DISCUSSION PAPERS IN ECONOMICS

Working Paper No. 12-08

Fixed Export Costs and Firm-Level Export Behavior

Luis Castro, Ben Li, Keith E. Maskus, & Yiqing Xie
University of Colorado at Boulder

October 2012

Department of Economics

University of Colorado at Boulder
Boulder, Colorado 80309

Fixed Export Costs and Firm-Level Export Behavior*

Luis Castro† Ben Li‡ Keith E. Maskus§ Yiqing Xie¶

This draft: September 27, 2012
Comments welcome

Abstract

This paper provides a direct test on how fixed export costs and productivity jointly determine firm-level export behavior. We construct fixed export cost indices for each industry-region-year tuple of Chile and match them to Chilean firms in those tuples. Our empirical results show that the effect of fixed export costs on export propensity is negative and that of productivity is positive, which is the foundation of the widely-used sorting mechanism in the theoretical literature on firm-level export behavior. In particular, high-productivity nonexporters face higher 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, and that large fixed export costs and productivity dispersion of a tuple both raise the export volume of the average exporter in the tuple.

JEL codes: F10, F12, F14.

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

---

*The paper used to be circulated under the title "Heterogeneous Fixed Trade Cost and Firm-level Exporting Performance." We thank Mary Amiti, James Anderson, Daniel Bernhofen, David Hummels, Beata Javorcik, Wolfgang Keller, Edwin Lai, Peter Neary, James Tybout, Zhihong Yu, and the audiences at Boston College, University of Oxford, Nottingham University, Stockholm University, Ljubljana Empirical Trade Conference, Midwest International Economics Group, and Bolivian Conference on Development Economics for their valuable comments. We particularly thank Jagadeesh Sivadasan who provides us with the stata routine that implements the Ackerberg-Caves-Frazer (2006) method. All remaining errors are ours.

†Department of Economics, University of Colorado at Boulder.

‡Department of Economics, Boston College, email: benli36@gmail.com.

§Department of Economics, University of Colorado at Boulder, email: keith.maskus@colorado.edu.

¶Department of Economics, University of North Dakota.

1 Introduction

Over the past decade, a phenomenal innovation in the trade theory was the introduction of firm-level export decisions. The key idea can be summarized using a sorting mechanism based on productivity and fixed export costs: a fixed export cost has to be paid if a firm exports, such that only firms that expect sufficiently high profits from exporting choose to pay the fixed cost and export.[1] The sorting mechanism has two empirical implications: (1) given fixed export costs, firms with high productivity export, and (2) given productivity, firms with low fixed export costs export. A direct empirical test of (1) and (2) remains absent, despite extensive empirical evidence on the productivity premium of exporters relative to nonexporters.[2]

Productivity premium of exporters alone is insufficient as evidence of the sorting mechanism, unless fixed export costs are homogeneous across firms. Fixed export costs might be less heterogeneous than productivity, though there is little reason for those costs to be identical across firms. Fixed export costs usually vary by industrial and regional characteristics. Without fixed export costs accounted for, productivity premium of exporters can be rationalized by various possibilities. For example, firms with high productivity (i.e., low variable production costs) perform better designing, marketing, and distribution that give them the edge in foreign markets. In other words, high productivity may not be the key difference between exporters and nonexporters, but just one presentation of some systematical difference between them.

This paper provides a direct test of the above implications (1) and (2). We use firm-level export expenses reported by the Annual National Industrial Survey of Chile (Encuesta Nacional Industrial Anual, or ENIA), to construct indices of export costs for each industry-region-year tuple of Chile. Then, we empirically examine how firms' export decisions vary with productivity as well as the fixed export costs of their residing tuples. We reach three findings. The primary finding is that, with productivity held constant, high fixed export costs are associated with a low export propensity. Moving from the 25th to the 75th percentile of the fixed export cost indices, export propensity lowers by approximately 6 to 12 percent. In particular, we find that high-productivity nonexporters face high fixed export costs. This helps to resolve the puzzle that there are high-productivity nonexporters and low-productivity exporters, even though on average exporters are more productive than nonexporters.[3]

[1] See, e.g., Helpman, Melitz, and Yeaple (2004), Melitz (2003), and Yeaple (2005).

[2] For discussions on the econometric estimation of firm productivity, see Ackerberg, Caves, and Frazer (2006), Levinsohn and Petrin (2003), and Olley and Pakes (1996). For discussions on the productivity premium of exporters, see Bernard and Jensen (1999, 2004), De Loecker (2007), and Lileeva and Trefler (2009).

[3] See, e.g., Bernard, Eaton, Jensen, and Kortum (2003, US firms), Mayer and Ottaviano (2008, Belgian firms), Wakasugi (2009, Japanese firms). We find the same pattern in Chilean firms (see Figure 1).

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

Figure 1 illustrates the puzzle and our resolution using the two largest industries in the Chilean data, "fabricated metal" and "wood and cork." In either industry, the mean of exporters' productivity is larger than that of nonexporters, but there is also an overlap area between the two distributions. We define high (respectively, low) productivity as more (respectively, less) productive than the 75th percentile exporter, and then compare the fixed export costs between high-productivity nonexporters and low-productivity exporters. High-productivity nonexporters turn out to face higher fixed export costs than low-productivity exporters, as shown by the t-statistics in the upper corners of the two panels (three different indices used, all differences significant at least at the 5% level).

Two other findings follow from the first one. For one, given the export propensity, high productivity and low fixed export costs are substitutable; further, this substitution effect is decreasing in firm-level productivity. In other words, covering fixed export costs is less a concern for high-productivity firms than for low-productivity ones. For two, at the tuple level, the export volume of an average exporter is larger where either fixed export costs or productivity dispersion is larger. The intuition is as follows. Given the dispersion of firm productivity, fixed export costs raise the productivity threshold for exporting, while given fixed export costs, a larger dispersion of productivity means more firms that have productivity beyond the threshold. In either case, firms that end up exporting are more productive and thus export larger volumes. Moving from the 25th to the 75th percentile of the fixed export cost index, firm-level export volume increases on average by one third to one half in magnitude.

To our knowledge, this paper is the first direct test of the sorting mechanism in firm-level export behavior. This paper is featured by its reduced-form approach. The ENIA provides data on exporters' export expenses, in addition to export decisions and productivity that are available in common firm-level datasets. Within the exporters' export expenses, we can isolate the portion that does not vary with exporter's export volume and use it to construct fixed export cost indices for each industry-region-year tuple. These indices apply to nonexporters in the tuple and thus enables us to examine export decisions conditional on fixed export costs and productivity. This departs from the empirical literature in which fixed export costs are inferred from export decisions.[4] This literature, usually taking a structural approach, has strength in doing counterfactual predictions, though cannot tease out the relationship between export decisions and fixed export costs, because the variations in fixed export costs are estimated using the variations in export decisions.

This paper also speaks to the literature on trade costs, which has focused

[4]See Arkolakis (2010), Das, Roberts, and Tybout (2007), Eaton, Kortum, and Kramarz (2011), Hanson and Xiang (2011), Irarrazabal, Moxnes, and Opromolla (2010), and Roberts and Tybout (1997). Among them, Hanson and Xiang (2011) is an exception that uses reduced-form estimation on separable variations in the data, but their focus is different from ours; they focus on the importance of global relative to bilateral fixed export costs.

on variable trade costs.[5] This paper documents a positive association between average export volume of exporters and fixed export costs as well as productivity dispersion, indicating that fixed export costs change the composition of exporters. This said, a data-based measure of fixed export costs will be a key to understanding how micro-level exports aggregate into industry and country trade statistics.

The limitation of this paper is that it draws little light on the sunk costs paid by firms to start exporting. The fixed export cost indices in this paper are constructed using the export expenses paid by exporters, which would be *necessary* for nonexporters if they decided to export, but perhaps *insufficient*. Nonexporters may need to pay additional costs to start exporting, referred to as *sunk* export costs in the literature. The sunk costs of nonexporters, which are counterfactual, cannot be linked to the sunk costs of exporters; moreover, the sunk costs of exporters are not estimable without assumptions on how they spread over their transaction cycles. In comparison, the fixed export costs of nonexporters, despite being counterfactual, can be linked to the fixed export costs paid by exporters, and thus a zero-volume setup cost can be estimated for nonexporters. To this end, this paper addresses the counterfactuality of fixed export costs faced by nonexporters.[6]

The rest of the paper is organized as follows. Section 2 builds a theoretical framework and presents its predictions. Section 3 discusses data and the construction of fixed export cost indices. Section 4 reports our empirical findings. Section 5 concludes.

2 Conceptual framework

This section employs a simple theoretical model to generate testable predictions.[7] Consider two countries, Home and Foreign (rest of the world). They have the same preference over a collection of varieties made in Home:[8]

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

[5]See Anderson and van Wincoop (2003, 2004), Anderson and Yotov (2008), Bernard, Jensen, and Schott (2006), Bougheas, Demetriades, and Morgenroth (1999), Blonigen and Wilson (2008), Clark, Dollar, and Micco (2004), Donaldson (2010), Limão and Venables (2001), Wilson, Mann, and Otsuki (2003), among others. Helpman, Melitz, and Rubinstein (2008) introduce fixed export costs to the studies on aggregate trade statistics, but takes it as a confounding factor to control for.

[6]With such assumptions, the sunk costs of exporters become estimable; see, e.g., Das, Roberts, and Tybout (2007) and Roberts, and Tybout (1997).

[7]It is a variant of Melitz (2003) and Helpman, Melitz and Rubinstein (2008).

[8]This is only part of the utility function. The utility from consuming varieties made in Foreign is not relevant to our context, so we do not write it out.

where j is the variety index, J is the set of varieties, and $0 < \alpha < 1$ determines the elasticity of substitution between varieties $\sigma \equiv 1/(1-\alpha)$. The foreign demand for a particular variety j made in Home is

$$x(j) = \frac{p(j)^{-\sigma}\gamma}{P(J)^{1-\sigma}}, \tag{1}$$

where $p(j)$ is delivery price, P is the foreign price index associated with Home varieties J, and γ is the foreign expenditure spent on Home varieties.

In Home, each variety j is produced by a unique firm, labeled as firm j. The input demand per unit output of firm j is $a(j)$. Firms compete in a monopolistic competition fashion in the foreign market, leading to constant mark-up pricing:

$$p(j) = \frac{va(j)c}{\alpha}, \tag{2}$$

where v is an iceberg variable export cost and c is the input price. Since productivity is inversely related to unit factor demand, we define $A(j) \equiv a(j)^{1-\sigma}$, a decreasing function of a, to denote productivity. When confusion does not arise, we suppress the index j. Combining equations (1) with (2), we obtain firm j's exported value

$$V \equiv px = (\frac{vc}{\alpha P})^{1-\sigma}\gamma A, \tag{3}$$

and potential profit from exporting

$$\pi = \chi A - f, \tag{4}$$

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

Next, define X as export indicator, a binary variable that denotes whether a firm exports, and $\Pr(X = 1)$ as export propensity. Each firm draws a foreign business opportunity with parameter u. This opportunity realizes only if $\pi > u$, where u can be considered as the minimum caliber required by the foreign business opportunity; otherwise, the firm does not export. Export propensity depends on the probability for $\pi > u$ to hold:

$$\Pr[X = 1] = \Pr[\pi > u] = \Pr[u < \pi] = \Phi[\pi], \tag{5}$$

where u follows a standard normal distribution Φ. Equation (5) has two implications. First, the export propensity of a given firm is increasing in its potential profit from exporting, but the marginal increase is decreasing in the potential profit. 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. Formally, $\Phi'[\pi] > 0$ and $\Phi''[\pi] < 0$ given $\pi > 0$.

Second, equation (5) can translate to a probit model for empirical testing, where π is the latent variable determined by a linear function of profit determinants such as A and f, as well as a constant term 1. We will discuss the probit model in detail in Section 4. Reverting to the firm decision, for later usage, we define a threshold productivity A^* such that $\pi = \chi A^* - f = 0$; clearly, A^* is an increasing function of f. Also, given 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.[9] The timing of the model is as follows. On date 0, firms draw A from distribution $G(A)$ and f from distribution $\Gamma(f)$. On date 1, firms draw u from distribution $\Phi(u)$ and their export decisions settle down.

According to equation (5), a firm's export propensity depends on its A and f. Below, we derive three hypotheses for empirical testing.

