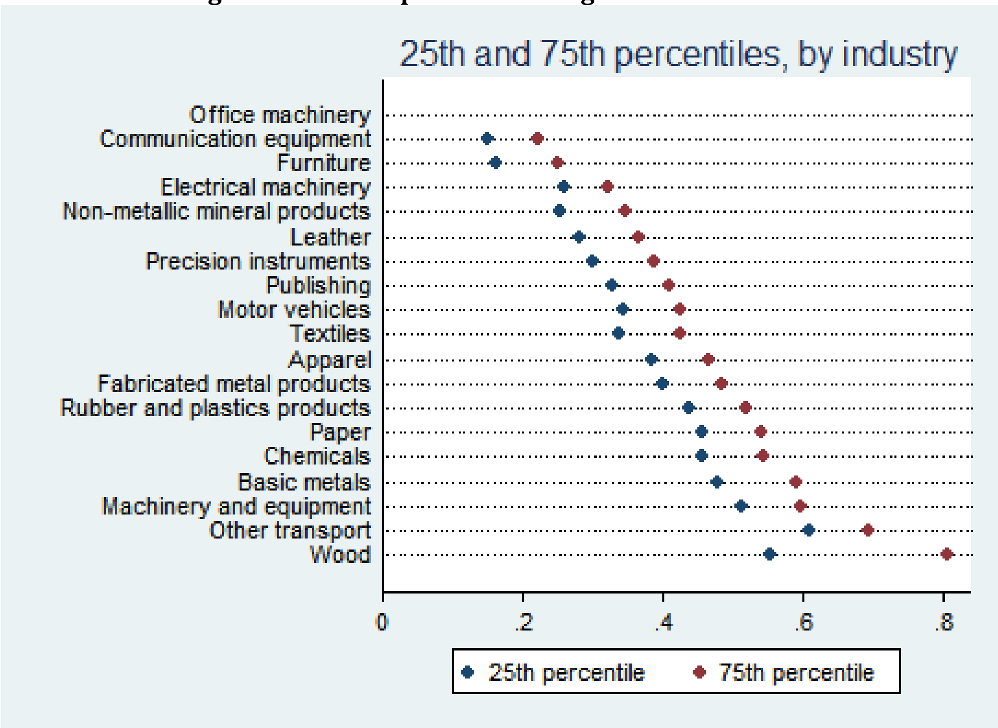
Panel (b): Changes in export propensity and potential profit π from exporting

Figure 3: The unique geography of Chile

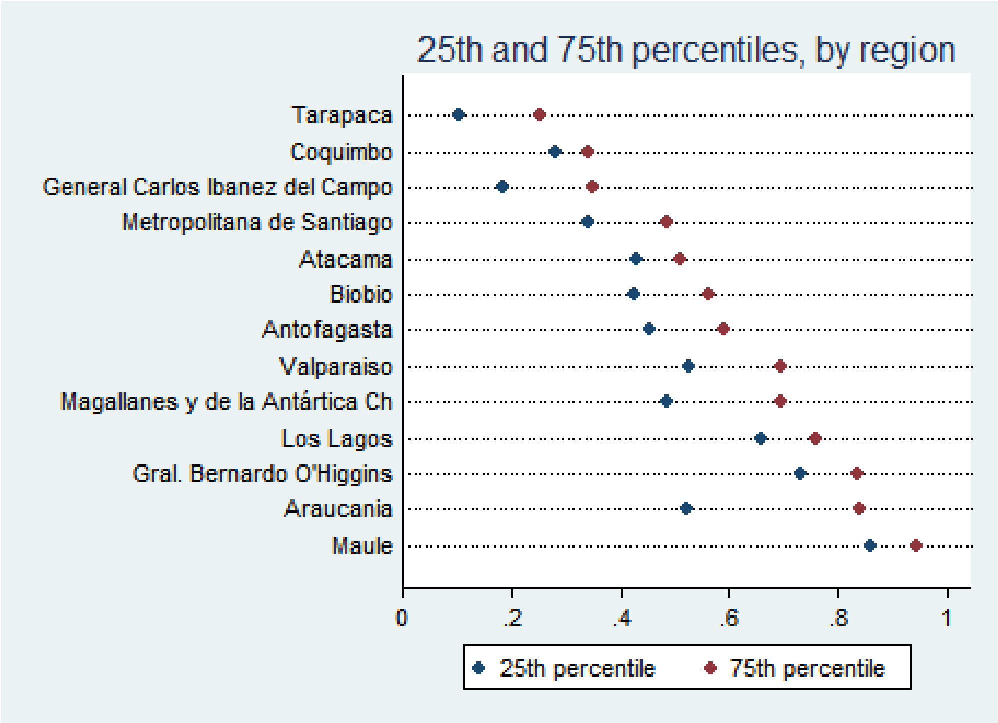


Left: administrative regions | Middle: seaports | Right: airports

Figure 4: Fixed export costs along three dimensions

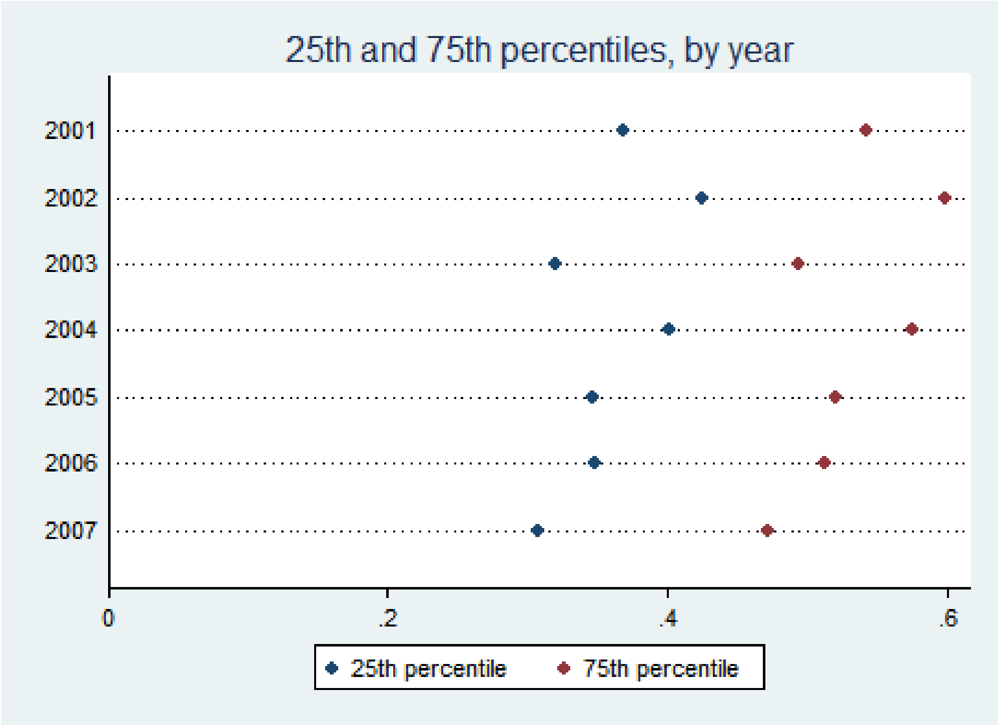


Panel (a): By industry



Panel (b): By region

Figure 4: Fixed export costs along three dimensions (cont'd)



Panel (c): By year