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The Micro-economics of Export Supply: Firm-Level Evidence from Mexico*

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Abstract: This paper uses firm-level data for Mexican exporters to understand how firm-level export decisions shape a country's aggregate exports. The data allows for a characterization of both the cross-sectional distribution of Mexican exports, across destinations and across exporting firms, and of the time-series variation in aggregate exports and its relation to time-series variation in the export supply decisions of firms. It is found that the cross-sectional variation of exports is mostly accounted for the extensive margins of trade, particularly the extensive margin of number of products exported, while the time-series variation in aggregate exports is mostly accounted for by the intensive margin of trade, and in particular by the growth of exporting firms that retain their export status from year to year.
Keywords: International trade, firm heterogeneity, productivity, multi-product firms, exporter dynamics.
JEL Classification: D21, F10, F12, F14, L1, L11, L21, L25, L60.

Resumen: Este documento utiliza datos a nivel empresa de exportadores mexicanos para entender cómo las decisiones de exportación de las empresas determinan las exportaciones agregadas del país. Los datos permiten una caracterización de tanto la distribución transversal de las exportaciones mexicanas, a través de destinos y a través de empresas exportadores, así como de la variación en el tiempo de las exportaciones agregadas y su relación con la variación en el tiempo de las decisiones de exportación de las empresas. Se encuentra que la variación transversal en las exportaciones se explica principalmente por el margen extensivo del comercio, en particular por el margen extensivo del número de productos exportados, mientras que la variación en el tiempo de las exportaciones agregadas se explica principalmente por el margen intensivo del comercio, en particular por el crecimiento de aquellas empresas que mantienen su estatus exportador año tras año.
Palabras Clave: Comercio internacional, empresas heterogéneas, productividad, empresas multi-producto, dinámica de exportadores.

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1 Introduction

In this paper I exploit comprehensive firm-level data from Mexico to establish a series of facts regarding the participation of Mexican firms in international trade. These facts help us to further our understanding of the relationship between productivity distributions, market size and geography, foreign market presence, and export dynamics, thus gaining a deeper understanding of the micro-economic underpinnings of the economy's aggregate export supply. Furthermore, these facts can be useful to discipline structural models of firm-level participation in export markets. A particular focus of this paper, given the three-dimensional nature of the firm-level data - two extensive margins (products and destinations) and one intensive margin- is a characterization of the dynamics of the extensive margins (products and destinations) and the intensive margin of the participation of firms in export markets as firms transition from new export entrants into well established exporters. These dynamics allow us to better understand the firm-level dynamics of growth and survival in export markets and shed light on the process that firms undergo as they evolve from a narrow foreign market presence to the kind of multi-product multi-destination firms that dominate world trade flows (see Bernard et al. [2011] and Bernard et al. [2018]). A better understanding of the dynamics of export supply is particularly relevant for a developing country such as Mexico, that has relied heavily on trade openness and the signing of free trade agreements as part of its development strategy during the last thirty years.

The increasing availability of micro-level data sets that document the activities of individual firms has provided a new window on the determinants of international trade flows. The last two decades have seen a surge of research in international trade, both theoretical and quantitative, that has increasingly drawn attention to the role that firm-level decisions have in understanding the causes and consequences of international trade. This paper follows in the tradition of early papers in this literature that include, among others, Bernard and Jensen [1995,1999], Melitz [2003], Eaton et al. [2004], and Bernard et al. [2007]. These studies have provided insights into why some producers export and others do not, and the role that trade barriers - such as market entry costs- play in shaping the export market participation of firms. While the scope of this paper is narrow, in the sense that the primary objective is to establish the stylized facts regarding the participation of Mexican firms in aggregate Mexican exports, it contributes to this literature in two ways: (i) it studies a series of disparate stylized facts found elsewhere in the literature, that have been established separately using different data sets for different countries (see, for example, Arkolakis and Muendler [2012, 2015],

Bernard et al. [2007, 2009], Eaton et al. [2004, 2011], and Eaton et al. [2008 a,b]), under the umbrella of a single data set. Thus, this paper provides a unified view of both the cross-sectional and time-series facts regarding the participation of exporting firms in a country's aggregate exports; and (ii) it provides a more comprehensive characterization of the dynamics on new export entrants as they grow and mature in export markets than what is available in the literature (see Albornoz et al. [2012] and Ruhl and Willis [2017]). In particular, it provides a characterization of the evolution of the extensive margins of new export entrants as they breach new destinations and add products to their export mix.

The literature on firm-level trade has stressed the importance of incorporating firm heterogeneity to account for features of disaggregated trade data that cannot be interpreted under the paradigm of a representative firm model.[1] Accounting for firm heterogeneity has increased the predictive power of our models (see, for example, Melitz et al. [2008]), furthered our understanding of the forces shaping production and trade patterns and flows of foreign direct investment (see Melitz et al. [2004] and Bernard, Redding, and Schott [2007]), and enhanced our understanding of the margins along which an economy adjusts to trade liberalization that are germane for evaluating the welfare gains from trade (see Melitz and Costantini [2007], Melitz and Trefler [2012], and Melitz and Redding [2015]). Furthermore, by explicitly studying the firm-level decisions to participate in export markets, this literature has provided a better understanding of: (a) the economy's response to exogenous shocks and the co-movement properties of macroeconomic variables (see Melitz and Ghironi [2004, 2007] and Fitzgerald and Haller [2018]), and (b) the effect of access to foreign markets on the firm-level decision to innovate and its consequences for aggregate productivity (see Lileeva and Trefler [2009], Atkeson and Burstein [2010], Bustos [2011], and Aghion et el. [2018], among others).

The rest of this paper is organized as follows. Section 2 presents a theoretical framework for understanding firm-level export participation decisions. The discussion is divided into two sections: a static framework that emphasizes the two extensive margins of trade (destinations and products) in the firm-level export participation decision, and a dynamic framework that emphasizes the dynamics of the firm-level decision to export or not.[2] Section 3 contrasts the implications of the static model outlined in section regarding the cross-sectional distribution

[1] In this literature, firm heterogeneity is understood as the fact that even within narrowly defined industries some firms are much larger and more profitable than others. The reason behind these differences could be due to, for example, differences in productivity across firms.

[2] As will be discussed in section 2, for simplicity the dynamic framework abstracts from the choice of serving multiple destinations and exporting multiple products, to focus on the firm level decision of whether to export or not.

of aggregate exports across destinations and firms to Mexican trade data. Section 4 highlights systematic features of the data related to entry and exit patterns and the participation of firms over time related to the dynamic framework outlined in section 2. In particular, this section focuses on the dynamics of new export entrants and the way that the foreign market presence of new exporters evolves over time. Section 5 concludes.

2 A Framework for Understanding Firm-Level Export Supply Decisions

In this section we present a framework to understand the determinants of firm-level export participation decisions. This framework will be useful as both a guide to exploring the firm-level data and as a lens through which we can examine and interpret patterns in the data. The discussion is divided as follows: in section 2.1 we present a static framework that emphasizes the firm-level decision to serve multiple markets and export multiple products. This framework is an useful guide to study the forces shaping the cross-sectional distribution of exports across firms, destinations, and products. In section 2.2 we present a dynamic framework, that abstracts from the possibility of exporting to multiple markets and exporting multiple products, to highlight the dynamics of the firm-level decision of whether to export or not. In both cases the discussion is purposefully simple and has the objective of highlighting in a simple and intuitive manner the main forces that shape firm-level decisions regarding the various margins of export participation. The interested reader can consult more detailed treatments in, for example, Melitz [2003], Das et al. [2007], Melitz and Constantini [2007], Bernard et al. [2011], and Melitz and Redding [2014].

2.1 The Export Supply Decisions of Multi-product, Multi-Destination Firms

In this section I present a framework to understand how productivity, geography, and market size interact to shape the export market participation decisions of firms. This framework draws heavily from various elements present in the models of Das et al. [2007], Bernard et al. [2011], Arkolakis and Muendler [2012, 2013], and Metliz and Redding [2014], and will serve as a lens through which the firm-level export data is analyzed and results are interpreted. I

present a simplified setting that allows me to highlight in a transparent way the main determinants of the export market presence of multi-product firms.[3] In particular, I focus on the firm-level decisions of: (i) whether to serve a particular export market or not, and (ii) conditional on serving the market, which products to export to this market. Variations in trade flows across destinations and products reflect, among other things, the decisions of multi-product firms to vary the range of their exported products across destinations that have different market conditions. In this sense it is important to emphasize that: (a) the model outlined in this section does not represent and original contribution to the literature on firm heterogeneity, but rather it merely combines various elements present in the literature to provide a useful organizing framework for data analysis given the characteristics of the Mexican firm level data used here, and (b) the data analysis of subsequent sections should not be understood as a formal test of this model of export supply.

To concentrate attention on the firm-level export decision, I assume that firms are profitable enough to operate domestically and produce goods $g \in \{1, \ldots, G\}$ in the domestic market. That is, this framework will focus on the export supply decisions of those firms that have already decided to produce for the domestic market. I assume that each firm has available a differentiated variety in each of $\{1, \ldots, G\}$ product categories. Thus, the product range $\{1, \ldots, G\}$ constitutes the set of products that the firm has available for exporting.[4] Furthermore, to streamline the presentation, I assume that the elasticity of substitution across varieties within products is the same as the elasticity of substitution across products. Bernard et al. [2011] assume the more realistic case in which the former elasticity is larger than the latter. The assumption here is closer to the preference specification in Mayer et al. [2014] where the degree of substitutability across the products produced within the firm is the same as the degree of substitutability of products across firms.

Firms will decide whether they want to enter an export market or not, and -conditional on exporting- which products to export to each destination. Products are imperfect substitutes in demand and I assume an underlying CES demand structure such that revenues for a firm

[3] I present a partial equilibrium model since the main insights on which I will draw on for sections 3 and 4 can be most easily presented and understood without worrying about general equilibrium effects. General equilibrium models of multi-product, multi-destination firms that incorporate various of the elements of the framework presented here have been studied by Bernard et al. [2011], Mayer et al. [2014], and Arkolakis and Muendler [2015].

[4] Notice that we have made the simplifying assumption that all firms produce the same number of products for the domestic market. Of course, a more general version of this model would allow for the number of products that each firm has available in the domestic market, and thus for exporting, to differ. Furthermore, Bernard et al. [2011] and Arkolakis and Muendler [2015] allow for the possibility that the range of goods sold domestically may differ from the range of goods sold abroad.

selling product $g \in \{1,\ldots,G\}$ to country $j \in \{1,\ldots,J\}$ are given by

$$r_{jg}(q) = \zeta_{jg} D_j q^{\frac{\sigma-1}{\sigma}}, \tag{1}$$

where q is the quantity sold by the firm, ζ_{jg} is the strength of demand for product g in country j (i.e. it is a preference parameter), D_j is the strength of demand in country j, and $\sigma > 1$ is the elasticity of substitution.[5] This demand system is commonly used in the international trade literature as it is flexible and amenable to analytic solutions (see Costinot and Rodríguez-Clare [2014] and Melitz and Redding [2014] for details).

Variable trade costs are modeled in the standard iceberg form such that transport costs between the firm's home country and export destination j imply that a firm producing one unit of output (for any good) will only get to sell $1/\tau_j$ of these units in market j ($\tau_j > 1$ for all j). I assume that firms satisfy the demand for their products in the markets they choose to enter (i.e. $q_{jg} = y_{jg}/\tau_j$). Therefore, the export revenue for a firm producing y_{jg} units of good g to be sold in market j is

$$r_{jg}\left(y_{jg}\right) = \zeta_{jg} D_j \tau_j^{\frac{1-\sigma}{\sigma}} y_{jg}^{\frac{\sigma-1}{\sigma}}. \tag{2}$$

Notice that variable trade costs $\left(\tau_j\right)$ act as an overall dampener of the revenues that any given firm can earn in destination j. Thus, the overall or average profitability of destination j is shaped by market size $\left(D_j\right)$ and geography and other determinants, such as trade policy, of variable trade costs $\left(\tau_j\right)$.

On the production side, I assume that the firm is characterized by a productivity profile

$$\left\{\varphi_g : \varphi_g = \frac{\varphi}{g^{\alpha}} \quad g \in \{1,\ldots,G\}\right\}, \tag{3}$$

for a firm with "core productivity" $\varphi > 0$.[6] This profile defines a firm-level "productivity ladder" with decreasing productivity as the firm gets further away from its core product $g = 1$ (see Mayer et. al [2014] and Arkolakis and Muendler [2015]).[7] This productivity profile

[5] In general equilibrium the demand shifter that affects all firms, D_j, is related to the CES ideal price index and income.

[6] A firm's core productivity is sometimes referred to as its "Melitz productivity", since it defines the overall efficiency with which the firm operates.