Hypothesis I (export propensity) *With productivity A held constant, the export propensity of a firm is decreasing in the fixed export cost f.*

This prediction follows from $\frac{d\Pr(X=1)}{df} = \Phi'[\pi]\frac{\partial \pi}{\partial f} = -\Phi'[\pi] \leq 0$; the inequality is strict when $\pi > 0$. Hypothesis I has another version that focuses on high-productivity nonexporters. Since firms with $\pi \leq 0$ do not export, $E(\pi|X = 1) > E(\pi|X = 0)$;[10] therefore, by equation (4),

$$E(\chi A|X = 1) - E(f|X = 1) > E(\chi A|X = 0) - E(f|X = 0), \tag{6}$$

or

$$E(f|X = 0) - E(f|X = 1) > E(\chi A|X = 0) - E(\chi A|X = 1). \tag{7}$$

This is an inference on the f and A of firms based on their export decisions. High-productivity nonexporters refer to a positive right side of inequality (7), which are then expected to have a higher fixed export cost, namely, a positive left side of inequality (7). This inference is an alternative version of Hypothesis I that does not resort to export propensity:

Hypothesis I' (nonexporters) *High-productivity nonexporters have higher fixed export costs than low-productivity exporters.*

In contrast to the fixed export cost, productivity raises export propensity: $d\Pr(X = 1)/dA > 0$. The two marginal changes interact with each other: the fixed export cost reduces export propensity less if A is high than in the case when A is low; formally, $\frac{d^2 \Pr[X=1]}{df dA} = \Phi''[\pi]\frac{\partial \pi}{\partial A}\frac{\partial \pi}{\partial f} + \Phi'[\pi]\frac{\partial^2 \pi}{\partial f \partial A} = -\Phi''[\pi]\frac{\partial \pi}{\partial A} \geq 0$, and the the inequality is strict when $\pi > 0$. The inequality derives from the fact that $\Phi''(\cdot) < 0$ if $\pi > 0$, and $\partial^2\pi/\partial f\partial A = 0$. Thus,

Hypothesis II (interaction) *The negative effect of fixed export cost f on the export propensity becomes weaker given a higher productivity A.*

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

[10] 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 on date 1), $X = 0$ means $\pi < 0$, so $E(\pi|X = 1) > E(\pi|X = 0)$.

Put differently, a given decrease in fixed export cost raises export propensity to a larger magnitude if the productivity is lower. Figure 2 illustrates the intuition underlying Hypothesis II. Panel (a) of Figure 2 displays the contours of potential profits from exporting. Recall $\pi = \chi A - f$ such that the contours are straight lines. Segments $\Delta f_1 = \Delta f_2$ are two decreases in fixed export cost with 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 ($\Delta\pi_1 = \Delta\pi_2$) though Δf_2 links to higher potential profit levels ($\pi_2 > \pi_1$, $\pi'_2 > \pi'_1$). Panel (b) plots export propensity against potential profit, a concave function that stems from $\Phi''(\cdot) < 0$. $\Delta\pi_2$ is shown to generate a smaller increases in export propensity than $\Delta\pi_1$ ($\Delta\text{Prob}_2 < \Delta\text{Prob}_1$), because its larger profit level limits its marginal growth.

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

The third hypothesis is concerned with an average exporter. Assume that A follows Pareto distribution $G(A) = 1 - (A_{\min}/A)^g$, where $A_{\min}$ is the location parameter (minimum of A) and $g > 2$ is the shape parameter.[11] 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 $\sigma^2(A) = \frac{gA^2_{\min}}{(g-1)^2(g-2)}$. For later empirical purpose, we want a measure of dispersion that is free from the magnitude of A, such that 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 $G^*(A) = 1 - (A^*/A)^g$. Recall that firm-level export volume is $(vc/\alpha P)^{1-\sigma}\gamma A$; thus, the export volume of an average exporter is equal to the export volume of the exporter with the mean productivity, namely, $gA^*/(g-1)$. Therefore, a larger dispersion of productivity (a smaller g) generates a larger export volume of the average exporter. Also, recall that A^* is an increasing function of f, then a higher f also leads to a larger exported value of the average exporter. To summarize,

Hypothesis III (average export volume) *The average export volume of firms is increasing in the dispersion of firm productivity $\sigma(A)/\mu(A)$ as well as the fixed export cost f.*

[11] $g > 2$ is assumed to ensure a finite variance of A; see, e.g., Helpman, Melitz, and Yeaple (2004) for similar use.

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 is conducted by the National Statistics Institute of Chile on all manufacturing firms with ten or more workers. 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),[12] total sales, exported value, and employment.[13] Panel (a) of Table 1 reports annual statistics.[14] Our data cover 2,896 firms in an average year, 18% of which are exporters. Sales and exported values rise over the seven years. Panel (b) reports firm-level statistics. The variable *export expenses* contains all relevant expenses that firms incur in the exporting process. On average, export expenses are equal to approximately 9% of exported values of an average exporter. We will revisit export expenses in the next subsection. Panel (c) of Table 1 reports statistics at the industry-region-year (tuple) level, at which our fixed export cost indices are constructed.

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

The unique geography of Chile provides us with convenience in identifying local fixed export costs. As shown in Panel (a) of 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; therefore, locally made products tend to be locally exported rather than transported elsewhere and then exported. Since the ENIA does not report shipment details on firms' exports, we aggregate the ENIA data to the industry-region level and compare them to industry-region level customs statistics.[15] Take the year 2004 for example, we compute the share of region r in Chile's total exports in industry i with both the ENIA data and the customs data, and denote the two shares as $S(i,r)$ and $S'(i,r)$, respectively. The difference $S(i,r) - S'(i,r)$ has a distribution that centers around zero. Panel (b) of Figure 3 is the histogram of $S(i,r) - S'(i,r)$, along with a reference normal distribution, descriptive statistics on the difference, and a t-test that cannot reject $S(i,r) - S'(i,r) = 0$. Evidently, the two shares are very close to each other, indicating that the majority of locally made products are exported through local customs.

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

[13] Earlier versions of this dataset have been used by Levinsohn (1999), Pavcnik (2002), and Lopez (2008), among others.

[14] We drop multinational subsidiaries and licensees in regressions, since their export behaviors are heavily influenced by their overseas parent firms. The included industries (ISIC-Rev.3 codes) are 17, 18, 19, 20, 21, 22, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36.

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

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

There are three groups of control variables used in this study. (1) Firm-level control variables, including capital/labor ratio (KL) and value added ratio (VA),[16] are computed using variables reported by the ENIA. (2) Regional and industrial characteristics, obtained from the *Estadísticas Vitales* and *Carabineros*, will be detailed later when they are used.[17] (3) The productivity measure, total factor productivity (TFP) in logarithm, is estimated using the Ackerberg-Caves-Frazer (2006) method, which builds on the Olley-Pakes (1996) and Levinsohn-Petrin (2003) methods.[18] The TFP has been standardized using industry-year mean and standard deviation: $TFP_{jt}^{STAN} = [TFP_{jt} - \mu(TFP)_{it}]/\sigma(TFP)_{it}$, where j, i, and t are firm, industry, and year identifiers, respectively. The standardization is to ensure the comparability of TFP across industries. In the rest of the paper, the standardized TFP is used unless noted otherwise.

3.2 Measurement of fixed trade costs

In this section, we construct fixed export cost indices for each industry-region-year (irt) tuple of Chile. The construction of an index consists of two steps. The first step is to regress exporters' export expenses on their export volumes and extract the fixed effects associated with each industry, each region, and each year. Exporters in the ENIA report expenses resulting from exporting activities for each year, denoted by $ExportExpenses_{jt}$, with j as the firm identifier. This variable is a remarkable feature of the ENIA data, considering that export costs are rarely reported in firm-level datasets available to empirical economists.

This variable is not readily usable. Export expenses have a fixed component and nonfixed components that include tariffs and other payments in proportion to export volume (e.g., variable charges incurred in crating, packing, warehousing, consolidation, storage, loading and shipment). Tariff rate and export volume are denoted by $\tau \geq 0$ and $V > 0$, respectively. To distinguish fixed export costs from nonfixed costs, we specify a regression of $\ln ExportExpenses$ using the sample of exporters:[19]

[16]Value-added ratio is defined as value added divided by total sales.

[17]Publicly available at http://www.ine.cl/canales/chile_estadistico/.

[18]TFP using methods along this line are widely used in the trade literature. See, e.g., Amiti and Konings (2007), Goldberg, Khandelwal, Pavcnik, and Topalova (2010), Greenaway, Guariglia and Kneller (2007), Javorcik (2004), Javorcik and Spatareanu (2008, 2011), Kasahara and Rodrigue (2008), Park, Yang, Shi, and Jiang (2010), and Topalova and Khandelwal (2011). In particular, for the use of the Ackerberg-Caves-Frazer method, see Arnold, Javorcik, Lipscomb and Mattoo (2008), Javorcik and Li (2008), and Petrin and Sivadasan (2011).

[19]The foundation for regression (8) is as follows. Export expenses is equal to

$$ExportExpenses = e^{f+\zeta_1 \ln V + \zeta_2 \ln(1+\tau V)}.$$

This exponential form with linearly added covariates follows the literature, see, e.g., Anderson and van Wincoop's (2004) review article (p.710), Anderson and Yotov (2010) and Limão and

$$\ln ExportExpenses_{jt} = \delta_i + \delta_r + \delta_t + \zeta_1 \ln V_{jt} + \zeta_2 \ln(1+\tau_{it}V_{jt}) \qquad (8)$$
$$+\zeta_{3i}\ln V_{jt} + \zeta_{3r}\ln V_{jt} + \zeta_{3t}\ln V_{jt} + \zeta_4 FirstTime + \epsilon_{jt},$$

where j, i, r, and t are firm, industry, region, and year identifiers, respectively. δ_i, δ_r and δ_t are the fixed effects specific to industry i, region r, and year t, respectively. To isolate them from the industry-, region-, or year-specific factors that affect export expenses through export volume, we control for fixed effects in the coefficient of $\ln V_{jt}$ by including ζ_{3i}, ζ_{3r}, and ζ_{3t}. τ_{it} is at the industry-year level, proxied by weighted tariff-equivalent trade barrier for Chile's five largest trade partners (see Appendix A2 for details). First-time exporters, which are small in number, may pay different export expenses and thus we also include a first-time exporter dummy variable $FirstTime$.[20]

Export volume may refer to the value, quantity, or weight of exports. The V in regression (8) is exported value, whereas one may argue that either quantity or weight of exports is more relevant to export expenses than value. The ENIA does not report quantity or weight exported by firms, whereas we address the above concern by using two alternative specifications of regression (8). The first is to add the capital-labor ratio KL and the value-added ratio VA of firms into regression (8). If the "true" export volume is quantity, these two ratios help to control for the price variation in the logarithm of exported value and thus the remaining variation is the quantity of exports.[21] The second alternative is to add the weight/value ratio, denoted by WV_{it} for industry i and year t, into regression (8). If the "true" export volume is weight, this ratio helps to control for the unit weight variation in the logarithm of exported value, and thus the remaining variation is the weight of exports.[22] We extract the value/weight 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 such that we have more missing values when this specification is used. Notably, in regression (8), the term V serves only as a covariate of export expenses, using which we remove the variations associated with export volume. Given the

Venables (2001). It becomes, in logarithm,

$$\ln ExportExpenses = f + \zeta_1 \ln V + \zeta_2 \ln(1+\tau V).$$

[20] They are small in number (see Table A1 for details), and the majority of them are frequent switchers that keep changing from one export status to the other.

[21] Suppose that 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 $\ln q_{jt}$ are the price and quantity of firm j's output in year t. Assume $p_{jt} = p(KL_{jt}, VA_{jt})$, then controlling for KL and VA holds $\ln p_{jt}$ constant and the effective variation in $\ln V_{jt}$ is q_{jt}.

[22] Suppose that W_{jt} is the "true" export volume. W_{jt} can be approximated by the product of WV_{it} and firm-level V_{jt}, and $WV_{it} \equiv (\frac{W}{V})_{it}$ as a packaged industry-year level measure can be found in international trade data (e.g., Hummels (2007)). That is, $\ln W_{jt} = \ln[(\frac{W}{V})_{it} \times (V_{jt})] = \ln(\frac{W}{V})_{it} + \ln V_{jt}$, or $\ln V_{jt} = \ln W_{jt} - \ln(\frac{W}{V})_{it}$; then, after controlling for $\ln(\frac{W}{V})_{it}$, the effective variation in $\ln V_{jt}$ is $\ln W_{jt}$.

above ambiguity in what is "true" export volume, we refrain from labeling the coefficients of $\ln V$, namely the ζ's, as variable export costs.