[7] While the term "productivity ladder" has been used in the literature to denote the fact that firms possess a "core" competency and that efficiency in production decreases as the firm moves away from this core, the term differs somewhat from its usage in the endogenous growth literature (see, for example, Grossman and Helpman [1993]).

implies that marginal costs of production are constant for each variety, but are larger for products further away from the firm's core competency.[8]

The cost function for a firm producing output level y of product g for market j is given by

$$C_{jg}(y) = f_j + \frac{y}{\varphi_g}, \tag{4}$$

where f_j is a per-product fixed cost. In addition, firms face a market entry cost F_j to enter destination j. Bernard et al. [2011] interpret F_j as the cost of serving export market j associated with, among other things, the costs of developing a distribution network. On the other hand, f_j can be interpreted as the costs of, for example, market research, advertising, and conforming to regulatory standards. I assume that $\left(F_j, f_j\right)$ are paid in the home market in units of output.[9] The assumption of constant marginal costs in the production of any product for any market together with the assumption of market-specific fixed costs implies that the firm's profit maximization problem is separable across markets and products. This separability is key for characterizing in a simple and intuitive way the firm's optimal export supply decision.

Let ι_{jg} be an indicator function denoting the firm's export status for product g in market j.[10] Conditional on ι_{jg} the firm chooses its scale of operation y_{jg} to maximize variable profits:

$$\max_y \left\{ \zeta_{jg} D_j \tau_j^{\frac{1-\sigma}{\sigma}} y^{\frac{\sigma-1}{\sigma}} - \frac{g^{\alpha}}{\varphi} y \right\}. \tag{5}$$

[8]An alternative interpretation of the firm's productivity profile is in terms of quality ladders, such that products of greater quality are costlier to produce for the firm. Given the CES demand structure, either interpretation is isomorphic in terms of the firm's variable profits.

[9]For simplicity I assume that the per-product fixed cost is paid in units of the good being produced, while the fixed cost to breach destination j is paid in units of the "core product" or first product introduced into that market. The results established under this assumption are not qualitatively different than if I had assumed that the fixed costs are paid domestically in units of labor, specially given the partial equilibrium framework considered here where the wage that firms take as given would just be another parameter. To see this, assume that producing y units of product g for market j requires hiring labor according to

$$l_{jg} = \alpha_j + \beta_g y.$$

Taking the wage w as given, the firm faces the cost function

$$C_{jg}(y) = w\alpha_j + w\beta_g y.$$

Setting $f_j = w\alpha_j$ and $\varphi_g^{-1} = w\beta_g$ would result in the cost function in the main text.

[10]That is, $\iota_{jg} = 1$ if the firm exports product g to destination j, and $\iota_{jg} = 0$ otherwise.

It will prove convenient to define the "destination specific productivity" $\varphi_{jg} \equiv \varphi_g \zeta_{jg}^{\frac{\sigma}{\sigma-1}}$.[11] Then, the profit maximizing scale of operation for good g in destination j is given by

$$y_{jg}^* = \left(\left(\frac{\sigma - 1}{\sigma} \right) \zeta_{jg}^{\sigma} \varphi_{jg} D_j \tau_j^{\frac{1-\sigma}{\sigma}} \right)^{\sigma}. \tag{6}$$

Conditional on export status, a firm with core productivity φ will earn profits in market j equal to

$$\tilde{\pi}_j \left(\left\{ \iota_{jg} \right\}_{g=1}^{G} \right) = \sum_{g=1}^{G} \iota_{jg} \left[\psi \varphi_{jg}^{\sigma-1} D_j^{\sigma} \tau_j^{1-\sigma} - f_j \right] - F_j, \tag{7}$$

where $\psi = \sigma^{-1} \left((\sigma - 1) / \sigma \right)^{\sigma-1}$.

Observe that the destination specific productivity profile $\left\{ \varphi_{jg} \right\}$ is positively correlated to the "core" productivity ladder $\left\{ \varphi_g \right\}$, but that the destination specific profile of preferences $\left\{ \zeta_{jg} \right\}$ can induce a reordering in the product hierarchy. This implies that product hierarchies are positively correlated across markets, but not perfectly so. In particular, this means that for any given firm, a highly successful product in one market may be less so in others. For each destination we can reorder the products according to the destination-specific quality ladder: $\varphi_{1_j} \geq \varphi_{2_j} \geq \cdots \geq \varphi_{G_j}$.

Conditional on exporting to j, firms will only export those products that earn non-negative profits. Thus, we will have that $\iota_{jg_j} = 1$ if and only if

$$\varphi_{jg_j} \geq B_j, \tag{8}$$

where I define $B_j \equiv \psi^{\frac{1}{1-\sigma}} D_j^{\frac{\sigma}{1-\sigma}} f_j^{\frac{1}{1-\sigma}} \tau_j$ as the "barriers to exporting" to country j. These destination-specific barriers to trade, which are faced by all firms in the source country wishing to serve destination j, are high when: (i) transport costs τ_j are high; (ii) per-product fixed costs f_j are high, and (iii) the strength of demand D_j is low. Thus, a firm will choose to export good g_j to destination j if its productivity in that product is high enough to overcome the barriers to exporting to country j.

Since products have been ordered according to a productivity ladder, the optimal scope

[11] The "destination specific productivity" is a composite of efficiency in production (φ_g) and the preference for product g in market j (ζ_{jg}). Under the assumption of CES preferences these two distinct concepts enter equilibrium revenue isomorphically.

(range) in destination j for a firm with "core" productivity φ is given by

$$G_j^*(\varphi) = \max\left\{g \in \{1,\ldots,G\} : \varphi_{jg_j} \geq B_j\right\}. \tag{9}$$

That is, $G_j^*(\varphi)$ denotes the marginal product exported by a firm with core productivity φ to destination j (i.e. $\varphi_{jG_j^*(\varphi)} = B_j$). Notice that, given the destination-specific ordering of products, $G_j^*(\varphi)$ will also corresponds to the number of products exported to destination j by a firm with core productivity φ. Since the destination-specific productivity profile $\left\{\varphi_{jg}\right\}$ is increasing in "core" productivity φ, the optimal product scope in all destinations is increasing in firm productivity (i.e. in any given destination, more productive firms export more products than less productive firms).

Conditional on exporting to destination j, firm profits in that destination are given by

$$\pi\left(G_j^*\right) = \psi D_j^{\sigma} \tau_j^{1-\sigma} \left(\sum_{g_j=1}^{G_j^*} \varphi_{jg_j}^{\sigma-1}\right) - G_j^* f_j - F_j \tag{10}$$

I define $\tilde{B}_j \equiv \psi^{\frac{1}{1-\sigma}} D_j^{\frac{\sigma}{1-\sigma}} \left(\frac{F_j + G_j^* f_j}{G_j^*}\right)^{\frac{1}{1-\sigma}} \tau_j$, which is similar to the "barriers to exporting" defined above but in place of the per product fixed costs f_j we have the average fixed costs per product $\left(\left(F_j + G_j^* f_j\right)/G_j^*\right)$. Notice that in contrast to B_j, $\tilde{B}_j$ does not depend only on characteristics of the export market since it depends on the firm's optimal scope G_j^*, which in turn depends on the firm's core productivity φ.

It will prove convenient to define a firm's average product efficiency index in destination j under the optimal scope as

$$H\left(G_j^*\right) = \left(\frac{1}{G_j^*} \sum_{g_j=1}^{G_j^*} \zeta_{jg_j}^{\sigma} g_j^{-\alpha(\sigma-1)}\right)^{\frac{1}{\sigma-1}}. \tag{11}$$

This efficiency index can be interpreted as a weighted average of the productivity of the menu of products that a firm optimally exports to destination j, where the productivity of each exported product (φ_g) is weighed by the preference for that product in the destination country $\left(\zeta_{jg}\right)$. The average product efficiency index is decreasing in the firms optimal scope since increasing the firm's scope requires the introduction of products further down in the productivity ladder.

Firms will decide to serve export market j iff $\pi\left(G_j^*\right) \geq 0$ (i.e. the firm can earn profits in that market). Using equations (10) and (11), the firm's export participation decision in market j can be easily characterized as: export to destination j if and only if

$$\varphi H\left(G_j^*\right) \geq \tilde{B}_j. \tag{12}$$

Thus, a firm will choose to serve destination j if and only if under its optimal product scope (range) in that destination it is productive enough to overcome the barriers to exporting that range to destination j. Notice that by defining the firm's efficiency index the firm's optimal policy for serving destination j can be expressed as a simple cutoff rule that depends on: (a) the firm's core productivity φ, which is the same across all potential markets it may enter; (b) the firm's efficiency index at destination j, that depends on destination specific characteristics that affect the firm's profitability in serving that market, and (c) the barriers to exporting to destination j.

This simple framework defines a number of key relationships between productivity, geography and market size, and the export market participation decisions of firms, which can be summarized as follows: a firm with "core" productivity φ will

1. Conditional on exporting to destination j, export product g if and only if $\varphi_{jg} \geq B_j$, and earn revenues for that product equal to

$$r_{jg}(\varphi) = \sigma\psi\left(D_j^\sigma \tau_j^{1-\sigma}\right)\left(\zeta_{jg}^\sigma g^{-\alpha(\sigma-1)}\right)\varphi^{\sigma-1}. \tag{13}$$

   (a) The optimal product range for the firm in destination j is given by

$$G_j^*(\varphi) = \max\left\{g_j \in \{1,\ldots,G\} : \varphi_{jg_j} \geq B_j\right\}. \tag{14}$$

2. Export to destination j if and only if $\varphi H\left(G_j^*\right) \geq \tilde{B}_j$, where $H\left(G_j^*\right)$ is the firm's average product efficiency index, and earn revenues equal to

$$r_j(\varphi) = G_j^*\left[\sigma\psi\left(D_j^\sigma \tau_j^{1-\sigma}\right)\right]\left[H\left(G_j^*\right)\right]^{\sigma-1}\varphi^{\sigma-1}. \tag{15}$$

This simple set of expressions have profound implications for the three-way relationship between export market presence, productivity, and geography and market size. The threshold conditions $\varphi H\left(G_j^*\right) \geq \tilde{B}_j$ and $\varphi_{jg_j}(\varphi) \geq B_j$ imply that *selection* operates at two levels: the former condition implies that only a subset of firms are productive enough to export profitably

to destination j, while the latter implies that within the firm there is an endogenous selection of its optimal product range in each destination. The idea of selection into export activities is central to our understanding of the forces shaping international trade flows and the effects of trade liberalization on, for instance, aggregate productivity and welfare. For instance, the idea of selection is key to understanding the prevalence of 'zeros' in international trade (i.e. exporter-importer-product triplets that register no trade flows. See Melitz et al. [2008] for the implications that this has on estimating the forces that shape trade flows.).

These expressions make strong predictions regarding the distribution of exports across destinations and across firms:

1. Destinations with higher barriers to exporting will
   (a) Have a lower expected number of firms choosing to export (extensive margin of firm entry).
   (b) Have a lower share of a firm's product range for existing exporters (within-firm product extensive margin).
   (c) If the higher barriers to exporting are the result of geography and/or market size, then exports of a given product to a given country by a given firm decrease but there is an ambiguous effect on average exports per firm-product-category because of changes in export composition (within-firm selection of optimal product range).
2. Firms with higher "core" productivity φ will
   (a) Reach a larger expected number of export destinations.
   (b) Export a larger share of their products to a given destination.
   (c) Export more of a given product to a given destination, but may or may not have higher average exports per product due to changes in export composition.

The intuition underlying how a nation's aggregate exports are distributed across destinations and across firms follows readily from the selection effects that operate across and within firms: higher barriers to exporting make it more difficult for any given firm to export and conditional on exporting make it more difficult to export a large share of the firm's product range. On the other hand, for given barriers to exporting, more productive firms will

more easily overcome more the barriers to reaching a destination and the barriers to adding additional products in those destinations.

For the results regarding export volumes, notice that at the firm-country-product level exports are given by

$$r_{jg}(\varphi) = \frac{\sigma\psi}{\hat{B}_j^{\sigma-1}} \left(\zeta_{jg}^{\sigma} g^{-\alpha(\sigma-1)}\right) \varphi^{\sigma-1}, \tag{16}$$

and that in every destination, average exports per product in a given firm are given by

$$\frac{r_j(\varphi)}{G_j^*} = \frac{\sigma\psi}{\hat{B}_j^{\sigma-1}} \left[H\left(G_j^*\right)\right]^{\sigma-1} \varphi^{\sigma-1}, \tag{17}$$

where $\hat{B}_j = D_j^{\frac{\sigma}{1-\sigma}} \tau_j$ are the barriers to exporting arising from geography and market size.

From the first expression above, it is easy to see that more productive firms will export more of a given product to a given destination, and that higher barriers $\hat{B}$ result in lower exports for a given product by a given firm. From the second expression we can see that higher productivity (barriers) have two distinct effects on a firm's average exports per product: there is the *direct effect* that comes from higher (lower) exports of a given product and there is the *indirect effect* that comes from the firm's endogenous choice of optimal scope that is reflected in the average product efficiency index $H\left(G_j^*\right)$, which decreases (increases). In principle the effect of higher productivity (barriers) on average export per product by a firm is ambiguous. Bernard et al. [2011] show that in general equilibrium and under a Pareto distribution for firm productivity these two effects exactly offset one another.