Regression (8) indicates that given zero volume, exporters still pay the export expenses $\delta_i+\delta_r+\delta_t$, which are fixed but *non-sunk* export costs. In other words, $\widehat{\delta}_i + \widehat{\delta}_r + \widehat{\delta}_t$ is the counterfactual fixed export costs that nonexporters would necessarily pay if they had exported. In the second step, we assign each tuple (irt) an fixed export cost value $\widehat{\delta}_{irt} = \widehat{\delta}_i + \widehat{\delta}_r + \widehat{\delta}_t$ and transform $\widehat{\delta}_{irt}$ into an index that ranges between 0 and 9:

$$f_{irt} = \frac{\widehat{\delta}_{irt} - \min_{irt}\{\widehat{\delta}_{irt}\}}{\max_{irt}\{\widehat{\delta}_{irt}\} - \min_{irt}\{\widehat{\delta}_{irt}\}} \times 9. \tag{9}$$

The 0-9 scale is used for convenience, with 0 and 9 being the minimum and maximum value of the index. In the following analysis, a firm, regardless of its export status, can be linked to its tuple's f_{irt}. Since three different specifications are used to estimate $\{\delta_i, \delta_r, \delta_t\}$, there are three indices constructed, labeled as *benchmark*, *KL and VA adjusted*, and *WV adjusted*, respectively.

We depict in Figure 4 the 25th and 75th percentiles of f_{irt} for each industry, region and year. In panel (a), fixed export costs are shown to be high in the industries that manufacture products of wood, transportation equipments, machinery and basic metals, because firms in these industries usually need special facilities that can ship sizable cargo; in contrast, the manufacturing of communication and office equipments as well as furniture, which can be transported using regular facilities, are shown with low fixed export costs. Panel (b) of Figure 4 demonstrates a large dispersion of fixed trade costs among 13 administrative regions of Chile,[23] which mainly varies according to geographic characteristics. Tarapaca and Coquimbo have low fixed export costs, where large cities are usually also important seaports and national trade centers, such as Iquique, La Serena, and the Coquimbo city. In comparison, the majority of population in Maule lives in rural areas and Maule is a region with high fixed export costs. Panel (c) indicates that fixed export costs were trending down between 2001 and 2007, which was likely due to nationwide improvements in trade-related infrastructure; the downturn in fixed export costs was particularly significant in the year 2003, when Chile's recession hit its bottom.

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

Notably, f_{irt} is constructed using three single fixed effects $\{\widehat{\delta}_i, \widehat{\delta}_r, \widehat{\delta}_t\}$ rather than three-way fixed effects or two-way fixed effects. The reasons are twofold. First, the three-way unit *irt* and two-way units *ir*, *rt* and *it* have too few observations. A median three-way unit *irt* has only two exporters, while median two-way units *ir*, *rt*, and *it* have 10, 11, and 26 exporters, respectively. Considering the total number of exporters 3,702, there is not enough variation in three-

[23] 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.

or two-way fixed effects to identify parameters on fixed export costs. The second reason is that the peculiarities of three- and two-way units will bias the fixed export cost estimation. Take the three-way fixed effects for example. Suppose that region r' in year t' has industrial policies favorable to industry i', which will influence the fixed effect of the three-way unit $i'r't'$, as well as export decisions in the three-way unit; consequently, it would be difficult to tease out the the policy-driven fixed cost reduction and policy-driven export increase. The same argument applies to other two- and three-way peculiarities, such as shocks to weather, local labor market, and local shipment-service market.

3.3 Checks on the fixed export cost indices

Before using the fixed export cost indices estimated above in empirical analysis, we check (1) the functional form on which they are based, (2) their relationship with firm-level idiosyncratic export expenses, and (3) the source of their variations. In fact, several additional checks on these indices are undertaken, though they are more relevant to the testing of the theoretical predictions and thus placed in Section 4.

The first check is concerned about the linear functional form of regression (8). Regression (8) is based on the assumption that export expenses have two components, fixed and variable. The first check asks what if the construction of fixed export cost index does not account for export volume. We hypothesize that the resulting fixed export cost index will then be correlated with export volume; in other words, the fixed export cost index will be *variable*. We test this hypothesis by running regression (8) without the export volume term $\ln V$, then use its estimates to construct an experimental fixed export cost index f°_{irt}, and lastly regress f°_{irt} on tuple-level average export volume. This experimental index f°_{irt}, as shown in column (1) of Table 2, rises with export volume. In contrast, the three indices constructed earlier are shown in columns (2)-(4) to have no correlation with export volume.

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

The second check is to determine how heavily the three indices are influenced by idiosyncratic export expenses paid by firms, such as certification exam costs and marketing costs incurred abroad.[24,25] A skeptic may wonder whether

[24]Export expenses paid in foreign markets, if firm-specific, are not absorbed into $\{\widehat{\delta}_i, \widehat{\delta}_r, \widehat{\delta}_t\}$. Take $\widehat{\delta}_i$ of industry i for example. It does not capture the marketing cost paid by some exporters of industry i in one foreign market. The exception is that all exporters of industry i pay the marketing cost in that foreign market; in this case, the marketing cost is equivalent to an industry-specific export fixed cost that will be absorbed by $\widehat{\delta}_i$, because paying it is a uniform practice of all domestic exporters in industry i. The same reasoning holds for $\widehat{\delta}_r$ and $\widehat{\delta}_t$.

[25]See, e.g., Arkolakis (2010) and Mrázová and Neary (2012) for a discussion on marketing costs.

such idiosyncrasies are picked up by the three indices. Assuming time-invariant idiosyncratic export expenses of firms, we develop a check that can detect the correlation between idiosyncratic export expenses paid by firms and the three indices. The check has three steps. First, we first estimate firm fixed effects in export expenses,

$$\ln ExportExpenses_{jt} = \delta_j + \widetilde{\zeta}_1 \ln V_{jt} + \widetilde{\zeta}_2 \ln(1 + \tau_{it} V_{jt}) + \widetilde{\zeta}_3 FirstTime + \widetilde{\epsilon}_{jt},$$

where over-tildes distinguish the coefficients from those in regression (8). Second, we extract the estimates $\{\widehat{\delta}_j\}$, scale them between 0 and 9 as in equation (9), and average $\{\widehat{\delta}_j\}$ at the industry-region (ir) level: $\widetilde{f}_{ir} = \frac{1}{N_{ir}} \sum_{j \in ir} \widehat{\delta}_j$, where N_{ir} is the number of firms in the unit ir. Accordingly, we average the previous f_{irt} to the industry-region level: $f_{ir} = \frac{1}{T} \sum_{t=1}^{T} f_{irt}$ to make it comparable with $\widetilde{f}_{ir}$. Third, we examine the correlation between $\widetilde{f}_{ir}$ and f_{ir}; a positive correlation between them would indicate that the indices are driven by local firms' idiosyncratic expenses. The results are reported in Table 3. Positive correlation is not detected between $\widetilde{f}_{ir}$ and f_{ir}, either with or without controlling for averaged capital-labor ratio and value-added ratio of firms. Notably, higher fixed export costs are positive associated with capital-labor ratio, possibly because selling capital intensive products, being opposite of Chile's comparative advantage, is relatively incompatible with the local infrastructure (e.g., transport facilities).

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

The correlation between trade and infrastructure has been documented in the literature.[26] We now further look into this as **the third check**, a reality check that pinpoints (1) what factors can explain the variations in the fixed export cost indices and (2) whether the indices are consistent with findings from external data sources. Specifically, we link the three indices to the World Bank Enterprise Surveys (WBES). The WBES evaluates business environments in nearly all developing countries by tracking a representative sample of local firms. The WBES undertook surveys in Chile in 2006 and 2010. We choose the 2006 survey because this year is also covered by our ENIA sample. Next, we average the firm responses to the industry-region level that can be matched to the indices $\{f_{irt}\}_{t=2006}$. Here, we use only the benchmark and KL & VA adjusted indices, because the WV adjusted index does not cover the year 2006. We regress $\{f_{irt}\}_{t=2006}$ on the averaged responses to each relevant survey question. The questions are listed in the first column of Table 4, and the coefficients are summarized in the rest of the columns.[27] Notably, some of the questions are on

[26] See, e.g., Bougheas, Demetriades, and Morgenroth (1999), Blonigen and Wilson (2008), Clark, Dollar, and Micco (2004), Donaldson (2010), Limão and Venables (2001), and Wilson, Mann, Otsuki (2003).

[27] We average firm-level WBES data to the industry-region level and end up with 35 industry-region pairs (5 regions and 7 industries). The regressions are linear and weighted by the square root of the number of firms in each pair to address averaging-induced heteroskedasticity.

regional characteristics, though the perceptions of a given region characteristic (e.g., power outage as a concern) can vary across industries in the region; the same hold for questions that concentrate on industrial characteristics. Therefore, we run each regression with three specifications: with no fixed effects, with region fixed effects, and with industry fixed effects.

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

The results are reported in Table 4. Fixed export costs are found to be higher where there are more frequent power outages, fewer competitors, more informal-sector competitors, more licensing and permits requirements as well as customs and trade regulations. The coefficients are self-explanatory, though we would like to make three observations. First, not all respects of business environment are significant under every specification, because the WBES business environment indicators do not necessarily vary along both industry and region dimensions. For example, frequent power outage as an important indicator of weak infrastructure affects all industries and regions, such that it is significantly associated with fixed export costs under all three specifications; in comparison, business licensing and permits and customs and trade regulations are related to nationwide regulations, the variations of which are mainly across industries, which lose significance when industry fixed effects are included.

Second, fixed export costs are correlated with a mix of business environment indicators, including but not limited to infrastructure. As Table 4 reveals, institutions, regulations, and market structure also matter; thence, high fixed export costs should not be equated to weak infrastructure.[28] In fact, fixed export costs are shown to be higher in regions where transportation is viewed not as a severe problem, possibly because regions with high fixed export costs have more severe problems, such as rampant competition from the informal sector. Third, fixed export costs are lower where there are more competitors overall, but higher if there are more competitors in the informal sector. We speculate that competitors in the formal sectors may share some fixed export costs, because for example the construction of transport facilities can be economized by a large number of users. This is not the case of competitors in the informal sector, who may take advantage of the positive externality spilled over by formal-sector firms; this said, rampant competition from the informal sector raises local fixed export costs.

[28]The quality of infrastructure is not a good indicator of fixed export costs also because it affects both fixed and variable export costs. Put more generally, export costs can be categorized into four types that are mutually exclusive of each other: (i) fixed export costs driven by infrastructure, (ii) variable export costs driven by infrastructure, (iii) fixed export costs not driven by infrastructure, and (iv) variable export costs not driven by infrastructure. Measures of trade-related infrastructure pinpoint types (i) and (ii), while our fixed export cost indices capture types (i) and (iii). Our index construction deliberately expunges variations in export expenses driven by variable export costs, and thus pins down variations in infrastructure and institutions that impact fixed export costs.

4 Empirical Evidence

This section tests Hypotheses I to III. Hypothesis I is the focus. We start with a reduced-form regression and next examine four issues that may disturb the reduced-form identification. The examination results corroborate the reliability of the specification, which is then applied to the test of Hypothesis II. Last, we test Hypothesis III, a direct implication of Hypothesis I that helps to understand the role of fixed export costs in aggregated trade data.

4.1 Hypothesis I

Equation (5) in the theoretical model can be transformed into a binary dependent variable regression

$$\Pr[X_{jt} = 1] = \Phi[\beta_f f_{irt} + \beta_{TFP} TFP_{jt} + \lambda' \mathbf{Z}_{firt}], \tag{10}$$

where as before j, i, r, t are identifiers for firms, industries, regions, and years, respectively, 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. Columns (1) does not include control variables. Based on column (1), columns (2) controls for firm-level capital-labor ratio KL and value-added ratio VA. Column (3) further includes (i) tariff rates (industry-year level) to control for the impacts of global trade liberalization, and (ii) crime rates and infant death rates to control for regional infrastructure.[29] We have also included in all three columns industry and year fixed effects to control for Chile's industrial comparative advantage and possible macroeconomic shocks.[30] Hypothesis I receives supports from all the three columns, and including control variables hardly affect the regression coefficients. We further experiment with the fixed export cost index lagged by one year, as well as indices adjusted for KL & VA and VW; they lead to very similar results in columns (4)-(6).

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

Table 6 presents the marginal effects of fixed export costs on export decisions based on the coefficients estimated in columns (3), (5), and (6) of Table 5. Take column (3) for example. Moving from the 25th percentile to the 75th percentile, fixed export costs rise by 49.7 percent (1.590/3.198), and the export propensity of firms decreases by two percentage points, equivalent to a 12 percent change

[29] Crime rate is defined as the ratio of arrests to population; infant death rate is defined as the number of deaths per 1,000 births.

[30] Region fixed effects are not used because regional control variables vary little over time.

(0.02/0.17). When the KL and VA adjusted index used, the two magnitudes are 46.7 percent and 12 percent, respectively. When the WV adjustment applied, the two magnitudes are 41.6 percent and 6 percent, respectively. Evidently, other factors held constant, fixed export costs lead to a nontrivial change in export propensity.