In section 3 I contrast some of the implications of this framework for the cross-sectional distribution of aggregate exports against firm-level data for Mexican exporters.

2.2 Heterogeneous Firms and Export Dynamics

In this section I consider a version of the type of industrial structure outlined in the previous section, but in a stochastic dynamic environment, where firms face aggregate and idiosyncratic shocks that can lead to entry into and exit out of exporting, and contrast its main implications against the data. Again, several key simplifying assumptions are adopted in order to easily highlight key mechanisms shaping the dynamics of export supply at the firm level.

In a dynamic setting with forward-looking firms, the dynamics of firm-level export supply can be strongly affected by the structure of the market entry costs faced by firms. For example,

complementarities in market entry costs as suggested by Morales et al. [2017], where entry costs in a given market depend on how similar it is to other countries to which the firm has previously exported, imply that exporters cannot make independent entry decisions for each destination market. In the presence of such complementarities there is path dependence in a firm's entry pattern. Additionally, such models are complicated because they imply that firms must examine the dynamic implications of every possible combination of export destinations.

The empirical evidence regarding the importance of these complementarities in market entry costs is mixed. Morales et al. [2017] find evidence in favor of significant complementarities in the up-front costs of exporting using firm-level data from Chilean firms in the chemical industry. On the other hand, McCallum [2016] -using a panel of U.S. manufacturing firms- finds that market entry costs are market specific and that complementarities are of limited importance. For the sake of simplicity I abstract from these forces and consider a single product and single destination version of the framework of the previous section so that I may streamline the discussion of the key economic forces shaping the dynamics of firm-level export supply.

I present a simplified version of the framework considered by Das et al. [2007] and Ruhl and Willis [2017]. By focusing on a single-product, single destination I reduce the problem to a simple binary exporting decision that emphasizes the entry into and exit from exporting of heterogeneous firms. Recall that in from the results discussed in the previous section, the net profits from exporting for a single-product, single-destination firm with core productivity φ_i where given by $\pi(\varphi_i) = \psi D^{\sigma} \tau^{1-\sigma} \varphi_i^{\sigma-1} - F$. Now, I assume that firms face: (i) Aggregate shocks: $D_t = \exp(\varepsilon_t) D$, where ε_t is a shock to "market size" that affects all firms equally, and (ii) Idiosyncratic shocks: $\tau_{it} = \exp(\varepsilon_{it}) \tau$ and $\varphi_{it} = \exp(z_{it}) \varphi_i$, where $(\varepsilon_{it}, z_{it})$ are idiosyncratic shocks affecting firm profitability (i.e. the firm's marginal costs).

Finally, market entry costs are given by

$$F_{it} = F + (1 - \iota_{it-1}) F_s, \tag{18}$$

where F denote per-period fixed costs that have to be paid anytime the firm decides to serve the foreign market, and F_s denote "sunk" entry costs that have to be paid up front every time the firm starts or resumes exporting, and as before ι_{it} is a indicator function for firm $i's$ export status at time t.

In this setting, the decision to export today is not purely determined by the per period profit

$$\pi\left(\varepsilon_t, \varepsilon_{it}, z_{it}; \varphi_i\right) = \exp\left(\sigma\varepsilon_t + (\sigma - 1)\left(z_{it} - \varepsilon_{it}\right)\right) \psi D^{\sigma} \tau^{1-\sigma} \varphi_i^{\sigma-1} - F_{it}, \tag{19}$$

since export status today has implications for the market entry costs paid by the firm tomorrow. It is the presence of these sunk entry costs that makes the firm's problem truly dynamic. Otherwise the firm would just face a sequence of static profit-maximization choices.

Define V_{it+1}^1 as the firm's continuation value conditional on exporting today and V_{it+1}^0 as the firm's continuation value conditional on not exporting today. Then, the firm will choose to serve the foreign market at t $(i.e.\ \iota_{it} = 1)$ if and only if

$$\pi\left(\upsilon_{it}; \varphi_i\right) + (\beta\delta)\,\mathbb{E}_t\left[V_{it+1}^1 - V_{it+1}^0\right] - F_{it} \geq 0, \tag{20}$$

where $\upsilon_{it} = (\varepsilon_t, \varepsilon_{it}, z_{it})$ is the firm's state vector, β is the time-discount factor, $1 - \delta$ is the probability of exogenous firm death, and $\mathbb{E}_t\left[\cdot\right]$ denotes expectation conditional on information at t. This condition can be re-written as

$$\tilde{\varphi}_{it} \geq \left[\psi^{\frac{1}{1-\sigma}} D^{\frac{\sigma}{1-\sigma}} \tau \left(F_{it} - \mathscr{O}_{it}\right)^{\frac{1}{\sigma-1}}\right], \tag{21}$$

where $\tilde{\varphi}_{it} = \exp\left(\gamma\upsilon_{it}\right)\varphi_i$ denotes the firm's "current profitability" and $\mathscr{O}_{it}$ denotes the "option value" of the firm. This option value is part of the return to becoming an exporter today since it summarizes, given the perceived distribution of future potential exporting profits, the value to the firm of being able to continue exporting next period without incurring the start-up costs F_s. The fact that firms can preserve their export status without having to incur the start-up cost once again means that, in the data, we should expect to see entering firms maintain their export status in the immediate periods after export entry.

In the absence of sunk entry costs, $V_{it+1}^1 = V_{it+1}^0$ and the above condition can be written as

$$\iota_{it} = 1 \quad \Leftrightarrow \quad \tilde{\varphi}_{it} \geq B, \tag{22}$$

where $B = \psi^{\frac{1}{1-\sigma}} D^{\frac{\sigma}{1-\sigma}} F^{\frac{1}{\sigma-1}} \tau$ are the "barriers to exporting" as defined in the previous section. In this case, the firm comes in and out of exporting as aggregate and idiosyncratic shocks $\upsilon_{it} = (\varepsilon_t, \varepsilon_{it}, z_{it})$ move the firm's current profitability up and down. That is, in the absence of sunk entry a firm's export status would be highly variable as it responds seamlessly to shocks

affecting the profitability of exporting. However, the export participation condition

$$\iota_{it} = 1 \quad \Leftrightarrow \quad \tilde{\varphi}_{it} \geq \left[\psi^{\frac{1}{1-\sigma}} D^{\frac{\sigma}{1-\sigma}} \tau \left(F_{it} - \mathscr{O}_{it} \right)^{\frac{1}{\sigma-1}} \right], \tag{23}$$

shows that the presence of sunk entry costs generates *selection* not only on a firm's current profitability, but also on its expectations about its future profitability (through the option value). In the absence of sunk entry costs firms will export today if and only if they expect to earn profits in the export market today. On the other hand, forward-looking firms that face sunk entry costs may decide to export today even at a loss if they expect high export profits in the future. Furthermore, changes in option values that arise from changing expectations about the future distribution of potential export profits can induce large changes in the return to becoming an exporter, even if current profits are unaffected. For example, anticipated reductions in transport costs τ could lead to more export entry today even with no changes to current export profits.

Das et al. [2007] estimate that these option values are the largest component of export value for most producers and that they are particularly important in certain industries. Additionally, they show that for many of the smaller firms in their study, the option value of being able to export in future years without paying entry costs substantially exceeds the export profits that they expect to earn in the current year. Thus, they argue, there is a well-defined sense in which history and expectations are important for many producers.

Impullitti et al. [2013] consider a general equilibrium version of the framework presented here. Their key result establishes that sunk costs of entry, coupled with idiosyncratic shocks to firm profitability, creates a wedge between the efficiency level at which firms decide to start exporting, φ_H, and the efficiency level at which firms decide to stop exporting, φ_L (see also Dixit [1989]). The interval (φ_L, φ_H) is a "band of inaction" (that is endogenously determined in the model). That is, there is a range of efficiency levels where the optimal decision is to stick with the status quo: non exporters will not enter the export market and exporters will not leave it. Therefore, in contrast to results presented in the previous section, a firm's efficiency is not a sufficient statistic to determine the export status of a firm: a firm's history has to be taken into account. To see this last point, notice that it is possible that

$$\exp\left(\gamma \upsilon_{it}\right) \varphi_i \geq \left[\psi^{\frac{1}{1-\sigma}} D^{\frac{\sigma}{1-\sigma}} \tau \left(F - \mathscr{O}_{it} \right)^{\frac{1}{\sigma-1}} \right] \tag{24}$$

$$\exp\left(\gamma \upsilon_{it}\right) \varphi_i < \left[\psi^{\frac{1}{1-\sigma}} D^{\frac{\sigma}{1-\sigma}} \tau \left(F + F_s - \mathscr{O}_{it} \right)^{\frac{1}{\sigma-1}} \right], \tag{25}$$

so that two firms with the same core productivity φ_i and the same shocks υ_{it} (and thus the same expectations about future profitability), may have different export status at t depending on their export status at $t-1$.

In a stochastic dynamic environment both firm-level dynamics and aggregate entry and exit patterns and export dynamics depend on the nature of the shocks that firms confront. However, one immediate implication of the export participation condition

$$\iota_{it} = 1 \quad \Leftrightarrow \quad \tilde{\varphi}_{it} \geq \left[\psi^{\frac{1}{1-\sigma}} D^{\frac{\sigma}{1-\sigma}} \tau \left(F_{it} - \mathscr{O}_{it} \right)^{\frac{1}{\sigma-1}} \right], \tag{26}$$

is that firms with higher core productivity φ, that have higher expected "current profitability" *and* higher option values, should have a more persistent participation in export markets. Since firms with higher core productivity export more, these "continuing" firms should account for the largest share of exports in a given year. Additionally, variations in the export volume of these firms should account for most of the year-to-year variation in total exports.

In any given year, firm's selecting out of exporting will be such that

$$\exp\left(\gamma \upsilon_{it}\right) \varphi_i < \left[\psi^{\frac{1}{1-\sigma}} D^{\frac{\sigma}{1-\sigma}} \tau \left(F - \mathscr{O}_{it} \right)^{\frac{1}{\sigma-1}} \right], \tag{27}$$

while firms selecting into exporting must be such that

$$\exp\left(\gamma \upsilon_{jt}\right) \varphi_j \geq \left[\psi^{\frac{1}{1-\sigma}} D^{\frac{\sigma}{1-\sigma}} \tau \left(F + F_s - \mathscr{O}_{jt} \right)^{\frac{1}{\sigma-1}} \right]. \tag{28}$$

This implies that in any given year the firms selecting into exporting are expected to have a higher core productivity than the firms that are selecting out of exporting (the former have to pay the up-front sunk entry cost while the latter do not). As such, entering firms are expected to have higher export volumes than exiting firms. Additionally, the average exports of both entering and exiting firms should be lower than the average exports of incumbent firms that are largely driven by the high core productivity associated with "continuing firms" (i.e. firms that remain productive enough to retain their export status).

Impullitti et al. [2013] show that there is a stationary density for firm efficiency that implies that there is a stationary mass of exporters. This in turn implies that there is a steady state flow of firms entering into and exiting from exporting. At an aggregate level, the extension of the single-product and single-destination framework of the previous section to a dynamic stochastic environment makes the following predictions:

1. There is a steady state mass of exporters and a steady state flow of firms entering into and exiting from exporting.

2. "Continuing" firms should account for most of total exports and most of the year-to-year variation in total exports.

3. Entering firms are expected to have larger export volumes than exiting firms.

4. Both entering and exiting firms are expected to have lower export volumes than incumbent firms.

5. Entering firms are expected to maintain their export status in the immediate periods after export entry.

At the firm level the stochastic process for the idiosyncratic and aggregate shocks affecting current profitability and the distribution of future potential export profits has important consequences for the dynamics of the firm-level export supply decision. The performance of an export entrant depends on the particular realization of the sample path of the shocks faced by the firm $\{\upsilon_{it}\}_{t=1}^{\infty}$. The standard assumption in the literature has been to assume that (ε_t, z_{it}) are stationary and serially correlated (see Das et al. [2007] and Ruhl and Willis [2017]). The persistence of shocks implies that a firm that receives a positive shock that raises its current profitability $\tilde{\varphi}_{it}$ will also expect to be profitable in subsequent periods (i.e. has a high option value). This, coupled with the sunk nature of entry costs, implies that a firm that selects into exporting will be unlikely to exit the foreign market in the first few years after export entry: survival rates are initially high for export entrants and decline over time as the positive shocks that led to export entry die over time. Export entrants will also immediately adjust their exports to the optimal level since there is no other barrier to exporting: the firm immediately exports as much as it can. This implies that the exports of entrants are expected to gradually decline over time as the positive shocks that led to export entry die over time.