Reverting to regression (10), we next examine four identification issues to which the regression might be exposed: whether the estimated correlation between export propensity and fixed export costs is driven by sample (issue 1), index construction (issue 2), regression techniques (issue 3), or confounding effects of variable export costs (issue 4).

1. By industry study We first check whether the findings from Table 5 hold for individual industries, as an alternative approach to using standardized TFP. In general, there are two approaches to address the incomparability of TFP across industries. One is, as done above, to standardize the TFP of each industry using its mean and standard deviation. By doing so, TFP is transformed to be comparable across industries,[31] because the standardized TFP of a firm reflects its standing relative to its peers within the industry. For example, firms with productivity above their industry means by one standard deviation are considered as equally productive regardless of their industries, and the mean differences across industries have been absorbed into industry fixed effects. The merit of this approach is the usage of the full sample.

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

The alternative approach is to run regressions using individual industries. This approach does not transform data but substantially reduces sample size. In table 7, we run regression (10) for four largest industries, which in total account for 35% of the total sample size. These individual industries lead to similar findings as above. The industry "publishing, printing and reproduction of recorded media" has the largest $\widehat{\beta}_f$ in magnitude. The printing industry, compared to other three, relies more heavily on design, reputation, and communication, which possibly explain why its export propensity is more sensitive to fixed export costs.

2. Applying estimated fixed export costs to nonexporters The fixed export cost indices for nonexporters are compiled using those of exporters. One may worry that exporters are more (or less) efficient than nonexporters in managing costs, such that fixed export costs paid by exporters do not represent the fixed export costs that non-exporters would pay if they had exported. To address this concern, we conduct an experiment that assumes that fixed export costs perfectly discriminate among firms based on their characteristics: productivity, employment, total sales, and total value added. Specifically, the first step is to use the sample of exporters to estimate a correlation between the indices

[31] We looked into the distribution of TFP both prior to and after standardization and did not find systematical difference. Details are available upon request.

and a standardized firm characteristic y_{jt}: $f_{irt} = \omega y_{jt}(X_{jt} = 1) + \widetilde{\varepsilon}_{irt}$, and the second step is to average $\widetilde{\varepsilon}_{irt}$, the residuals obtained from the first step to generate a new tuple-level index $\widehat{\widetilde{\varepsilon}_{irt}}$. If f_{irt} is just the fixed export costs of local high-performing firms, the results from using f_{irt} 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 fixed export cost index and each column uses a different firm characteristic y_{jt}. The coefficients are close to those in Table 5, in both magnitude and significance levels. Notably, the drawbacks of using $\widehat{\widetilde{\varepsilon}_{irt}}$ are its hypothetical nature and the difficulty in interpreting the magnitude of $\widehat{\widetilde{\varepsilon}_{irt}}$'s coefficient in the regression; therefore, $\widehat{\widetilde{\varepsilon}_{irt}}$ serves only in this robustness check.

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

3. Fixed export costs of high-productivity nonexporters The probit regression (10) treats export statuses (exporters and nonexporters) as export decisions made by a representative firm. We next test Hypothesis I' by examining whether high-productivity nonexporters face high fixed export costs, an alternative empirical approach that does not treat export status as an export decision. We search the productivity distribution of exporters for a criterion for "high productivity." Recall that a firm has a high export propensity if it has either a high productivity or a low fixed export cost; in other words, exporters may not have high productivity though exporters are on average more productive than nonexporters. As a compromise, we choose a level above the productivity of the average exporter–the productivity of the 75th percentile exporter in a given industry–as the criterion for "high productivity;" that is, a nonexporter is labeled as 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 fixed export costs with those of exporters. The preliminary results have been presented in Figure 1 as discussed in the introduction. Figure 1 shows the productivity distribution of exporters and nonexporters, respectively, in two industries with the largest number of observations ("fabricated metal products" and "wood and cork").[32] It conveys two messages. First, in both industries, there exist high-productivity nonexporters, which are by definition more productive than the 75th percentile exporters. Second, according to the t-test results, high-productivity exporters face higher fixed export costs than the exporters that are less productive than them (i.e., "low-productivity" exporters).

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

Now we undertake a more detailed look at the comparison of fixed export costs between high-productivity nonexporters and exporters. We divide exporters into ten productivity deciles; an exporter is more productive if it is in a

[32]Since only one industry is examined, the TFP is not standardized.

higher decile. Table 9 examines the industry "fabricated metal products." We compare the fixed export costs 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 face higher fixed export costs than all exporters except those in deciles 9 and 10. The same finding is reached when adjusted fixed export cost indices are used. Table 10 examines the industry "wood and cork," which shows still stronger results: high-productivity nonexporters face higher export fixed costs than nearly all exporters.

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

4. Fixed export costs vs. variable export costs The fourth identification issue is whether $\widehat{\beta}_f$ in regression (10) is contaminated by the negative effect of variable export costs on $\Pr[X_{jt} = 1]$. Conceivably, fixed export costs are higher where variable export costs are high, which is the reason why we control for infrastructure quality in regression (10). To further address this, we examine the correlation between fixed export costs and firm-level export volume using the regression

$$\ln(V_{jt} + 1) = \kappa_f f_{irt} + \kappa_{TFP} TFP_{jt} + \xi' \mathbf{Z}_{jirt} + \eta_{jt}, \tag{11}$$

where $V_{jt} \geq 0$ is the export volume of firm j in year t, and other notations are the same as in regression (10). If fixed trade costs capture the effect of variable export costs, we would see a negative and significant $\widehat{\kappa}_f$; namely, a negative association between firm-level export volume and fixed export costs.

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

A noteworthy issue on the estimation of regression (11) is its truncated dependent variable: export volume is truncated at zero and this causes inconsistent estimates of all parameters. Thence, we estimate regression (11) jointly with regression (10) using a Type II Tobit model, which assumes that, conditional on $(f, TFP, \mathbf{Z})$, $(u, \eta)'$ follows distribution $N((0,0)', \Sigma)$, where

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

This joint model integrates the estimation of two export behaviors: (i) whether to export and (ii) if to export, how large is the volume. (i) and (ii) correspond to regressions (10) and (11), respectively.

The results are reported in Panel (a) of Table 11.[33] As in Table 5, we have experimented with all three indices. $\widehat{\beta}_f$ and $\widehat{\beta}_{TFP}$ are both significant and

[33] It is difficult to find convincing tuple-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.

negative and positive, respectively, just as in Table 5, attesting again to the effects of fixed exports costs and TFP on export propensity. In contrast, in the export-volume regression (11), $\widehat{\kappa}_f$, the coefficient of fixed export costs, is not significantly different from zero, while $\widehat{\kappa}_{TFP} > 0$ is significant.[34] Thus, our fixed export cost indices are unlikely to have captured 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 f_{irt} is again statistically insignificant, while the coefficient of TFP retains similar significance and magnitude just as in Panel (a). This is in line with the prediction of the conceptual framework–recall that firm-level export volume, as shown in equation (3), does not have the fixed cost parameter f in it. In other words, fixed export costs do not affect the export volume of a firm that has already been an exporter.

4.2 Hypotheses II and III

Hypothesis II The previous section shows that the results from regression (10) are robust to a battery of identification concerns. We now apply a similar specification to the test of Hypothesis II, which claims that the association between fixed export costs and export propensity becomes weaker for firms with higher productivity. We introduce into regression (10) interaction terms between f_{irt} and dummy variables $TFPQ_{jtq}$'s that denote firm j's productivity in year t to be in quartile $q = 2, 3, 4$:[35]

$$\Pr[X_{jt} = 1] = \Phi[\iota_f f_{irt} + \iota_{TFP} TFP_{jt} + \sum_q \theta_q TFPQ_{jtq} \times f_{irt} + \lambda' \mathbf{Z}_{jirt}]. \quad (12)$$

Then, Hypothesis II is equivalent to $\widehat{\iota}_f < 0$, $\widehat{\iota}_{TFP} > 0$, $\widehat{\theta}_q > 0$, and that the magnitude of $\widehat{\theta}_q$ increases in q.

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

Results from regression (12) are reported in Table 12 using three fixed export cost indices, respectively. In line with Hypothesis II, $\widehat{\iota}_f < 0$, $\widehat{\iota}_{TFP} > 0$, and $\widehat{\theta}_q$ increases as q increases. Quartile 1, the quartile with the lowest TFP, is used as the reference group; take column (2) for example, $\widehat{\iota}_f = -0.147$ reflects the negative effect of fixed export costs on the export decision. The same effect, in quartiles 2, 3, and 4 can be calculated using $\widehat{\iota}_f + \widehat{\theta}_2$, $\widehat{\iota}_f + \widehat{\theta}_3$, and $\widehat{\iota}_f + \widehat{\theta}_4$,

[34] $\widehat{\rho}$ is positive and significant, indicating that regression (11) is not independent from regression (10) and thus sample selection needs to be corrected.

[35] As noted earlier, TFP has been standardized using industry means and standard deviations, such that it is comparable across industries. The alternative specification of the interaction term in regression (12) is to use within-industry ranking of firm j instead of $TFPQ_{jtq}$, which leads to the same findings.

respectively. Since $\widehat{\theta}_4 > \widehat{\theta}_3 > \widehat{\theta}_2 > 0$, the negative effect of fixed export costs on the export decision decreases as predicted when TFP rises; in other words, low fixed export costs substitute for high productivity, and the substitution effect is weaker for firms with higher TFP. These findings also hold in columns (3)–(5).[36]

The substitution effect in Hypothesis II should be symmetric in the sense that high productivity substitutes for low fixed export costs, and the substitution becomes weaker when fixed export costs are lower. This symmetric effect is tested in column (6) of Table 12, which reports a regression (12) with interactions between TFP and quartiles of fixed trade costs:

$$\Pr[X_{jt} = 1] = \Phi[\widetilde{\iota}_f f_{irt} + \widetilde{\iota}_{TFP} TFP_{jt} + \sum_q \varphi_q FQ_{jtq} \times TFP_{jt} + \widetilde{\lambda}' \mathbf{Z}_{jirt}], \quad (13)$$

where FQ_{jtq} is a dummy variable denoting firm j's fixed export costs in year t to be in quartile $q = 2, 3, 4$.[37] Quartile 1, the quartile with the lowest fixed export costs, 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 worry 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 column (7), we interact f_{irt} directly with TFP_{jt} . In column (8), we replace TFP_{jt} using the productivity percentile of a firm within its industry-year; that is, the most (least) productive firm in an industry-year will be at the 100th (0th) percentile. The interaction terms in both columns are positive, in line with Hypothesis II. We also use the residual-based fixed export cost indices calculated earlier to examine the interaction, which lead to the same findings (reported in Table A2).

The relationship between Table 12 and Tables 9–10 deserves elaboration. The findings from Tables 9–10 will be still stronger if the findings from Table 12 are taken into account. Table 12 shows that high-productivity firms, compared to low-productivity ones, are less sensitive to fixed export costs. However, according to Tables 9–10, high-productivity nonexporters are still blocked from exporting by fixed export costs, which lends further support to the negative effect of fixed export costs on export decisions.

Hypothesis III Hypothesis III claims that exporters export a larger volume if either (i) fixed export costs are higher or (ii) dispersion of productivity is larger. Intuitively, with fixed export costs held constant, a larger dispersion of productivity leads to more firms that are beyond the threshold; given the dispersion constant, higher fixed export cost raises the threshold. Below we submit this hypothesis to empirical testing. Fixed export costs of tuples have been estimated, and we now compile the coefficient of variation (CV), i.e., the

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

[37] We experimented with quartiles of fixed export costs at both the tuple level and the firm level, and reached the same findings.

standard deviation to the mean, of TFP for each tuple.[38] The dependent variable is the logarithm of total exports divided by number of exporters at the tuple level. Since it is an average, we weight the regression using the number of exporters at the tuple level.

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

The results are reported in Table 13. Column (1) includes the CV of productivity but not the fixed export cost index. Tuples with a larger dispersion of productivity are shown to have average exporters that export larger volumes. Columns (2) includes the benchmark fixed export cost index but not the CV of productivity; clearly, higher fixed export costs are associated with larger average export volumes. Column (3) includes both of the two variables and the findings from columns (1)–(2) remain, while their magnitudes both shrink slightly. This constitutes evidence of "survival of the fittest" in the exporting business. Recall that fixed export costs, if moving from the 25th percentile to the 75th percentile, will rise by 49.7 percent (1.590/3.198) and lower export propensity by 12 percent (columns (3) of Table 6). Now, this 49.7 percent change in fixed export costs translates into a nearly 50 percent increase in the export volume of an average exporter ($1.590 \times 0.297 \simeq 0.47$) if the dispersion of productivity (CV) is held constant. We repeat columns (2)–(3) using the adjusted fixed export cost indices in columns (4)–(7) and reach the same results; quantitatively, moving from the 25th percentile to the 75th percentile of fixed export costs, average export volume increases by one third to one half ($1.546 \times 0.319 \simeq 0.49$, $1.571 \times 0.202 \simeq 0.31$). The coefficients of control variables are consistent with expectation. Notably, crime rate has a slightly positive correlation with average export volume, possibly because organized crimes usually cluster around port areas where fixed export costs happen to be low.

The linkage between Table 13 and Table 11 is noteworthy. Higher fixed export costs affect export volume of average exporters by selecting firms with higher productivity to be exporters, but this mechanism does not affect firm-level export volume conditional on productivity. As theoretically illustrated in Section 2, f, once paid, does not affect export behavior any more; this has been empirically shown 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 tuples with higher fixed export costs are shown to export larger volumes when productivity is not held constant.

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

5 Conclusions

Firm-level export decisions 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). This has been 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 fixed export costs 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 fixed export costs than the latter. Second, the two parameters interact with each other: the effect of lowering fixed export costs 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 larger and the fixed export costs are higher. These findings as a whole indicate that the productivity premium of exporters stems from a sorting mechanism based on productivity and fixed export costs.

There are both theoretical and empirical avenues for future research. First, it will be interesting to incorporate heterogeneous fixed export costs into a general equilibrium framework. Recent trade models have vastly taken productivity heterogeneity into account, but not different fixed export costs across firms. We speculate that the gains from trade through market share redistribution also vary by fixed export costs. Second, fixed export cost is widely used in theoretical modeling due to its easiness in use and strength in directing results, though largely underexamined in empirical studies due to the difficult in measurement. Thus, using fixed export costs to rationalize trade behaviors runs the risk of arbitrariness, since assuming a sufficiently high fixed cost can block nearly any action. The fixed export cost indices developed in this paper can be applied to other datasets in which micro-level export expenses are available. We think empirical efforts in this direction will help to deepen our understanding of fixed export cost and its usage in theoretical modeling.

Last but not least, this paper alludes to new thinking on export-promotion policies. The conventional wisdom is that productivity improvement is the linchpin of promoting exports. Since raising local productivity involves more structural reforms, lowering local fixed export costs as an alternative way is usually easier, and this paper shows the nontrivial effects of fixed export costs on export propensity and volume. To this end, the linchpin of export-promotion polices is actually to dtermine the priority of goals, to raise revenue or cultivate long-term growth.

References

[1] Ackerberg, Daniel A.; Caves, Kevin and Frazer, Garth. 2006. "Structural Identification of Production Functions." Working paper.

[2] Amiti, Mary and Konings, Jozef. 2007. "Trade Liberalization, Intermediate Inputs, and Productivity: Evidence from Indonesia." *American Economic Review* 97(5): 1611-1638.

[3] Anderson, James E. and van Wincoop, Eric. 2003. "Gravity with Gravitas: A Solution to the Border Puzzle." *American Economic Review* 93(1): 170-192.

[4] Anderson, James E. and van Wincoop, Eric. 2004. "Trade Costs." *Journal of Economic Literature* 42(3): 691-751.

[5] Arkolakis, Costas. 2010. "Market Penetration Costs and the New Consumers Margin in International Trade." *Journal of Political Economy* 118(6): 1151-11.

[6] Arnold, Jens Matthias; Javorcik, Beata; Lipscomb, Molly and Mattoo, Aaditya. 2008. "Services Reform and Manufacturing Performance: Evidence from India."

[7] Bernard, Andrew B. & Bradford Jensen, J., 1999. "Exceptional exporter performance: cause, effect, or both?" *Journal of International Economics* 47(1): 1-25.

[8] Bernard, Andrew B. and Jensen, J. Bradford. 2004. "Why Some Firms Export." *Review of Economics and Statistics* 86(2): 561-569.

[9] Bernard, Andrew B.; Eaton, Jonathan; Jensen, J. Bradford and Kortum, Samuel. 2003. "Plants and Productivity in International Trade." *American Economic Review* 93(4): 1268-1290.

[10] Bernard, Andrew B.; Jensen, Bradford J. and Schott, Peter K. 2006. "Trade costs, firms and productivity." *Journal of Monetary Economics* 53(5): 917-937.

[11] Blonigen, Bruce A. and Wilson, Wesley W. 2008. "Port Efficiency and Trade Flows." *Review of International Economics* 16(1): 21-36.

[12] Bougheas, Spiros; Demetriades, Panicos O. and Morgenroth, Edgar L. W. 1999. "Infrastructure, transport costs and trade." *Journal of International Economics* 47(1): 169-189.

[13] Cameron, A. Colin and Trivedi, Pravin K. 2005. *Microeconometrics: Methods and Applications.* Cambridge University Press, New York.

[14] Chaney, Thomas. 2008. "Distorted Gravity: The Intensive and Extensive Margins of International Trade." *American Economic Review* 98(4): 1707-21.

[15] Clark, Ximena; Dollar, David and Micco, Alejandro. 2004. "Port efficiency, maritime transport costs, and bilateral trade." *Journal of Development Economics* 75(2): 417-450.

[16] Das, Sanghamitra; Roberts, Mark J. and Tybout, James R. 2007. "Market Entry Costs, Producer Heterogeneity, and Export Dynamics." *Econometrica* 75(3): 837-873.

[17] De Loecker, Jan. 2007. "Do exports generate higher productivity? Evidence from Slovenia." *Journal of International Economics* 73(1): 69-98.

[18] Donaldson, Dave. 2010. "Railroads of the Raj: Estimating the Impact of Transportation Infrastructure." Working paper.

[19] Eaton, Jonathan; Kortum, Samuel and Francis Kramarz. 2011. "An Anatomy of International Trade: Evidence From French Firms." *Econometrica* 79(5): 1453-1498.

[20] Goldberg, Pinelopi K.; Khandelwal, Amit K; Pavcnik, Nina and Topalova, Petia. 2010. "Multiproduct Firms and Product Turnover in the Developing World: Evidence from India." *Review of Economics and Statistics* 92(4): 1042-1049.

[21] Greenaway, David; Guariglia, Alessandra and Kneller, Richard. 2007. "Financial factors and exporting decisions." *Journal of International Economics* 73(2): 377-395.

[22] Hanson, Gordon and Xiang, Chong. 2011. "Trade barriers and trade flows with product heterogeneity: An application to US motion picture exports." *Journal of International Economics* 83(1): 14-26.

[23] Helpman, Elhanan; Melitz, Marc and Rubinstein, Yona. 2008. "Estimating Trade Flows: Trading Partners and Trading Volumes." *Quarterly Journal of Economics* 123(2): 441-487.

[24] Helpman, Elhanan; Melitz, Marc J. and Yeaple, Stephen R. 2004. "Export Versus FDI with Heterogeneous Firms." *American Economic Review* 94(1): 300-316.

[25] Hummels, David. 2007. "Transportation Costs and International Trade in the Second Era of Globalization." *Journal of Economic Perspectives* 21(3): 131-154.

[26] Irarrazabal, Alfonso A.; Moxnes, Andreas and Opromolla, Luca David. 2011. "The Tip of the Iceberg: A Quantitative Framework for Estimating Trade Costs." Working Papers w201125, Banco de Portugal, Economics and Research Department.

[27] Javorcik, Beata Smarzynska. 2004. "Does Foreign Direct Investment Increase the Productivity of Domestic Firms? In Search of Spillovers Through Backward Linkages." *American Economic Review* 94(3): 605-627.

[28] Javorcik, Beata Smarzynska and Li, Yue. "Do the Biggest Aisles Serve a Brighter Future? Global Retail Chains and Their Implications for Romania."

[29] Javorcik, Beata Smarzynska and Spatareanu, Mariana. 2008. "To share or not to share: Does local participation matter for spillovers from foreign direct investment? *Journal of Development Economics* 85(1-2): 194-217.

[30] Javorcik, Beata Smarzynska and Spatareanu, Mariana. 2011. "Does it matter where you come from? Vertical spillovers from foreign direct investment and the origin of investors." *Journal of Development Economics* 96: 126–138.

[31] Kasahara, Hiroyuki and Rodrigue, Joel. 2008. "Does the use of imported intermediates increase productivity? Plant-level evidence." *Journal of Development Economics* 87(1): 106-118.

[32] Levinsohn, James. 1999. "Employment responses to international liberalization in Chile." *Journal of International Economics* 47(2): 321-344.

[33] Levinsohn, James and Petrin, Amil. 2003. "Estimating Production Functions Using Inputs to Control for Unobservables." *Review of Economic Studies* 70(2): 317-341.

[34] Lileeva, Alla and Trefler, Daniel. 2010. "Improved Access to Foreign Markets Raises Plant-Level Productivity... for Some Plants." *Quarterly Journal of Economics* 125(3): 1051-1099.

[35] Limão, Nuno and Venables, Anthony J. 2001. "Infrastructure, geographical disadvantage, transport costs, and trade." *World Bank Economic Review* 15(3): 451-479.

[36] Lopez, Ricardo A. 2008. "Foreign Technology Licensing, Productivity, and Spillovers." *World Development* 36(4): 560-574.

[37] Mayer, Thierry and Ottaviano, Gianmarco. 2008. "The Happy Few: The Internationalisation of European Firms." *Intereconomics: Review of European Economic Policy* 43(3): 135-148.

[38] Melitz, Marc J. 2003. "The Impact of Trade on Intra-Industry Reallocations and Aggregate Industry Productivity." *Econometrica* 71(6): 1695-1725.

[39] Mrázová, Monika and Neary, J. Peter. 2012. "Selection effects with heterogeneous firms."

[40] Olley, G. Steven and Pakes, Ariel. 1996. "The Dynamics of Productivity in the Telecommunications Equipment Industry." *Econometrica* 64(6): 1263-97.

[41] Organisation for Economic Co-operation and Development (OECD). 2009a. *OECD Territorial Reviews.*

[42] Organisation for Economic Co-operation and Development (OECD). 2009b. *The Role of Communication Infrastructure Investment in Economic Recovery.* http://www.oecd.org/dataoecd/4/43/42799709.pdf

[43] Park, Albert; Yang, Dean; Shi, Xinzheng and Jiang, Yuan. 2010. "Exporting and Firm Performance: Chinese Exporters and the Asian Financial Crisis." *Review of Economics and Statistics* 92(4): 822-842.

[44] Pavcnik, Nina. 2002. "Trade Liberalization, Exit, and Productivity Improvement: Evidence from Chilean Plants." *Review of Economic Studies* 69(1): 245-76.

[45] Petrin, Amil and Sivadasan, Jagadeesh. 2011. "Estimating Lost Output from Allocative Ineciency, with an Application to Chile and Firing Costs."

[46] Roberts, Mark J. and Tybout, James R. 1997. "The Decision to Export in Colombia: An Empirical Model of Entry with Sunk Costs." *American Economic Review* vol. 87(4): 545-64.

[47] Petia Topalova; Khandelwal, Amit. 2011. "Trade Liberalization and Firm Productivity: The Case of India." *Review of Economics and Statistics* 93(3): 995-1009.

[48] Wakasugi, Ryuhei. 2008. "The Internationalization of Japanese Firms: New Findings Based on Firm-Level Data." The Research Institute of Economy, Trade and Industry, RIETI Research Digest No. 01.

[49] Wilson, John S.; Mann, Catherine L and Otsuki, Tsunehiro. 2003. "Trade Facilitation and Economic Development: A New Approach to Quantifying the Impact." *World Bank Economic Review* 17(3): 367-389.

[50] Yeaple, Stephen. 2005. "A Simple Model of Firm Heterogeneity, International Trade, and Wages." *Journal of International Economics* 65(1): 1-20.

Appendices:

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 crossing. They provide statistics of exports from Chile to the rest of the world, using the 2002 Harmonized System (HS) Classification at the 8 digit level. Statistics are reported in current US Dollars (FOB values). To combine it 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, 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,

$$\overline{TARIFF}_{it} = \sum_{b} \varsigma_{bit} \times TARIFF_{bit}$$

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	Total exported value	Export intensity, columns (4)/(3)	Share of exporters, columns (2)/(1)
2001	2739	498	9.62	3.49	0.05	0.18
2002	2987	513	10.40	3.15	0.05	0.17
2003	2987	546	11.36	2.90	0.05	0.18
2004	3070	524	14.49	4.79	0.05	0.17
2005	2985	512	16.83	4.46	0.05	0.17
2006	2846	500	18.87	5.89	0.05	0.18
2007	2660	481	21.49	7.51	0.06	0.18
Average	2896	511	14.72	4.60	0.05	0.18

Panel (b): by firm

Variable	Obs	Mean	Std. Dev.
Sales	20274	5.08	59.67
Capital	20274	2.17	22.37
Electronic bills	20274	0.003	0.034
Value added	20274	3.45	51.81
Skilled labor (persons)	20274	38.21	117.00
Unskilled labor (persons)	20274	26.63	62.35
Exported values	3702	8.70	54.14
Export expenses	3702	0.11	1.25
Export expenses/exported value	3702	0.09	0.50

Panel (c): by tuple (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 sales	594	17.90	107.44
Average exported values	594	4.53	18.41
Export intensity	587	0.09	0.14

Panel (d): statistics on fixed trade costs, by tuple

Fixed export cost index (0 to 9)	Obs	Mean	Sd.
Benchmark	593	4.58	1.89
Adjusted for KL & VA	593	4.68	1.89
Adjusted for WV	347	5.18	2.19

Note: the unit of currency values are billion pesos (in 2003 prices).