At the firm level the presence of sunk entry costs and serially correlated shocks to the profitability of exporting firms leads to export entrants that have:

1. High initial survival rates in the export market, with these rates declining over time.

2. High initial export volumes, with export volumes gradually declining over time.

In section 4 we study the dynamics of export supply and contrast with the implications and predictions outlined in this section.

	2000	2001	2002	2003	2004	2005	2006	2007
Firms	36,400	34,975	32,506	31,271	35,068	37,345	36,086	35,915
Products	4,713	4,729	4,902	4,706	4,695	4,723	4,696	4,883
Destinations	193	193	191	186	197	191	203	206
Intensive*	4.56	4.46	4.95	5.26	5.36	5.73	6.92	7.56

*Average Value of Exports per Exporter (Millions of US dollars).

Source: Author's own calculations using firm-level export data from the World Bank's *Exporter Dynamics Database.*

Table 1: Participation of Mexican Exporters in International Trade

3 The Role of Firms in Mexican Aggregate Exports

The database that I use covers the period 2000-2007, during which 112,826 different firms participated in Mexican exports, 5,534 different HS 6-digit products were exported and 220 destinations were reached. The source of the data is the "Exporter Dynamics Database" collected by the Trade and Integration Unit of the World Bank Research Department (see the Annex in Cebeci et al. [2012] for details). Table 1 presents an overview of the data regarding the participation of Mexican exporters in international trade. The dataset is such that, on average, every year 34,946 Mexican firms are active in the export market, serving 195 destinations, and exporting 4,756 unique products. The aggregate trade volumes derived from the firm-level data account for one hundred percent of the exports reported by UN Comtrade for Mexico during the years under consideration.[12] Thus, the firm-level data studied in this paper is comprehensive of all export activities in Mexico.

I start my exploration of the data by studying Mexico's most popular export destinations. I look at Mexico's top 5 export destinations both by the number of recorded transactions and by total value exported. Tables 2 and 3 present the top 5 export destinations for the period 2000-2007 according to these two classifications. From these two tables we can already discern an interesting pattern: destinations that are "easy to trade with", either because of geographic proximity and/or due to low trade costs because of free trade agreements, common language, etc., record many transactions. On the other hand, destinations that have large market size record the largest trade volumes. Also, notice that many of the destinations in Table 2 are close to Mexico, but represent relatively small potential markets for Mexican exporters, while the destinations in Table 3 are typically far away from Mexico, but offer a large market to Mexican exporters. These patterns speak to the forces outlined in Section 2. First, the barriers to exporting faced by a firm are shaped by both considerations of market size *and* trade costs.

[12]Throughout, export volumes are reported in current U.S. dollars.

Rank	2000	2001	2002	2003	2004	2005	2006	2007
1	USA	USA	USA	USA	USA	USA	USA	USA
2	GTM	GTM	GTM	GTM	GTM	GTM	GTM	GTM
3	CRI	CRI	CRI	CRI	CRI	CRI	CRI	CRI
4	CUB	CAN	CAN	CAN	SLV	SLV	SLV	SLV
5	CAN	CUB	SLV	SLV	CAN	CAN	HND	HND

CRI = Costa Rica; GTM = Guatemala; CAN = Canada; USA = United States of America; CUB = Cuba; SLV = El Salvador; HND = Honduras

Source: Author's own calculations using firm-level export data from the World Bank's *Exporter Dynamics Database.*

Table 2: Top 5 Export Destination For Mexican Exporters by No. of Transactions

Rank	2000	2001	2002	2003	2004	2005	2006	2007
1	USA	USA	USA	USA	USA	USA	USA	USA
2	CAN	CAN	CAN	CAN	CAN	CAN	CAN	CAN
3	DEU	DEU	ESP	DEU	ESP	ESP	ESP	DEU
4	ESP	ESP	JPN	ESP	DEU	DEU	DEU	ESP
5	JPN	JPN	DEU	JPN	ABW	COL	COL	COL

ABW = Aruba; CAN = Canada; COL = Colombia; DEU = Germany; USA = United States of America; ESP = Spain; JPN = Japan

Source: Author's own calculations using firm-level export data from the World Bank's *Exporter Dynamics Database.*

Table 3: Top 5 Export Destination For Mexican Exporters by Total Value of Exports

Small markets may be served if they can be breached easily enough by the firm, and remote or too difficult to trade with destinations may be served if they represent a large potential market for exporters. Second, the fact that, with the exception of the USA and Canada which hold a special trade relationship with Mexico due to NAFTA, the set of destinations in Table 2 does not overlap with the set of destinations in Table 3 is indicative of the fact that market size and trade costs do not impact the extensive and intensive margins of trade in the same manner. These results accord well with the results presented in section 2 on the effects of income and distance on the extensive and intensive margins of trade.

The United States is clearly Mexico's dominant export destination both in terms of number of transactions and in terms of export value. Tables 4 and 5 show that this is the result of a very high participation of the extensive margin -a very high percentage of exporting firms and exported products participate in U.S. exports- and of the intensive margin, since average firm exports to the U.S. are higher than the average exports of Mexican firms. The dominance of the U.S. as an export destination for Mexican firms is not surprising given: (a) its proximity to Mexico; (b) its large market size, and (c) its low trade barriers for Mexican exporters due to NAFTA.

	Fraction of Exporters	Fraction of Products	Share in Aggregate Exports
USA	81%	93%	88%
Canada	5.5%	38%	2.15%
Germany	3.14%	34%	0.93%
Guatemala	7.33%	56%	0.35%

Source: Author's own calculations using firm-level export data from the World Bank's *Exporter Dynamics Database.*

Table 4: Participation of Mexican Exporters in Top Destinations (2000)

	$\frac{\text{Average export sales per firm at destination}}{\text{Average export sales per firm}}$	$\frac{\text{Average export sales per firm per product at destination}}{\text{Average export sales per firm per product}}$
USA	1.08	1.16
Canada	0.39	1.01
Germany	0.30	0.88
Guatemala	0.05	0.08

Source: Author's own calculations using firm-level export data from the World Bank's *Exporter Dynamics Database.*

Table 5: Size of Mexican Exporters in Top Destinations (2000)

Next, I look at the persistence of export status at some of the top destinations by looking at the fraction of firms who served a market at $t-1$ and t. The results are reported in Table 6. It can be seen that, on average, persistence of export status in these destinations has gone up over time, but that there is a significant fraction of firms who do not retain their export status at the top destinations from year to year. Table 7 also looks at the attractiveness of the top destinations for new export entrants. It can be seen that while the U.S. is by far the most attractive destination for new export entrants, its importance as an initial export destination has decreased over time, while the importance of other destinations as an initial export destination has increased during the sample period.

In the remainder of this section and section 4 we explore these ideas in a more systematic fashion. The approach will draw heavily upon the results and intuitions outlined in section

Export Destination	2001	2002	2003	2004	2005	2006	2007
U.S.	59.81	58.64	61.45	64.80	65.21	62.46	63.81
Canada	50.45	54.95	52.61	61.42	61.5	56.69	57.04
Guatemala	60.37	62.69	63.58	65.89	68.45	66.27	67.40
Germany	51.53	52.61	54.55	58.10	59.54	57.02	57.90
Spain	44.23	45.76	48.90	50.76	47.26	46.33	47.56

Each cell in the table reports the fraction of firms that, having served a given destination at time $t-1$, kept exporting to that destination at time t.

Source: Author's own calculations using firm-level export data from the World Bank's *Exporter Dynamics Database.*

Table 6: Persistence of Export Status in Top Export Destinations

Export Destination	2001	2002	2003	2004	2005	2006	2007
U.S.	75.16	74.96	73.74	71.63	69.68	68.32	66.38
Canada	2.81	2.88	2.57	3.34	3.16	3.53	3.21
Guatemala	3.23	4.08	4.16	4.26	3.98	4.28	4.21
Germany	1.53	1.75	1.84	2.25	2.25	1.95	1.99
Spain	1.85	1.88	2.30	3.09	2.82	3.05	3.02

Each cell reports the fraction of new exporters (i.e. firms that where observed exporting for the first time in the sample in the given reference year) that served a given market upon export entry.

Source: Author's own calculations using firm-level export data from the World Bank's *Exporter Dynamics Database.*

Table 7: Participation of New Exporters in Top Export Destinations (% of new exporters)

2 as a way to provide a roadmap for exploring the data and as a lens through which patterns that are uncovered may be interpreted.

3.1 Geography, Market Size and the Distribution of Exports Across Markets

The framework presented in section 2 made several key predictions for the way that the "barriers to exporting" determine the distribution of a nation's exports across different export markets. These barriers to exporting summarize the way in which geography (τ), market size (D), and market entry costs (F, f) affect the export market participation decision of firms. In principle, the measures $B_j \equiv \psi^{\frac{1}{1-\sigma}} D_j^{\frac{\sigma}{1-\sigma}} f_j^{\frac{1}{1-\sigma}} \tau_j$ and $\tilde{B}_j \equiv \psi^{\frac{1}{1-\sigma}} D_j^{\frac{\sigma}{1-\sigma}} \left(F_j + f_j\right)^{\frac{1}{1-\sigma}} \tau_j$ could be used to produce a hierarchy of export destinations.[13] Eaton et al. [2011] show that for French exporters there is such a stable ranking of export destinations, although not all exporters strictly adhere to this export market hierarchy in the sense that some exporters may export to a given destination without also exporting to all other higher ranked destinations.[14]

In this section I contrast the implications of the model of section 2 for the effects of the

[13]Here $\tilde{B}_j$ can be taken as the barrier to introducing the firm's first product into destination j. In contrast to the definition of $\tilde{B}_j$ in section 2.2, here $\tilde{B}_j$ depends *only* on the destination market's characteristics.

[14]Firm-level heterogeneity in transport costs could account for the departure from the export market hierarchy. This heterogeneity could be the result of unobserved firm characteristics such as geographic location. For example, for firms located in Mexico the barriers to exporting to the U.S. are lower than the barriers to exporting to Guatemala. However, there are firms that export to Guatemala that do not export to the U.S. This can be easily explained by noticing that a firms geographic position within Mexico determines a firm-level transport cost to each destination and for firms located in Mexico's south the barriers to exporting to Guatemala may actually be lower than the barriers to exporting to the U.S. Eaton et al. [2011] introduce idiosyncratic noise to the transport cost τ to account for these firm-level departures from the export market hierarchy. If we think of τ_j as the average transport cost to destination j and of the firm-level transport cost to be a draw from a distribution with this mean, then firms face a firm-specific barrier to exporting.

barriers to exporting on the cross-country distribution of exports against Mexican firm level data. For brevity, I report results using 2000 data, but note that results for other years are similar.[15] To construct the destination-specific measure of barriers to exporting

$$\tilde{B}_j \equiv \psi^{\frac{1}{1-\sigma}} D_j^{\frac{\sigma}{1-\sigma}} \left(\tilde{F}_j\right)^{\frac{1}{1-\sigma}} \tau_j, \tag{29}$$

I proxy for market size D by using the log of PPP converted GDP at constant prices and I proxy for transport costs τ by using the log distance between Mexico and export destination j.[16] In the case of the fixed entry costs I follow Melitz et al. [2008] and model these costs as $\tilde{F}_j = \exp\left(\omega\phi_j\right)$ where ϕ_j is a vector of specific trade costs between Mexico and destination j. This vector includes: (1) a dummy variable for whether Mexico and destination j share a common language; (2) a dummy variable for whether Mexico and destination j share the same legal origin; (3) a dummy variable indicating if the relative cost (as percent of GDP per capita) of forming a business is above the median in Mexico and the importing country j, and (4) a variable indicating the extent to which Mexico and destination j share a common religion.[17] These variables have been shown to be statistically significant determinants of the probability that exporters from a given country serve a potential export destination (see Melitz et al. [2008]). I choose the weights ω to reflect the effect that these variables have on the probability of observing positive trade flows between a pair of countries.[18] I set the elasticity of substitution $\sigma = 5$, a standard value in the literature (see Lai and Trefler [2002] and Alessandria et al. [2013]).

As might be expected, the United States has the smallest "barriers to exporting" for Mexico. I create a barriers to exporting index by normalizing against the United States. According to this index the 10 most attractive destinations for Mexican exporters are: the United States, Canada, Guatemala, Brazil, Spain, Venezuela, France, Colombia, and Germany. To present the results from this exercise I exclude the United States and Canada since they hold a special

[15]The year 2000 is chosen as a good benchmark year since it allows sufficient time for most of the adjustments to NAFTA's enactment in 1994 to have occurred, and it precedes China's entry into the WTO in 2001, which represented a large shock to the organization of production and economic activities in Mexico. Results for other years do not vary greatly, either qualitatively or quantitatively, from the ones presented in this section.

[16]Distance data is from CEPII (see Mayer and Zignago [2006]) and data for PPP converted GDP at constant prices is from the Penn World Tables https://pwt.sas.upenn.edu

[17]The data for these indicators comes from Melitz et al. [2008] http://scholar.harvard.edu/melitz/publications/estimating-Trade-Flows-Trading-Partners-And-Trading-Volumes.