Table 2: Functional form

Dependent variable: fixed export cost indices				
	(1)	(2)	(3)	(4)
		Constructed with export volume		
The fixed export cost index used:	Constructed without 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	1.036**	1.048**	3.131***
	(0.818)	(0.463)	(0.452)	(1.067)
Averaged value-added ratio (VA)	-0.594	0.145	0.179	1.681
	(0.752)	(1.090)	(1.057)	(1.567)
Control variables	Yes	Yes	Yes	Yes
Observations	593	593	593	347
R-squared	0.082	0.697	0.707	0.124

Regressions are undertaken at the industry-region-year (tuple) level. Control variables are tariff rate, infant death rate, and crime rate. Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Table 3: Correlation between firm-year fixed effects 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-year fixed effects (scaled between 0 and 9)	-0.024	0.009	-0.030	0.005	-0.129	-0.069
	(0.126)	(0.124)	(0.128)	(0.125)	(0.132)	(0.136)
Capital-Labor ratio (KL)		2.898*		3.060*		4.166***
		(1.727)		(1.715)		(1.385)
Value-added ratio (VA)		-1.439		-1.632		0.512
		(2.388)		(2.403)		(2.652)
Constant	4.781***	5.169***	4.905***	5.373***	5.914***	5.210***
	(0.670)	(1.338)	(0.679)	(1.365)	(0.703)	(1.553)
Observations	105	105	105	105	99	99
R-squared	0.000	0.039	0.001	0.044	0.010	0.051

Regressions are undertaken at the industry-region level. "Firm-year fixed effects" is firm fixed effects that are averaged at the industry-region level. Accordingly, the three fixed export cost indices are also averaged at the industry-region level. See Section 3 of the text for details. *** p<0.01, ** p<0.05, * p<0.1.

Table 4: Reality 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)	+*	-**	+***	+	-**	+***

This table uses the responses in the World Bank Enterprise Surveys (WBES) to explain the fixed export cost indices constructed in this paper. The relevant WBES wave was done in Chile in 2006. We chose the indices for the year 2006, and match 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 for details. Robust standard errors 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 (f)	-0.064***	-0.057***	-0.065***	-0.061***	-0.067***	-0.038**
	(0.016)	(0.015)	(0.017)	(0.020)	(0.018)	(0.018)
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***	-0.003*	-0.003	-0.003*	-0.002
		(0.075)	(0.002)	(0.002)	(0.002)	(0.003)
Tariff rate			-0.832***	-0.860***	-0.833***	-0.681***
			(0.076)	(0.088)	(0.076)	(0.098)
Crime rate			-0.009	-0.010	-0.009	-0.007
			(0.008)	(0.010)	(0.008)	(0.012)
Mortality rate			0.005	0.007	0.009	0.052
			(0.022)	(0.025)	(0.022)	(0.034)
Constant	-1.833***	-1.025***	-0.993***	-0.846**	-1.007***	-2.067***
	(0.319)	(0.191)	(0.305)	(0.343)	(0.307)	(0.638)
Observations	20,271	20,271	20,271	15,184	20,271	11,783

Industry and year fixed effects are included. Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Table 6: Marginal effects of fixed export costs

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	0.17	-0.014	3.198	0.17	-0.015	3.307	0.16	-0.007	3.648
Median	0.16	-0.014	3.998	0.16	-0.014	4.100	0.16	-0.007	4.479
75th percentile	0.15	-0.013	4.788	0.15	-0.014	4.853	0.15	-0.007	5.218
From 25th to 75th percentile:	0.02	-0.001	-1.590	0.02	-0.001	-1.546	0.01	0.000	-1.571

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)

	(1)	(2)	(3)	(4)
Panel (a): benchmark fixed export cost index	Fab. Metal	Wood&Cork	Chemicals	Prints
Fixed export costs	-0.127**	-0.103***	-0.098***	-0.223**
	(0.055)	(0.024)	(0.038)	(0.092)
TFP	0.246***	0.455***	0.127***	0.244***
	(0.052)	(0.102)	(0.029)	(0.056)
Constant	-0.662***	0.513***	0.319*	0.244
	(0.243)	(0.163)	(0.176)	(0.286)
Observations	2,263	2,164	1,505	1,164

	(5)	(6)	(7)	(8)
Panel (b): fixed export cost index adjusted for KL & VA	Fab. Metal	Wood&Cork	Chemicals	Prints
Fixed export costs	-0.134**	-0.099***	-0.103***	-0.227**
	(0.055)	(0.025)	(0.038)	(0.093)
TFP	0.246***	0.461***	0.126***	0.247***
	(0.052)	(0.104)	(0.029)	(0.057)
Constant	-0.628**	0.504***	0.353**	0.278
	(0.244)	(0.166)	(0.180)	(0.295)
Observations	2,263	2,164	1,505	1,164

	(9)	(10)	(11)	(12)
Panel (c): fixed export cost index adjusted for WV	Fab. Metal	Wood&Cork	Chemicals	Prints
Fixed export costs	-0.102**	-0.107***	-0.061*	-0.171***
	(0.050)	(0.035)	(0.037)	(0.063)
TFP	0.213***	0.679***	0.133***	0.210***
	(0.060)	(0.183)	(0.042)	(0.059)
Constant	-0.490*	0.364	0.219	0.228
	(0.295)	(0.246)	(0.236)	(0.276)
Observations	1,280	1,288	832	642

The same specification as Table 5 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 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 characteristic	TFP	Employment	Total sales	Total Value added
$\widehat{\tilde{\varepsilon}_{irt}}$	-0.060***	-0.066***	-0.072***	-0.067***
	(0.017)	(0.017)	(0.017)	(0.017)
	0.262***	0.264***	0.263***	0.264***
TFP	(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 characteristic	TFP	Employment	Total sales	Total Value added
$\widehat{\tilde{\varepsilon}_{irt}}$	-0.062***	-0.068***	-0.074***	-0.069***
	(0.017)	(0.018)	(0.017)	(0.017)
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 characteristic	TFP	Employment	Total sales	Total Value added
$\widehat{\tilde{\varepsilon}_{irt}}$	-0.031*	-0.039**	-0.040**	-0.038**
	(0.017)	(0.018)	(0.018)	(0.018)
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

Control variables are capital-labor ratio, value-added ratio, tariff rate, infant death 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 characteristic. See Section 4 of the text for details. Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

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	0.182**	0.303**	0.343***	-0.089	-0.067
	(0.081)	(0.118)	(0.102)	(0.115)	(0.124)
Constant	3.893***	3.772***	3.732***	4.163***	4.142***
	(0.055)	(0.102)	(0.082)	(0.097)	(0.108)
Observations	497	286	326	313	276
R-squared	0.01	0.02	0.03	0.00	0.00
Panel (b): dependent variable: fixed export cost index adjusted for KL and VA					
High-productivity nonexporter dummy	0.188**	0.305**	0.355***	-0.086	-0.068
	(0.081)	(0.119)	(0.101)	(0.113)	(0.122)
Constant	3.953***	3.836***	3.786***	4.227***	4.209***
	(0.055)	(0.103)	(0.081)	(0.096)	(0.106)
Observations	497	286	326	313	276
R-squared	0.01	0.02	0.04	0.00	0.00
Panel (c): dependent variable: fixed export cost index adjusted for WV					
High-productivity nonexporter dummy	0.157	0.377**	0.413***	-0.34	-0.296
	(0.135)	(0.179)	(0.158)	(0.206)	(0.263)
Constant	4.486***	4.266***	4.231***	4.983***	4.939***
	(0.090)	(0.148)	(0.121)	(0.180)	(0.243)
Observations	278	153	180	165	141
R-squared	0.00	0.03	0.04	0.02	0.01

Notes: "High-productivity" nonexporters are defined as nonexporters that are more productive than the 75th percentile exporters.
Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

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	0.897***	1.089***	0.940***	0.758***	0.654***
	(0.190)	(0.214)	(0.204)	(0.203)	(0.214)
Constant	5.832***	5.641***	5.790***	5.972***	6.076***
	(0.055)	(0.111)	(0.091)	(0.088)	(0.112)
Observations	627	186	285	294	211
R-squared	0.04	0.14	0.08	0.05	0.05
Panel (b): dependent variable: fixed export cost index adjusted for KL and VA					
High-productivity nonexporter dummy	0.862***	1.049***	0.907***	0.723***	0.617***
	(0.185)	(0.209)	(0.199)	(0.197)	(0.208)
Constant	5.974***	5.787***	5.930***	6.113***	6.219***
	(0.054)	(0.110)	(0.089)	(0.085)	(0.108)
Observations	627	186	285	294	211
R-squared	0.04	0.13	0.08	0.05	0.04
Panel (c): dependent variable: fixed export cost index adjusted for WV					
High-productivity nonexporter dummy	0.634**	0.748**	0.671**	0.546*	0.401
	(0.266)	(0.313)	(0.287)	(0.282)	(0.297)
Constant	6.160***	6.045***	6.123***	6.248***	6.393***
	(0.080)	(0.181)	(0.132)	(0.121)	(0.152)
Observations	356	98	157	169	123
R-squared	0.02	0.06	0.03	0.02	0.02

Notes: "High-productivity" nonexporters are defined as nonexporters that are more productive than the 75th percentile exporters. Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

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	0.053	-0.049***	0.042	-0.053***	0.033	-0.052***	0.045	-0.055***	-0.028	-0.028*
	(0.066)	(0.015)	(0.061)	(0.018)	(0.068)	(0.020)	(0.062)	(0.018)	(0.062)	(0.017)
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)
Athrho & lnsigma	0.298***	0.888***	0.192***	0.793***	0.224***	0.784***	0.193***	0.793***	0.230***	0.817***
	(0.056)	(0.020)	(0.043)	(0.016)	(0.046)	(0.019)	(0.043)	(0.016)	(0.069)	(0.020)
Firm-level 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				0.059		0.052		0.063		-0.017
				(0.045)		(0.051)		(0.046)		(0.048)
TFP				0.765***		0.708***		0.765***		0.814***
				(0.047)		(0.051)		(0.047)		(0.060)
Firm-level 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

Control variables are capital-labor ratio, value-added ratio, tariff rate, infant death rate, and crime rate. Industry and year fixed effects are included. Robust

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 (f)	-0.149***	-0.147***	-0.132***	-0.146***	-0.128***	-0.087***	-0.087***	-0.208***
	(0.021)	(0.022)	(0.025)	(0.022)	(0.025)	(0.021)	(0.021)	(0.027)
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	0.056***	0.058***	0.052***	0.056***	0.065***			
productivity quartile 2	(0.011)	(0.010)	(0.011)	(0.010)	(0.014)			
Fixed export costs x	0.114***	0.108***	0.092***	0.105***	0.123***			
productivity quartile 3	(0.014)	(0.013)	(0.014)	(0.013)	(0.018)			
Fixed export costs x	0.146***	0.133***	0.117***	0.129***	0.144***			
productivity quartile 4	(0.019)	(0.017)	(0.018)	(0.017)	(0.023)			
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							0.088***	
productivity							(0.015)	
Fixed export costs (benchmark) x								0.256***
productivity percentile within industry-year								(0.028)
Constant	-1.797***	-1.031***	-0.799**	-1.038***	-2.103***	-1.721***	-1.369***	-1.126***
	(0.311)	(0.316)	(0.336)	(0.317)	(0.649)	(0.622)	(0.472)	(0.334)
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

Control variables are capital-labor ratio, value-added ratio, tariff rate, infant death rate, and crime rate. Industry and year fixed effects are included. Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Table 13: Average export volume of firms