[18]The weights ω are chosen based on the estimates reported in Table II of Melitz et al. [2008] for a probit regression of the probability of observing exports between a given pair of countries on observable characteristics that include the previously mentioned variables.

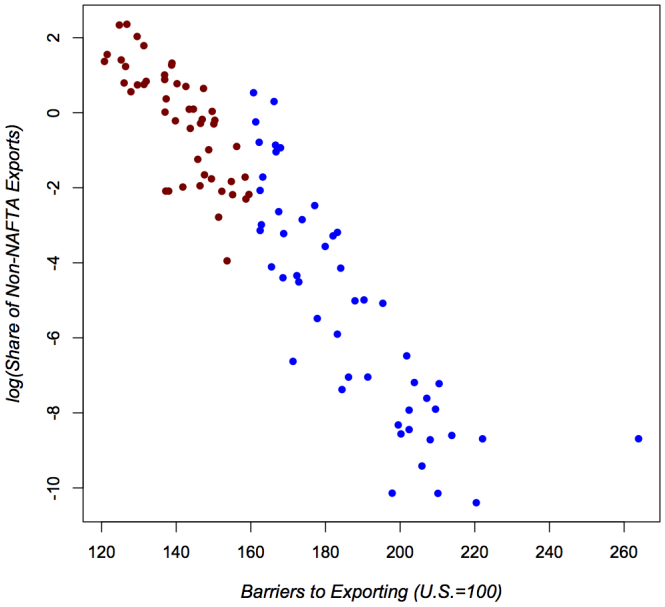
relationship with Mexico, accounting for 90% of Mexican trade.[19] The results reported below include 97 export destinations, covering all continents, for which the "barriers to exporting" index could be constructed.

Figure 1 presents the relationship between the barriers to exporting and the share of non-NAFTA exports commanded by an export destination. There is a strong negative association between the barriers to exporting and the log share of non-NAFTA exports. This result is related to the standard gravity results in the literature (see Bernard et al. [2007]), except that here I do not separately identify the effects of distance and market size, but rather focus on how these features of an export destination combine to produce a hierarchy of markets and see how export activity is distributed across this hierarchy. In what follows, I decompose the non-NAFTA export share of a destination into the effects that the barriers to exporting have on different margins of firm participation in foreign markets.

Figures 2, 3, and 4 look at the relationship between the barriers to exporting and the number of transactions, firms, and product categories recorded in each market.[20] The pattern in these figures is remarkably similar to that presented in Figure 1: there is a strong negative association between a nation's barriers to exporting and the number of firms, products, and recorded transactions for each market. Table 8 provides further evidence about the role that the barriers to exporting have on the extensive margin of firm participation and the within-firm extensive margin of export composition. As can be seen in Table 8, the average number of transactions, firms, and product categories is substantially higher for countries with below median export barriers than for countries with above median export barriers: the average number of firms and average number of product categories in destinations with below median export barriers is roughly 1450% higher than in destinations with above median barriers. These results are consistent with the framework of section 2, that predicted that destinations with higher barriers to exporting will have a lower expected number of firms serving the market (selection

[19] In particular, the U.S. accounts for 88% of Mexican trade with over 80% of all active exporters active in that market and with over 93% of all HS-6 digit products sold by Mexican exporters sold in this market. Additionally, I exclude the following countries from the sample: (*i*) Algeria where 98% of Mexican exports consist of chickpeas and beans; (*ii*) Tanzania where 93% of Mexican exports consisted of sugar; (*iii*) Mauritania where 100% of Mexican trade in 2000 was accounted for by a single shipment of railway parts, and (*iv*) Iran where over 90% of Mexican trade is accounted for by the petrochemical and oil producing industry. The share of these excluded categories in total Mexican exports is negligible.

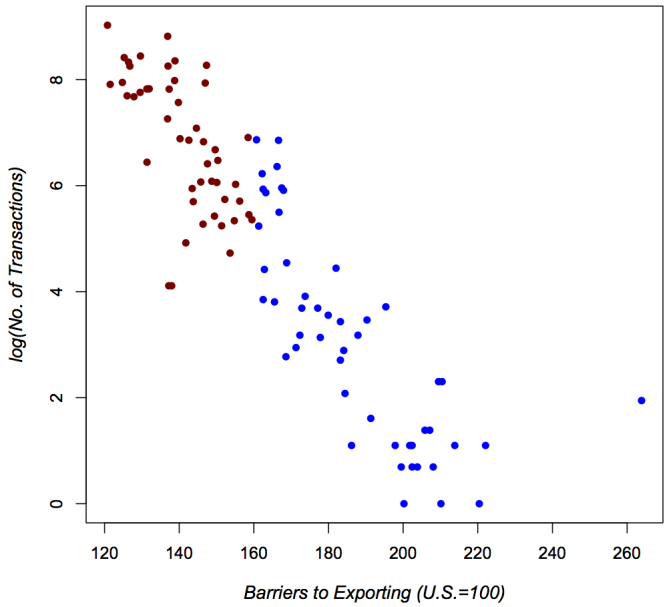
[20] For the purpose of the discussion and graphs of this section I define: (i) a product as a unique HS-6 digit product code; (ii) a variety as a firm-product code tuple, and (iii) a transaction as a firm-product tuple at a given destination. Thus, a product category could be "shoes", while a variety could be "shoes of firm X". Thus, for example, panel (a) of 4 depicts the ratio of the total number of product categories to the number of exporting firms at a given destination, which is approximately equal to the average number of products exported by firms that serve that destination.



Red dots denote observations with barriers to exporting below the median value.

Source: Author's own calculations using firm-level export data from the World Bank's *Exporter Dynamics Database.*

Figure 1: Barriers to Exporting and Export Participation: Share of non-NAFTA exports (%).



Red dots denote observations with barriers to exporting below the median value.

Source: Author's own calculations using firm-level export data from the World Bank's *Exporter Dynamics Database.*

Figure 2: Barriers to Exporting and the Extensive Margin: No. of Transactions.

	Barriers < Median	Barriers > Median
Average No. Transactions	1761.53	99.73
Average No. Firms	575.45	37.13
Average No. Product Categories	835.73	73.38

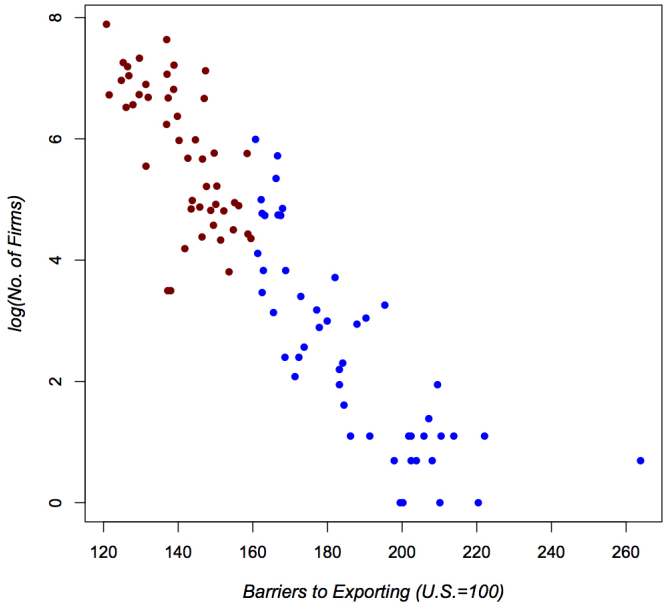
Source: Author's own calculations using firm-level export data from the World Bank's *Exporter Dynamics Database.*

Table 8: Barriers to Exporting and the Extensive Margin

across firms), and a lower share of a firm's product range for existing exporters (within-firm product extensive margin).

As a further robustness check I look at the effect that the barriers to exporting have on average firm entropy in a destination market. Following Baldwin and Gu [2009], firm entropy in destination j is defined as $ent_j = -\sum_{g_j=1}^{G_j^*} s_{g_j} \ln\left(s_{g_j}\right)$ where s_g is the share of product g in the firm's sales in destination j. Entropy captures the extent to which a firm's sales are skewed toward its largest rather than its smallest products.[21] According to the framework of section 2 destinations with lower barriers to exporting will exhibit higher firm entropy as

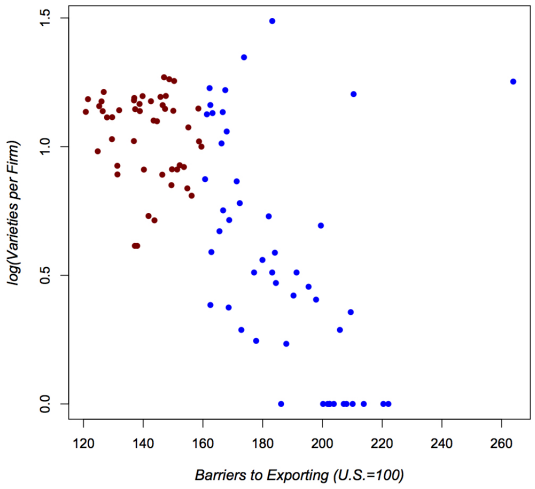
[21]Entropy increases when the number of products sold by the firm increases and when, conditional on the number of products sold, the shares become more even.That is, if a firms sells N products with product shares



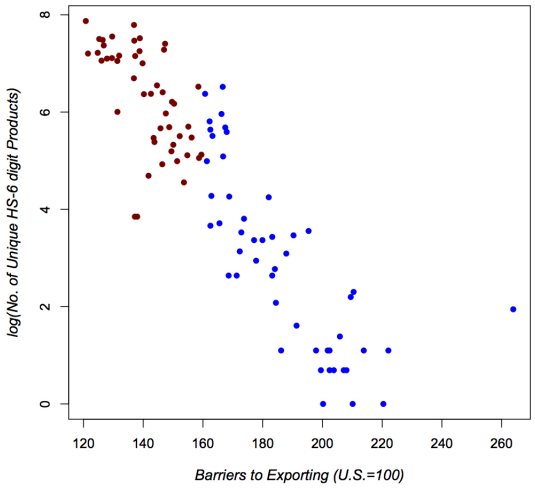
Red dots denote observations with barriers to exporting below the median value.

Source: Author's own calculations using firm-level export data from the World Bank's *Exporter Dynamics Database.*

Figure 3: Barriers to Exporting and the Extensive Margin: No. of Firms.



(a) No. of Varieties per Firm

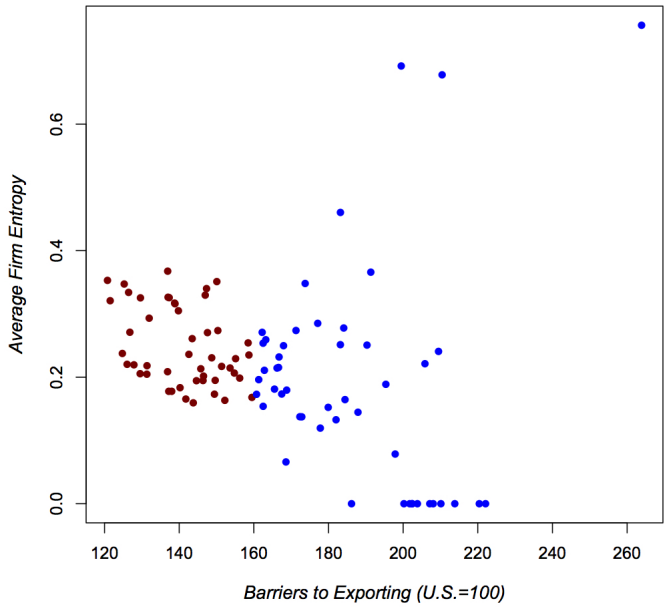


(b) No. of Product Categories

Red dots denote observations with barriers to exporting below the median value.

Source: Author's own calculations using firm-level export data from the World Bank's *Exporter Dynamics Database.*

Figure 4: Barriers to Exporting and the Extensive Margin: No of Products.



Red dots denote observations with barriers to exporting below the median value.

Source: Author's own calculations using firm-level export data from the World Bank's *Exporter Dynamics Database.*

Figure 5: Barriers to Exporting and Firm's Product Range: Average Firm Entropy

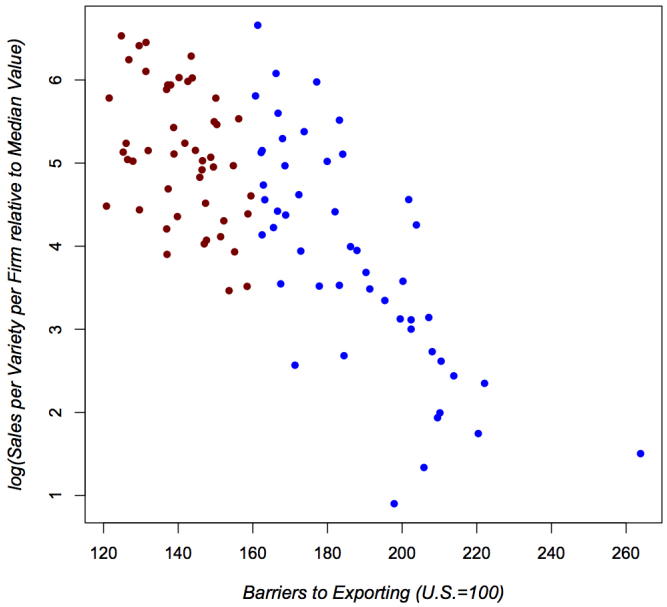
firms introduce more products and their sales are less concentrated on their largest product. Figure 5 shows that, with the exception of three outliers, there is a strong negative association between the barriers to exporting and average firm entropy, consistent with the framework of section 2. In fact, for destinations with below median barriers there is no destination where all of the firms active in that market concentrate their sales in a single product. On the other hand, 25% of the destinations with above median barriers are such that all the firms active in those markets concentrate their sales in a single product.

Finally, I consider the effects of the barriers to exporting on the intensive margin (sales per variety per firm). In this case, it the part of the barriers to exporting that arises from differences in geography (τ) and market size (D) that matter.[22] The framework of section 2 implied that the effect of the barriers to exporting on the intensive margin could be ambiguous because of

$\{s_i\}_{=1}^N$ then entropy for $\{s_i\}_{=1}^N$ is lower than for $\{\tilde{s}_i\}_{=1}^N$ where

$$\tilde{s}_i = \alpha s_i + (1-\alpha)\frac{1}{N},\ \alpha \in (0,1),\ i = 1,\ldots,N.$$

[22]This is true for infra-marginal firms. Fixed costs matter for the sales of the marginal firm.



Red dots denote observations with barriers to exporting below the median value.

Source: Author's own calculations using firm-level export data from the World Bank's *Exporter Dynamics Database.*

Figure 6: Barriers to Exporting and the Intensive Margin: Average Sales per Transaction

the firm's endogenous choice of product range in each destination. Higher barriers reduce the exports of a given product by a given firm, but they also induce firms to reduce their product scope which increases their average product efficiency index at that destination. This implies that firms will export less for a given product and they will also concentrate their exports in the best performing products. This in turn implies an ambiguous effect on the firm's average sales per product. Figure 6 exhibits a negative relationship between the barriers to exporting and the intensive margin, although the association is not as strong as those presented in Figures 2, 3, and 4.[23]

Table 9 summarizes the relationships presented in Figures 1 through 6 by presenting the sample correlations between the barriers to exporting index and the different outcomes of export participation. The framework presented in section 2 made sharp predictions regarding the effects of the "barriers to exporting" on the extensive margins of export entry (selection *across* firms) and on the extensive margin of optimal product range (selection *within* firms).

[23]The sales per firm per variety amongst destinations with below median barriers to exporting is twice as high than for destinations with above median barriers to exporting, but the coefficient of variation of sales per firm per variety amongst the former destinations is half that of the latter.

	Correlation with Barriers to Exporting
log(Share Non-NAFTA Exports)	-0.92
log(No. Transactions)	-0.89
log(No. Firms)	-0.90
log(Product Categories)	-0.89
log(Sales per Transaction)	-0.74
Entropy	-0.17*

*Figure 5 shows that there are three outliers in terms of average firm entropy. These correspond to Fiji, the Maldives and Papa New Guinea. For Fiji there is a unique supplier diversified in kitchen appliances/parts. In the Maldives there are two firms diversified in clothing accessories and apparel, and in Papa New Guinea there is a single firm with a 50-50 split of sales. Ignoring theses outliers, the sample correlation between barriers to exporting and average firm entropy is -0.63.

Source: Author's own calculations using firm-level export data from the World Bank's *Exporter Dynamics Database.*

Table 9: Barriers to Exporting and Foreign Market Presence: Sample Correlations

Figures 2, 3, and 4 confirm these predictions using firm-level data for Mexican exporters. Furthermore, the evidence suggests that the negative relationship between the barriers to exporting and the share of exports commanded by a destination presented in Figure 1 is almost entirely driven by the extensive margins of number of firms and number of products, since the negative association between the barriers to exporting and the intensive margin is less significant.

The results presented thus far are consistent with the framework presented in section 2, and in this sense confirm the importance of explicitly accounting for firm-level decisions in order to understand aggregate trade data. My results are consistent with those found by Bernard et al. [2011] using firm-level data for the United States.

3.1.1 Gravity Reconsidered

In this subsection I disentangle the "barriers to exporting" by focusing on the separate effects that market size and geography have on exports and the different margins of export participation. By decomposing aggregate trade flows into different margins of participation I can assess whether the effect of distance and market size on trade flows operate through firm participation, number of exported products, or the average value of a product exported by a firm. That is, as in Bernard et al. [2007], I reconsider the standard "gravity equation" of international trade.

	Export Value	Firms	Products	Intensive
GDP	1.37^{***}	0.78^{***}	0.75^{***}	-0.16^{***}
	(0.03)	(0.01)	(0.01)	(0.02)
Distance	-3.14^{***}	-2.3^{***}	-2.37^{***}	1.53^{***}
	(0.09)	(0.05)	(0.05)	(0.07)
Observations	1321	1321	1321	1321
R^2	0.98	0.94	0.94	0.96

Standard error in parentheses. *** denotes significance at the 0.1% level.

Source: Author's own calculations using firm-level export data from the World Bank's *Exporter Dynamics Database.*

Table 10: Gravity and Aggregate Mexican Exports

The value of log exports to destination j at time t can be expressed as

$$\ln X_{jt} = \ln N_{jt} + \ln M_{jt} + \ln \hat{x}_{jt}, \tag{30}$$

where X_{jt} denotes the total value of exports in year t to destination j, N_{jt} the number of exporters in year t in destination j, M_{jt} the total number of products exported in year t to destination j, and $\hat{x}_{jt}$ is the average value of exports per firm per product in year t to destination j. I consider a parsimonious specification that includes distance and income as the only explanatory variables, but expand the sample size by taking advantage of the time-series dimension of the data:

$$\ln Z_{jt} = \gamma_t + \delta \ln \tau_j + \lambda \ln Y_{jt} + \varepsilon_{jt}, \tag{31}$$

where γ_t are year fixed effects that control for factors that may affect exports at time t to all destinations, τ_j is the bilateral distance between Mexico and destination j, Y_{jt} is GDP in j at time t, and Z_{jt} is either the aggregate value of exports, number of exporters, number of products, or average value of exports per product in turn. [24]

Table 10 reports the results. Since the dependent and explanatory variables are in logarithms, the estimated coefficients correspond to elasticities. The first column confirms the standard gravity result: trade flows are increasing in destination GDP and decreasing in distance. The next three columns present the results for the extensive and intensive margins. These results show that the number of exporting firms and the number of exported products are positively related to destination GDP and negatively related to distance, consistent with the implications of the framework presented in section 2.2. Furthermore, the results from Table 10 confirm

[24] Notice that this an extremely simplified specification of the "gravity equation" that does not include terms for multilateral resistance or the price index. Additionally, with data for only one exporter I cannot consider a specification with exporter and importer fixed effects. However, this is the specification considered by Bernard et al [2007], and thus it facilitates comparison with their results.

those presented in section 3.1: the effects of geography and market size on aggregate trade flows are driven by the extensive margins of number of firms and number of products.

These results confirm those found by Bernard et al. [2007], and like these authors I also find that the elasticities on the two extensive margins - number of firms and number of products- are larger in absolute value than for the intensive margin, and that this is particularly true for the elasticity on importer GDP. Table 10 also shows that the elasticity of all outcome variables with respect to distance is larger (in absolute value) than the elasticity on income. This suggest that distance (i.e. transport costs) are a particularly important component of the "barriers to exporting" and that reductions in transport costs have important consequences for export market participation.[25]

On the other hand, to interpret the elasticities on the intensive margin recall that here $\hat{x}_j = X_j/N_jM_j$, where N_j is the number of firms serving destination j and M_j denotes the unique set of product categories exported to j. Since not all firms will be active in all product categories, the number of recorded transactions O_j is smaller than N_jM_j. Now, observe that we may re-write the intensive margin as

$$\hat{x}_j = \frac{X_j}{N_JM_j} = \frac{X_j}{O_j} \cdot \left(\frac{O_j}{N_jM_j}\right) = \tilde{x}_j \cdot \left(\frac{O_j}{N_jM_j}\right) \tag{32}$$

where $\tilde{x}_j$ corresponds to the average value of exports per transaction, and O_j/N_jM_j denotes the *density of trade* (i.e. the number of observed transactions relative to the number of potential transactions in a given destination). The density of trade is meant to capture that typically firms are only active in a subset of the overall number of products traded.

In Figure 6 it was found that $\tilde{x}_j$ is negatively associated with the "barriers to exporting", presumably because the change in the average efficiency index of exporters resulting from a change in the composition of their exports is not large enough to compensate for the adverse effect that higher barriers to exporting have on the exports of a particular good by a particular firm.

Higher barriers to exporting result in both lower O_j and lower N_jM_j, but proportionately speaking N_jM_j decreases more than O_j, which means that the ratio O_j/N_jM_j increases and could allow for a positive association between the intensive margin $\hat{x}_j$ and the barriers to exporting. This is indeed what happens in the data as shown by Figure 7. Figure 7a shows

[25] Since "transport costs" are a short-hand for variable trade costs, these results suggest that policy-driven changes in variable trade costs may have important implications for the number of exporters serving a given market and the number of products they export to said market.

that density O_j/N_jM_j increases as the barriers to exporting increase, while Figure 7b shows that there is a positive association between average exports per firm per product category and the barriers to exporting. Bernard et al. [2007, 2011], using data for U.S. exporters, also find that the intensive margin of average exports per firm per product are negatively associated with GDP and positively associated with distance.

3.1.2 Accounting for the Variation of Exports across Export Destinations

Based on previous results I have argued that the extensive margins of the number of firms and the number of products are important determinants of the cross-sectional distribution of a nation's exports across its export markets. In this subsection I take a step further to quantify the importance of each margin of adjustment in explaining the cross-sectional variation of a nation's exports.

Let X_j denote total export value to destination j, N_j denote the number of firms serving destination j, and let M_j denote the set of goods exported to destination j. Notice that the total number of *possible* transactions[26] with destination j is N_jM_j (i.e. it would be the number of recorded transactions if all firms N_j traded all products M_j with destination j). Let O_j denote the number of observed transactions with country j (i.e. the actual number of firm-product pairs that record positive trade with destination j), and define the "density of trade" d_j as $d_j = O_j/N_jM_j$. Then, total export value can be decomposed as

$$\ln X_j = \ln N_j + \ln M_j + \ln d_j + \ln \tilde{x}_j, \tag{33}$$

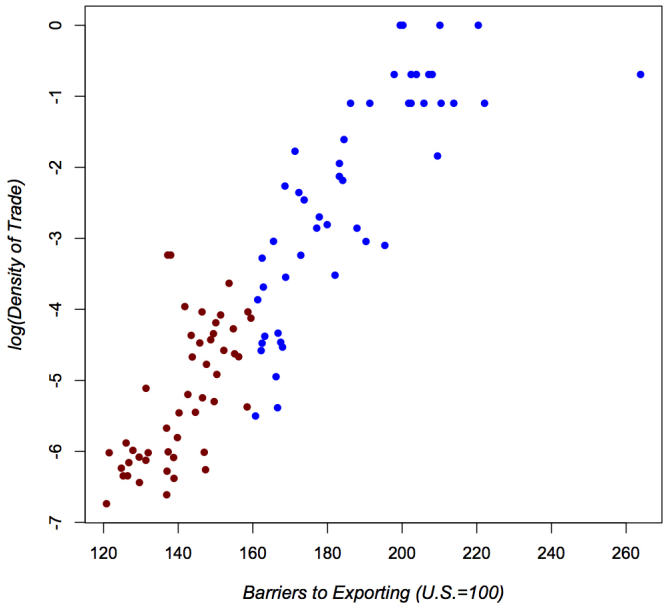
where the first three terms on the right hand side are the extensive margins of number of firms, number of products, and density of trade, while the last term is the intensive margin of trade.