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)	15.927***		13.107***		12.937***		11.813***
	(2.584)		(2.514)		(2.503)		(3.009)
Fixed export costs (f)		0.357***	0.297***	0.379***	0.319***	0.252***	0.202***
		(0.050)	(0.048)	(0.050)	(0.049)	(0.052)	(0.048)
Capital-Labor ratio (KL)	2.841	4.411*	-2.898**	4.312*	2.040	5.081**	3.372
	(2.185)	(2.246)	(1.472)	(2.235)	(2.091)	(2.581)	(2.437)
Value-added ratio (VA)	-2.849*	-3.981***	-0.096***	-3.825**	-2.784*	-2.670	-1.041
	(1.528)	(1.503)	(0.023)	(1.490)	(1.461)	(1.689)	(1.655)
Tariff rate	-0.095***	-0.094***	0.013	-0.094***	-0.096***	-0.078***	-0.080***
	(0.024)	(0.023)	(0.008)	(0.023)	(0.023)	(0.022)	(0.021)
Crime rate	0.003	0.021**	0.014	0.022**	0.013*	0.020	0.013
	(0.008)	(0.009)	(0.125)	(0.009)	(0.008)	(0.016)	(0.014)
Infant mortality rate	0.203*	0.106	2.104	0.079	-0.010	0.180	0.125
	(0.117)	(0.136)	(2.100)	(0.136)	(0.124)	(0.183)	(0.165)
Constant	12.422***	13.212***	12.704***	13.208***	12.712***	12.170***	11.157***
	(1.231)	(1.250)	(1.191)	(1.239)	(1.184)	(1.578)	(1.509)
Observations	506	506	505	506	505	306	306
R-squared	0.191	0.187	0.235	0.194	0.240	0.163	0.206

Robust standard errors 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%

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 $\widehat{\tilde{\varepsilon}_{irt}}$	-0.205***	-0.202***	-0.133***
	(0.034)	(0.034)	(0.033)
lnTFP	0.282***	0.281***	0.319***
	(0.021)	(0.021)	(0.033)
Residual-based fixed export costs x	0.073**	0.070**	0.034
productivity quarter 2	(0.029)	(0.029)	(0.032)
Residual-based fixed export costs x	0.179***	0.174***	0.139***
productivity quarter 3	(0.034)	(0.034)	(0.039)
Residual-based fixed export costs x	0.250***	0.246***	0.199***
productivity quarter 4	(0.037)	(0.036)	(0.040)
Constant	-1.603***	-1.603***	-2.453***
	(0.465)	(0.465)	(0.843)
Control variables	Yes	Yes	Yes
Observations	20,271	20,271	11,783

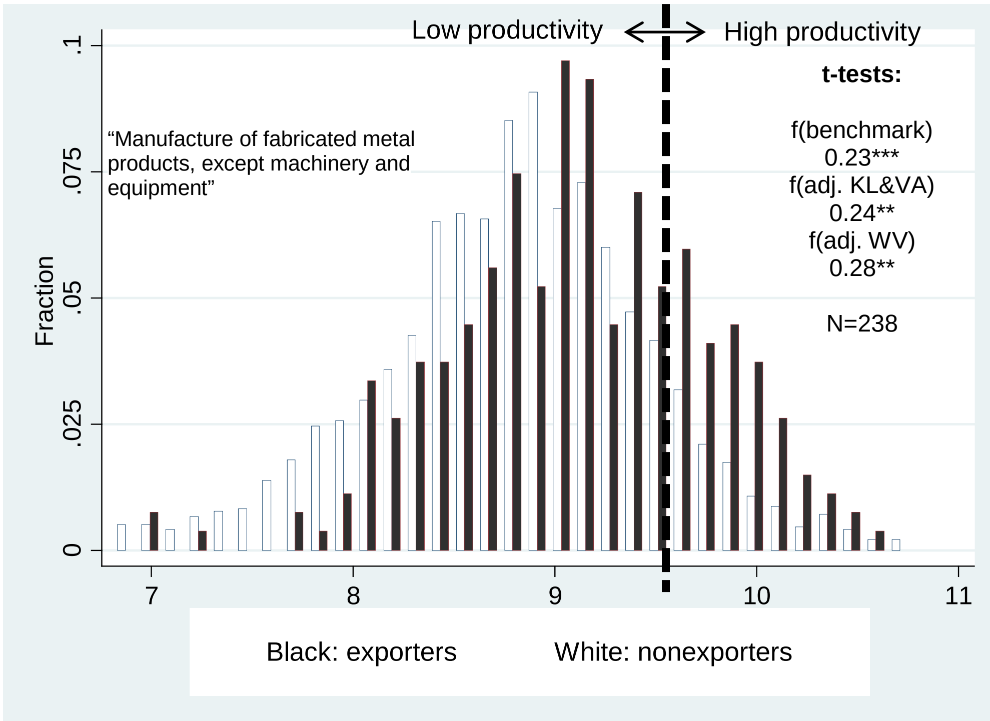
The residual-based fixed export costs are calculated based on productivity. See text for details. Control variables are capital-labor ratio, value-added ratio, tariff rate, infant death rate, and crime rate. Industry and year fixed effects are included. Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

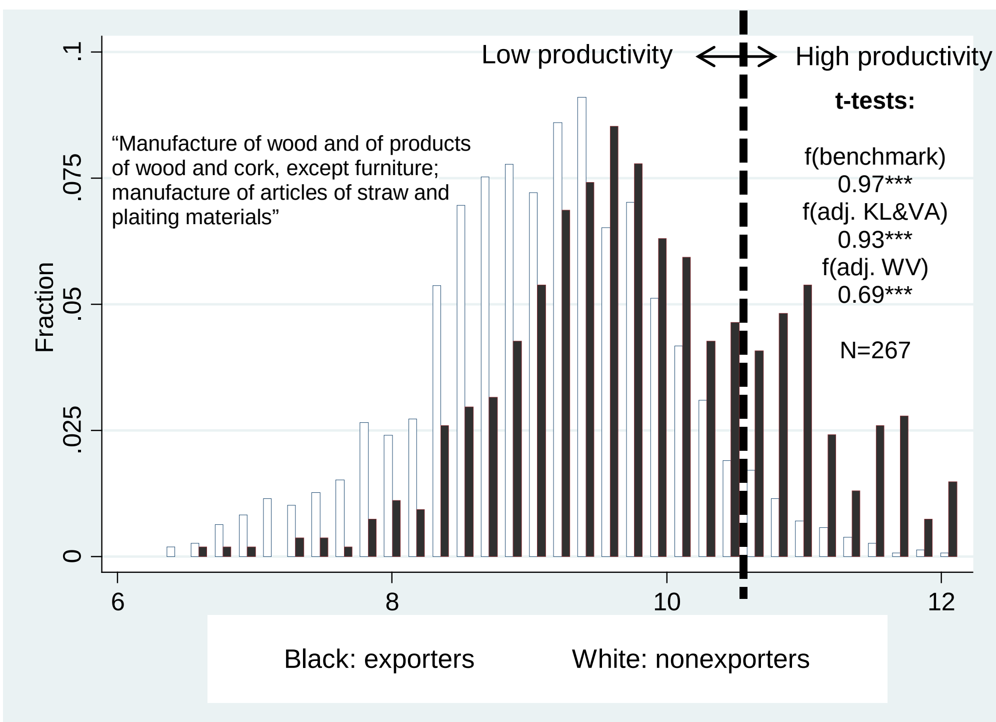
Table A3: Fixed export costs and export volume, without controlling for productivity

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	0.136***	0.229***	-0.050***
	(0.049)	(0.068)	(0.016)
Constant	9.531***	14.314***	-0.840***
	(0.856)	(0.917)	(0.201)
Athrho & lnsigma		-1.326***	1.270***
		(0.088)	(0.042)
Control variables	Yes	Yes	Yes
Observations	3,701	20,271	20,271

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. Industry and year fixed effects are included. Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

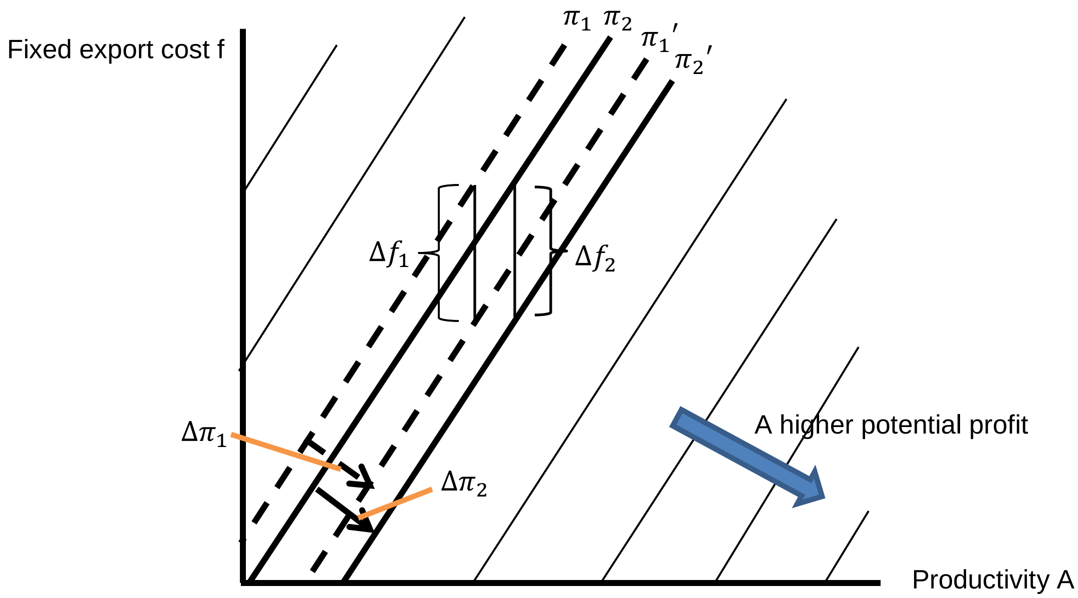
Figure 1: Productivity overlap between exporters and nonexporters



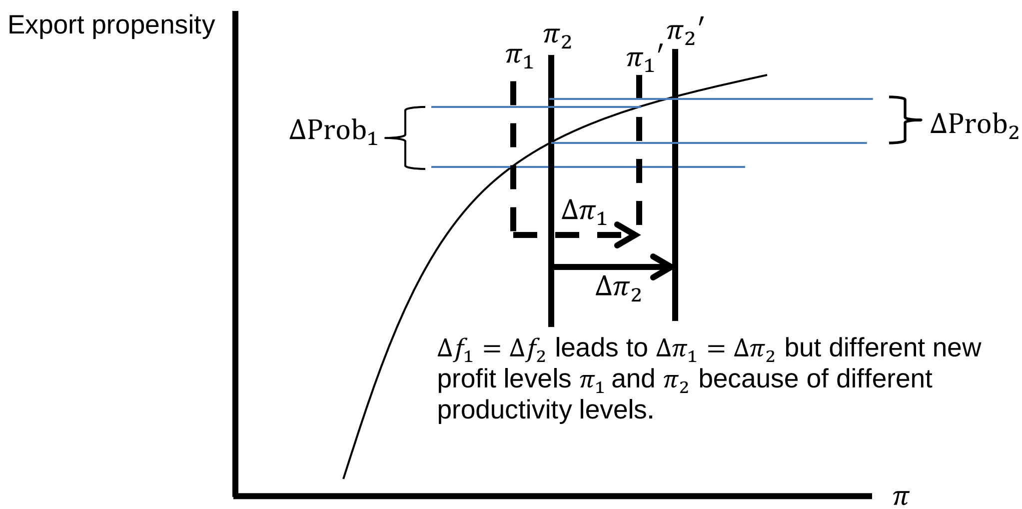


Notes: Productivity is estmated using the Ackerberg-Caves-Frazer (2006) method. The vertical dashed line is the median productivity of exporters, using which we define above (below) levels as high (low) productivity. Then we compare the fixed export costs between high-productivity nonexporters and low-productivity exporters. The differences measured with three differenct 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