The above expression for exports provides the basis for a decomposition of Mexican trade across export markets in a given year. Notice that if we were to run the OLS regression

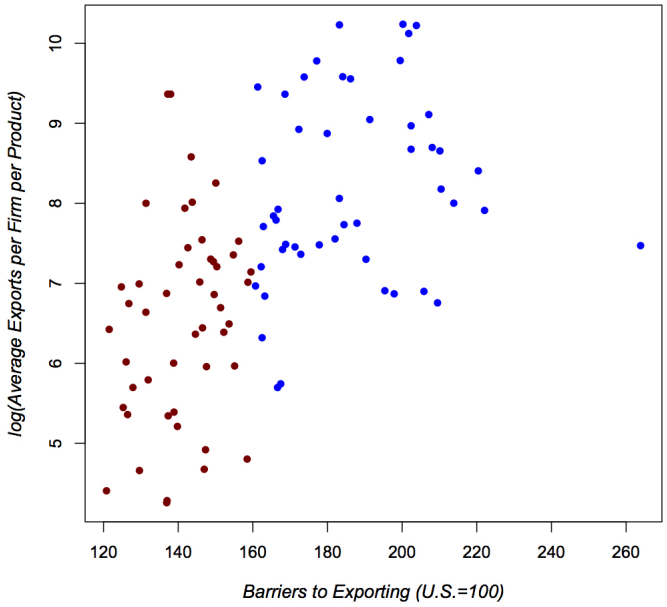
$$\ln X_j = \beta_N \ln N_j + \beta_M \ln M_j + \beta_d \ln d_j + \beta_x \ln \tilde{x}_j + \varepsilon_j, \tag{34}$$

we would obtain $\left(\hat{\beta}_N, \hat{\beta}_M, \hat{\beta}_d, \hat{\beta}_x\right) = (1,1,1,1)$ with an R^2 equal to 1. For any OLS regression

[26] A transaction is defined as an export sale by a firm in a given HS 6-digit category.



(a) Density of Trade



(b) Average Exports Per Firm Per Product
Red dots denote observations with barriers to exporting below the median value.

Source: Author's own calculations using firm-level export data from the World Bank's *Exporter Dynamics Database.*

Figure 7: Barriers to Exporting and the Intensive Margin

Margin	2000	2001	2002	2003	2004	2005	2006	2007
Firms	0.53	0.51	0.51	0.56	0.53	0.53	0.55	0.53
Products	0.55	0.52	0.53	0.56	0.53	0.52	0.54	0.52
Density	-0.47	-0.45	-0.46	-0.50	-0.45	-0.45	-0.46	-0.45
Intensive	0.39	0.42	0.42	0.38	0.39	0.39	0.38	0.40
No. Destinations	193	193	191	186	197	191	203	206

Source: Author's own calculations using firm-level export data from the World Bank's *Exporter Dynamics Database.*

Table 11: Decomposition of Mexican Exports Across Trading Partners

the coefficient of determination can be decomposed as

$$R^2 = \sum_h \delta_h r_h, \tag{35}$$

where δ_h is the standardized (beta) regression coefficient of the hth explanatory variable and r_h is the sample correlation between the dependent variable and the hth explanatory variable. The quantity $\delta_h r_h$ is the *contribution* of the hth explanatory variable to the explanation of the variance of the dependent variable (see Theil [1971] for details). Based on this decomposition I can account for the share of the overall variation in trade explained by each margin as

$$\underbrace{\rho_{N,X}\frac{sd\left(\ln N_j\right)}{sd\left(\ln X_j\right)}}_{\text{Extensive Margin 1}} + \underbrace{\rho_{M,X}\frac{sd\left(\ln M_j\right)}{sd\left(\ln X_j\right)}}_{\text{Extensive Margin 2}} + \underbrace{\rho_{d,X}\frac{sd\left(\ln d_j\right)}{sd\left(\ln X_j\right)}}_{\text{Extensive Margin 3}} + \underbrace{\rho_{\tilde{x},X}\frac{sd\left(\ln \tilde{x}_j\right)}{sd\left(\ln X_j\right)}}_{\text{Intensive Margin}} = 1, \tag{36}$$

where $\rho_{Z,X}$ is the sample correlation between $\ln(Z)$ and $\ln(X)$.

The results for this decomposition for the period 2000-2007 are reported in Table 11. These results reveal that most of the variation in Mexican trade across export markets is due to the extensive margins of number of firms that export and number of products that are traded. In total, the intensive margin accounts for (roughly) 40% of the overall cross-sectional variation in trade in any given year. This figure is higher than the contribution of the intensive margin found by Bernard et al. [2009] for U.S. trade. These authors find that the intensive margin accounts for 28% of the overall variation in U.S. trade.

3.2 The Concentration of Trade: The Distribution of Exports across Exporting Firms

The previous section focused on the implications of the framework presented in section 2 for the distribution of exports across export destinations. In this section I focus on the distribution of exports across exporting firms. In section 2 it was made clear that the concentration of exports across exporting firms depends on the distribution of productivity across these firms. In particular, we know that more productive firms will serve a higher expected number of export destinations, export a higher share of their product range in any given destination, and export larger volumes globally, in any given market they serve, and for any given product in any given market. Given a distribution $G(\varphi)$ for "core" productivity φ, the model makes strong predictions for the probability that a given product will be sold to a given market[27] and the share of total exports that are concentrated in firms of differing productivity.

The distribution of firm-level productivity is not only important to enhance the predictive power of the model regarding export participation and export volumes but, more importantly, can be germane to the evaluation of the welfare gains associated with trade liberalization. In recent work, Melitz and Redding [2015] argue that in models of heterogeneous firms the endogenous decision of firms to enter and exit the domestic and export markets can be an important margin of adjustment that is necessary to assess the welfare gains from trade. This stands in stark contrast to the sufficient statistics approach of Arkolakis et al. [2012] -henceforth ACR- who showed that for a wide class of heterogeneous and homogeneous firm models, the welfare gains from trade could be evaluated with two simple statistics available from aggregate data: a country's domestic trade share and the elasticity of trade with respect to variable trade costs. Melitz and Redding show that the existence of a single constant trade elasticity and its sufficiency property for welfare are highly sensitive to small departures from the restrictions that make their model fall under the purview of the ACR framework. In particular, one of the key restrictions that have to be imposed on their model for it to belong to the ACR class is that firm productivity φ must be drawn from an untruncated Pareto distribution. They show that even small departures from this functional form for the distribution of firm productivity implies a variable trade elasticity that differs across markets and levels of trade costs.[28] In this case, the trade share and the (endogenous) trade elasticity are no longer

[27] That is, if N is the set of firms active in the export market and P is the set of unique product categories exported, then the framework of section 2.2. together with the productivity distribution $G(\varphi)$ make strong predictions regarding the share of exporting firms that will be active in any of the $N \times P$ possible firm-product combinations.

[28] As Head et al. [2014] point out, a gravity equation with a constant trade elasticity is misspecified under any

sufficient statistics for welfare: when firm-level productivity is not distributed according to an untruncated Pareto the micro-structure matters for the evaluation of the welfare gains from trade.[29]

While firm productivity φ is unobservable, we can infer something about the distribution $G(\varphi)$ by studying the distribution of exports and export participation across firms. In contrast to the previous section, all the results reported in this section include the full set of destinations for Mexican exports.[30] Table 12 presents the distribution of exporting firms according to the number of products and destinations they serve. Table 12a presents the distribution by the share of firms in each category, while Table 12b presents the distribution by share of export value. The main message behind Table 12 is that exports are highly concentrated and that multi-product, multi-destination firms dominate Mexican trade: 4.3% of exporting firms account for nearly 50% of Mexican exports.[31] In particular, it appears that being multi-product rather than multi-destination is what is particularly important: multi-product firms account for 98% of Mexican exports versus 60% accounted for by multi-destination exporters. These results confirm those found for the U.S. by Bernard et al. [2007]: exports value is very highly concentrated in a small number of multi-product, multi-destination firms.

Regarding the concentration of trade across firms, Armenter and Koren [2014] use U.S. trade data for 2000 to document three key empirical regularities which form the basis of the calibration of their random assignment model of international trade: 1. 42% of firms are single product firms and these firms account for 0.4% of exports; 2. 64% of firms are single-destination firms and these firms account for 3.3% of exports, and 3. 40% of firms are single-product single-destination and these firms account for 0.2% of total exports. In contrast to these numbers, Mexican exports are more concentrated in terms of numbers of exporters, with higher proportions of single-destination, single-product and single-destination single-product firms. In particular, the fraction of single-destination exporters in Mexico is higher than that in the U.S. However, it is particularly noteworthy, that single-destination firms account for a much larger volume of trade in Mexico as compared to the U.S. Single-destination single-product

distribution other than Pareto.

[29] In particular, Melitz and Redding [2015] show that when the distribution of firm productivity is not an untruncated Pareto distribution the welfare gains from trade depend on the differences in the hazard rates of the distribution of log firm sizes between the domestic and export markets and the response of firm entry to changes in trade costs.

[30] Recall that previous results excluded the U.S. and Canada given that the extremely large share they command in Mexican exports would have hindered a visual representation of the relationship between the barriers to trade and different margins of export participation as depicted in Figures 1 to 6.

[31] In fact, the single biggest exporter accounts for 8.8% of all Mexican trade and the top 10 exporters account for nearly 30% of Mexican trade.

	No. destinations					
No. products	1	2	3	4	+5	All
1	49	2	0.5	0.3	0.4	52.2
2	12.2	2.6	0.6	0.3	0.5	16.2
3	5.6	1.5	0.6	0.3	0.4	8.4
4	3.2	0.9	0.4	0.2	0.4	5.1
+5	9	2.4	1.4	1	4.3	18.1
All	79	9.4	3.5	2.1	6	100

(a) Distribution by Share of Exporting Firms

	No. destinations					
No. products	1	2	3	4	+5	All
1	1.7	0.2	0.1	0.1	0.2	2.3
2	1.4	0.2	0.1	0.1	0.4	2.2
3	1.7	0.3	0.1	0.1	0.3	2.5
4	1.4	0.3	0.1	0.1	0.5	2.4
+5	32.7	5.6	3	1.7	47.6	90.6
All	38.9	6.6	3.4	2.1	49	100

(b) Distribution by Share of Export Value

Source: Author's own calculations using firm-level export data from the World Bank's *Exporter Dynamics Database.*

Table 12: Distribution of Exports Across Exporting Firms (2000)

firms also have a higher participation in Mexican total exports than they do in the U.S. This difference is likely due to the prominence of the U.S. as an export destination for Mexican firms. As was noted earlier, nearly all exporters active in any given year are active in the U.S. and average exports per firm per product are higher in the U.S. than in the rest of the world. Thus, single-destination single-product firms and single-destination firms in Mexico can have a high participation in total exports because, more likely than not, their export destination will be the U.S. into which they ship above average volumes of trade.

According to the framework of section 2, this pattern of concentration can be explained by an extremely unequal distribution of productivity across firms that leads to an unequal distribution of exports and export participation across firms as higher productivity firms penetrate more markets, do so with more products, and export more of any given product to any given destination. In light of the framework of section 2.1, Table 12 is highly suggestive of the fact that the underlying distribution of firm productivity is very skewed. In what follows I delve deeper into the shape of the distribution of export sales and export participation that, under the CES demand structure assumed in section 2.1, is tightly connected to the distribution of firm productivity $G(\varphi)$.

3.2.1 The Size Distribution of Exporters

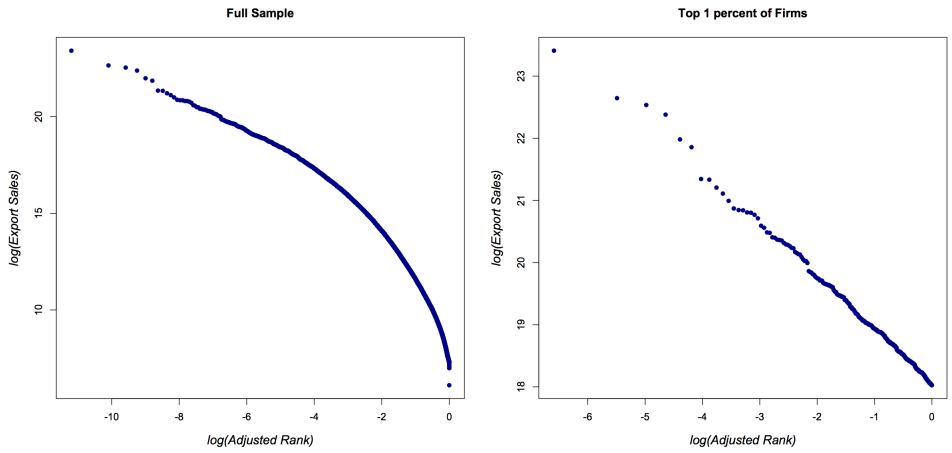
In this section I document the distribution of exports and export participation across firms by looking at the entire distribution of: export sales across firms, number of transactions per firm, number of products exported per firm, and the number of destinations served per firm.[32] For each measure of export participation (sales, number of transactions, number of products, and number of destinations) I construct the "size" distribution amongst exporters as the log-log graph of the counter-cumulative distribution $\log \Pr(\text{Size} > x)$ vs $\log(x)$, where "size" is one of the four previous measures of export participation. Plotting the counter-cumulative distribution means that the $y-$axis will be a measure of "size" plotted against the fraction of firms with at least that "size" along the $x-$axis.