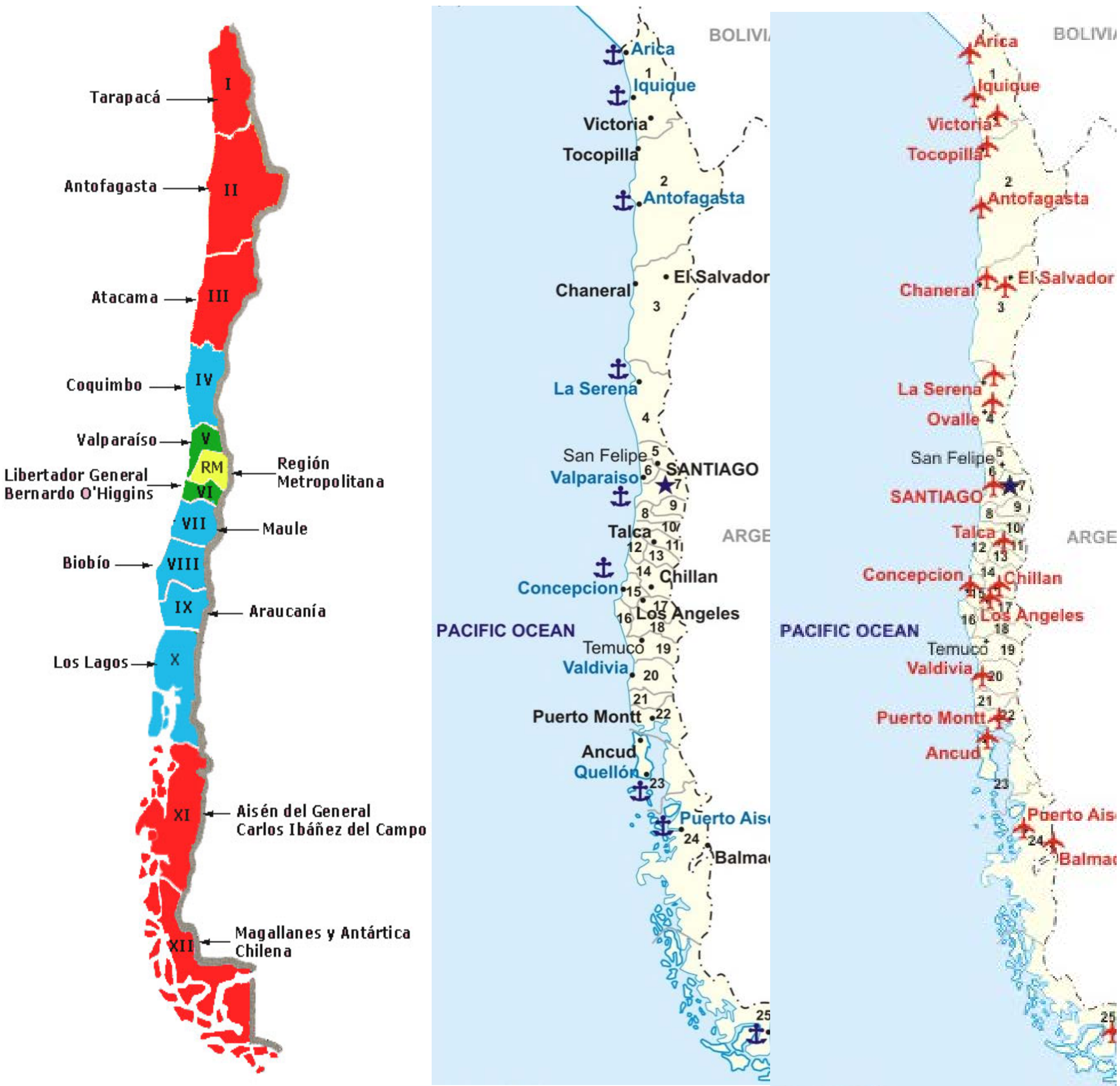


Panel (a): Contours of potential profits from exporting π
Note: only the contours of exporters are shown.



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

Figure 3: The Unique Geography of Chile



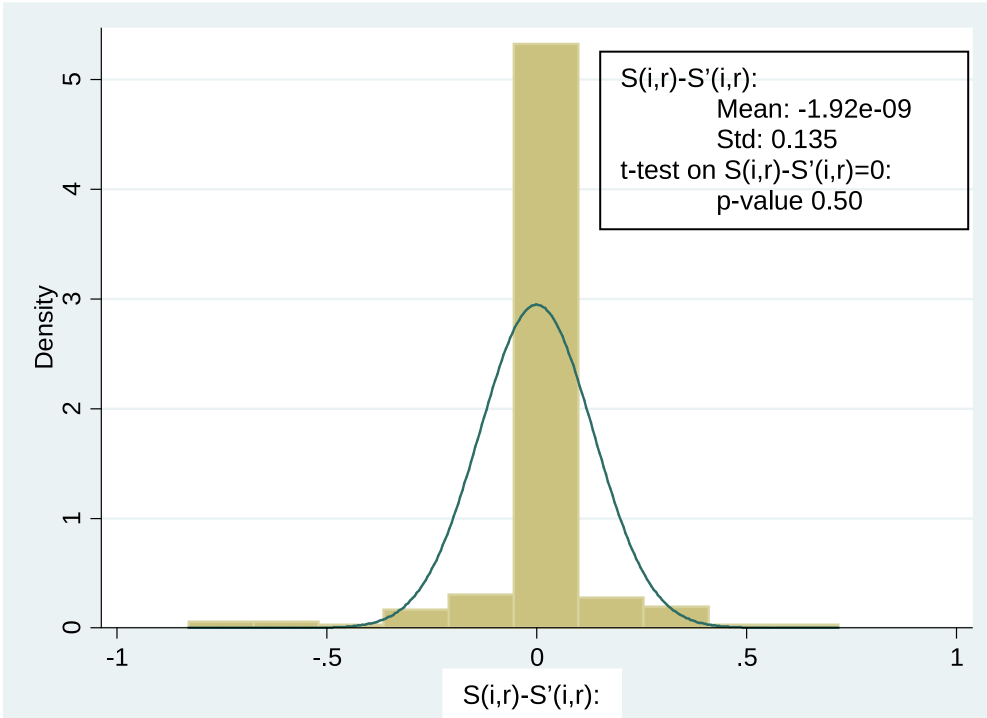
Left: administrative regions

Middle: seaports

Right: airports

Panel (a): Maps of Chile

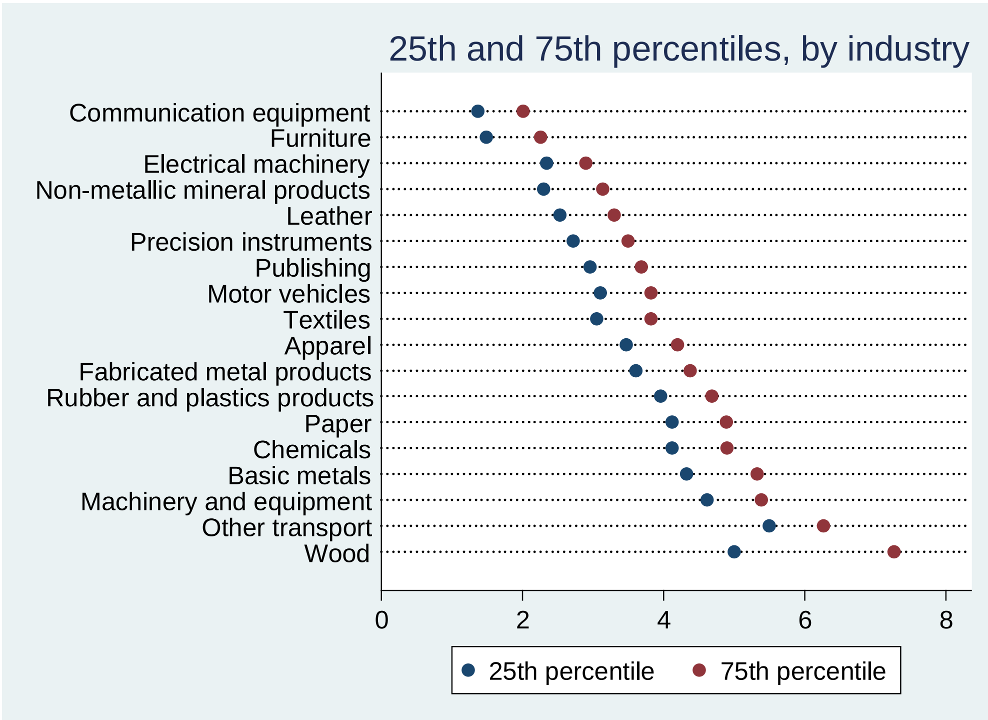
Figure 3: The Unique Geograph of Chile (cont'd)



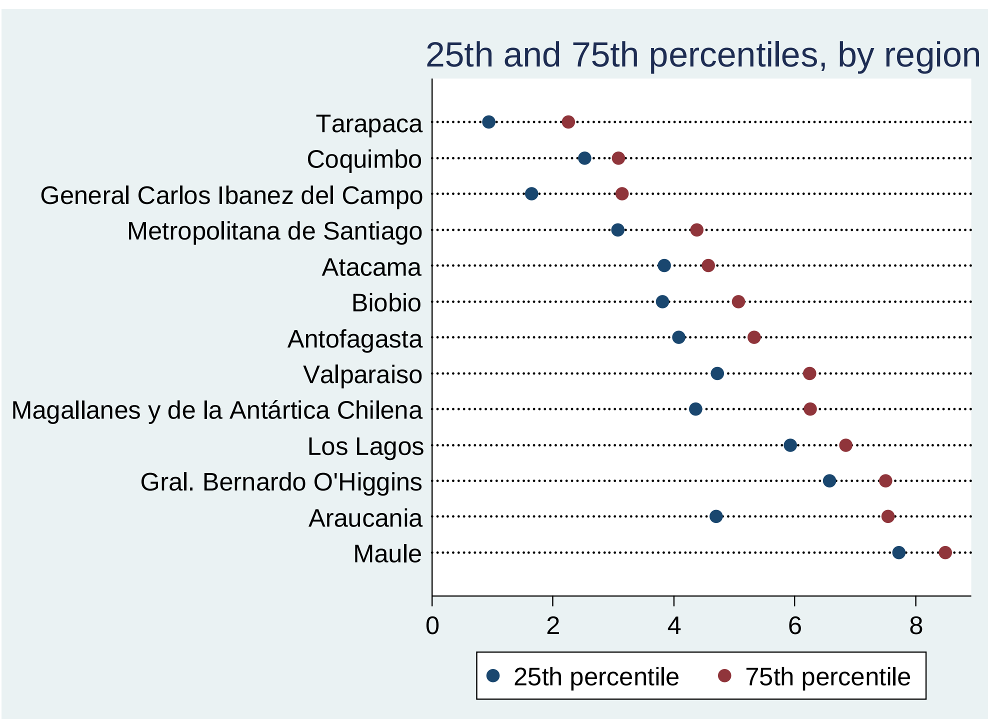
Panel (b): Description on S(i,r)-S'(i,r)

Notes: S(i,r) (respectively, S'(i,r)) is the share of region r in Chile's total exports in industry i, computed using the customs statistics (respectively, the ENIA data). Details on the customs statistics are provided in Appendix A1.

Figure 4: Fixed export costs along three dimensions

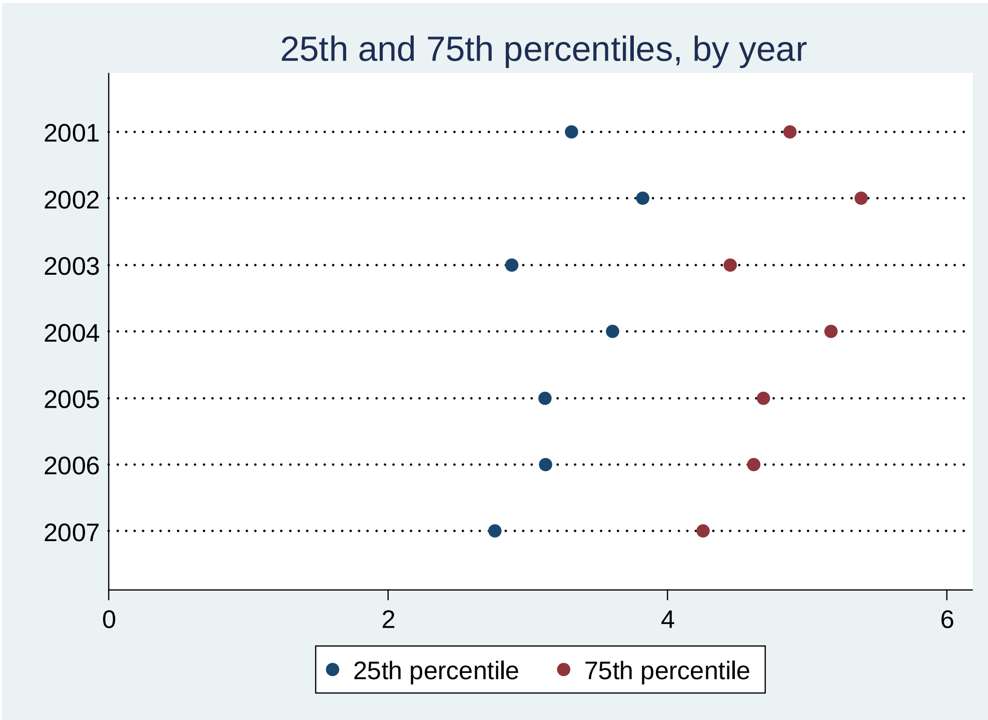


Panel (a): By industry



Panel (b): By region

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



Panel (c): By year