Following Gabaix and Ibragimov [2012], I define for each firm i its "adjusted rank" as

$$R_i = \frac{\text{Rank}_i - 0.5}{N - 0.5}, \tag{37}$$

where N is the total number of firms, and Rank_i is the ranking of firm i in a ranking of "size"

[32] A transaction is defined as recording positive exports for a country-product pair at the firm-level.



Source: Author's own calculations using firm-level export data from the World Bank's *Exporter Dynamics Database.*

Figure 8: Exporter Size Distribution: Sales

from largest (rank 1) to smallest (rank N) (i.e. firms are ordered as $\text{Size}_{(1)} \geq \text{Size}_{(2)} \geq \ldots \geq \text{Size}_{(N)}$). Notice that $R_i \simeq 0$ if $\text{Rank}_i = 1$ (and N is large), and $R_i = 1$ iff $\text{Rank}_i = N$. Thus, R_i roughly corresponds to the fraction of firms of "size" at least as large as firm i.[33]

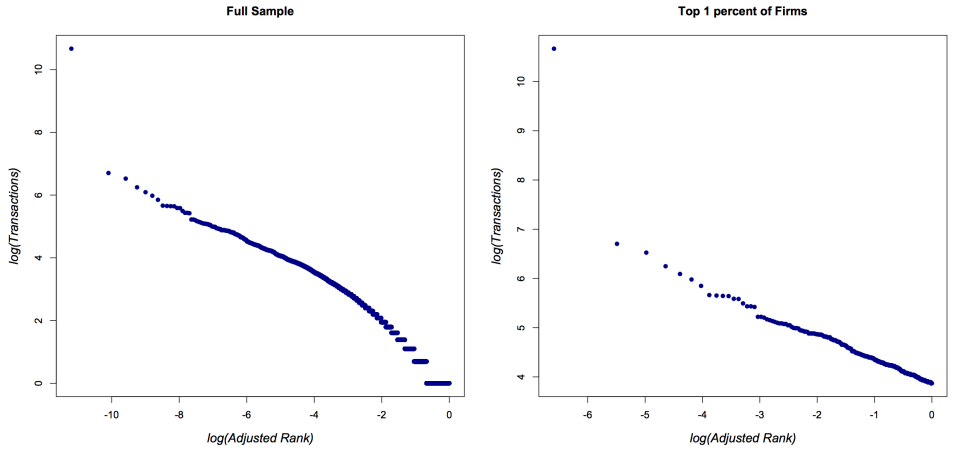
Figures 8 through 11 show the size distribution for these different measures of firm "size" in export markets by plotting $\log(\text{Size})$ on the $y-$axis and $\log(\text{Adjusted Rank})$ on the $x-$axis. Additionally, Figures 12 through 15 present the distribution of export sales in four of Mexico's top export destinations. For brevity, I report results using 2000 data, but note that results for other years are similar. The left-hand panel of each figure presents the "size" distribution for the full sample, while the right-hand panel presents the distribution for the top one percent of firms (top 10 in the case of the distribution in specific export markets).

By plotting the "size" distribution for different measures of size related to firm participation in export markets, and by doing so in individual export destinations, a remarkable similarity emerges: the basic shape is common for size distributions. In particular, at the tail end of the distribution the relationship between $\log(\text{Size})$ and $\log(\text{Rank})$ is almost linear. The fact that the distribution of export sales for the top firms is nearly linear suggests that in the upper tail sales are distributed approximately Pareto.[34]

The literature has made extensive use of the Pareto distribution as the parametric form for

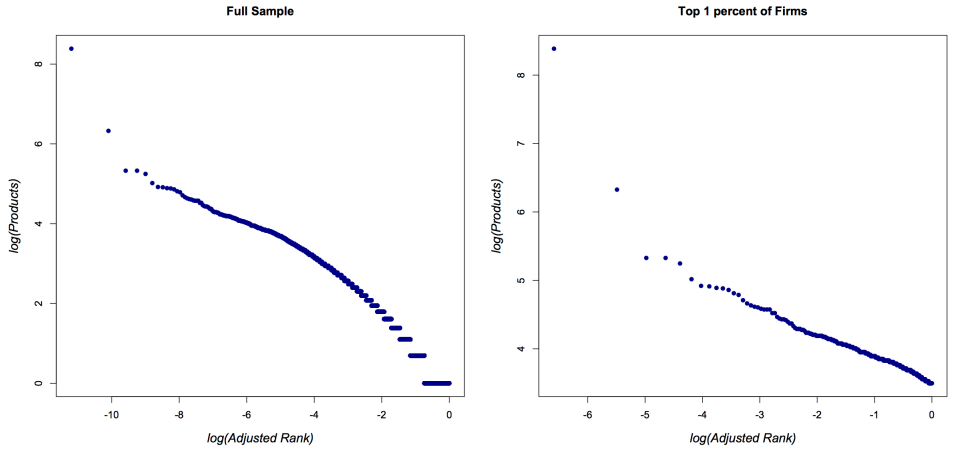
[33]Gabaix and Ibragimov [2012] propose this approach as a simple practical remedy for the bias present in OLS estimates of the tail exponent of the firm size distribution under the standard approach followed by most of the literature of to that point.

[34]See Gabaix [2009] for further details regarding the role of the Pareto distribution in the "size distribution" literature.



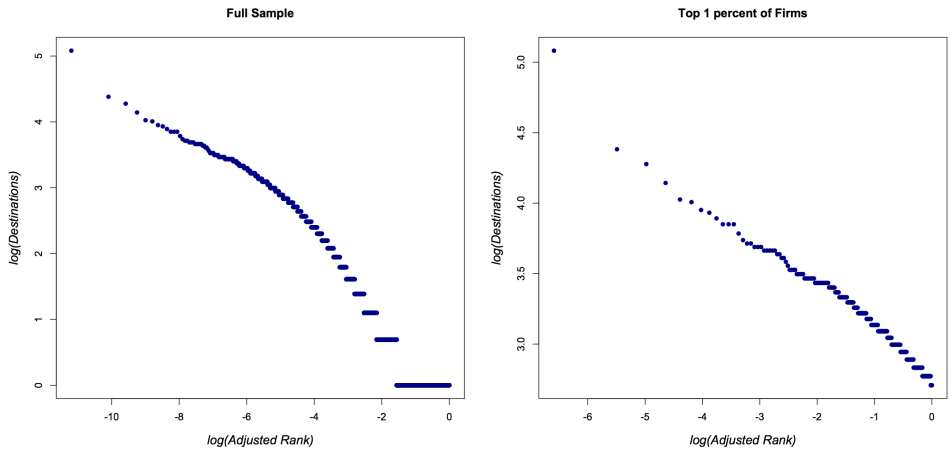
Source: Author's own calculations using firm-level export data from the World Bank's *Exporter Dynamics Database.*

Figure 9: Exporter Size Distribution: No. of Transaction



Source: Author's own calculations using firm-level export data from the World Bank's *Exporter Dynamics Database.*

Figure 10: Exporter Size Distribution: No. of Products



Source: Author's own calculations using firm-level export data from the World Bank's *Exporter Dynamics Database.*

Figure 11: Exporter Size Distribution: No. of Destinations

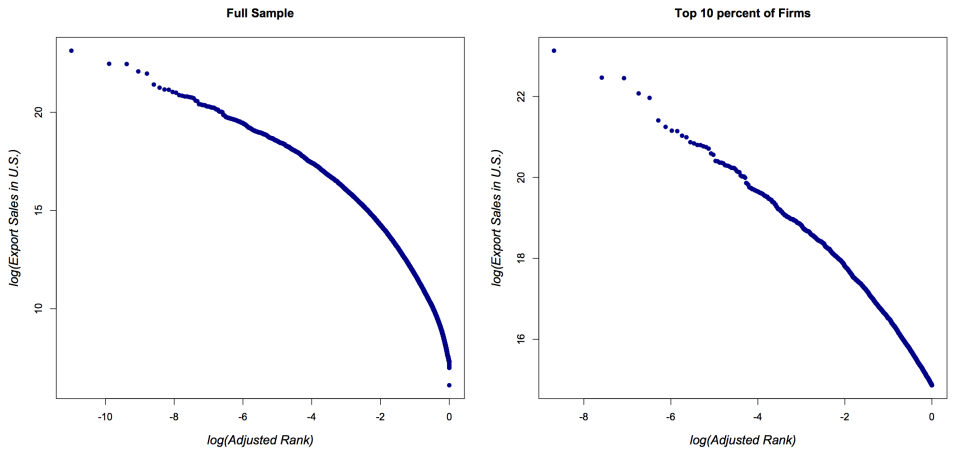
the underlying distribution of productivity across firms (see, for example, Melitz [2003] and Bernard et al. [2011]). The reason for this is three-fold: (i) it provides a reasonable approximation for the right tail of the observed distribution of firm sizes; (ii) it is consistent with simple stochastic processes for firm-level growth, entry and exit (see Simon and Bonini [1958] and Luttmer [2007]), and (iii) the Pareto distribution conveys some "scale-free" properties that are useful to provide analytical results in heterogeneous firms models. Given the CES demand structure assumed in section 2 and the assumption of a Pareto productivity distribution with tail exponent ζ, the distribution of sales is also Pareto with tail exponent $\zeta^* = \zeta/(\sigma - 1)$ where $\sigma > 1$ is the elasticity of substitution. Luttmer [2007] proved this result for the case of a closed economy and Impullitti et al. [2013] show that, despite the effects that selection into and out of exporting can have on the sales distribution, this result extends to the case of an open economy for the distribution of export sales.

Following Gabaix and Ibragimov [2012] I run the OLS log-log rank regression

$$\log(R_i) = a - b\log(\text{Size}_i) \tag{38}$$

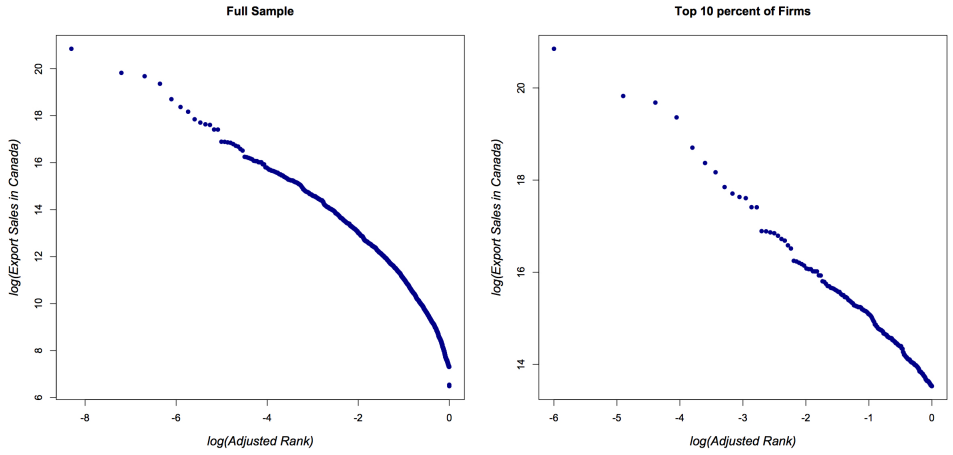
to obtain an estimate for the tail exponent of the firm size distribution using export sales as the measure of firm size. I run the log-log rank regression including all firms and including only the top 1000 firms. Table 13 presents the results. As can be seen, the parameter estimates are relatively stable over time.[35] The results in Table 13 also suggest that the description of

[35] Similar results hold for the years omitted from Table 13.



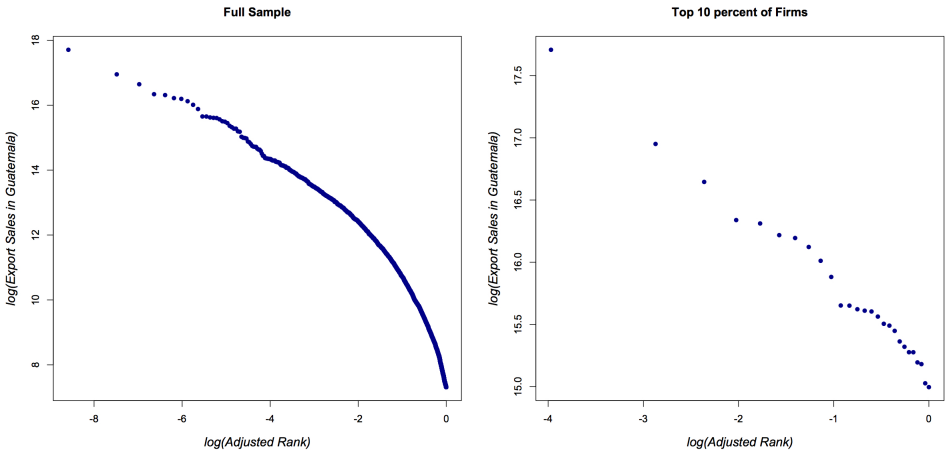
Source: Author's own calculations using firm-level export data from the World Bank's *Exporter Dynamics Database.*

Figure 12: Exporter Size Distribution: U.S.



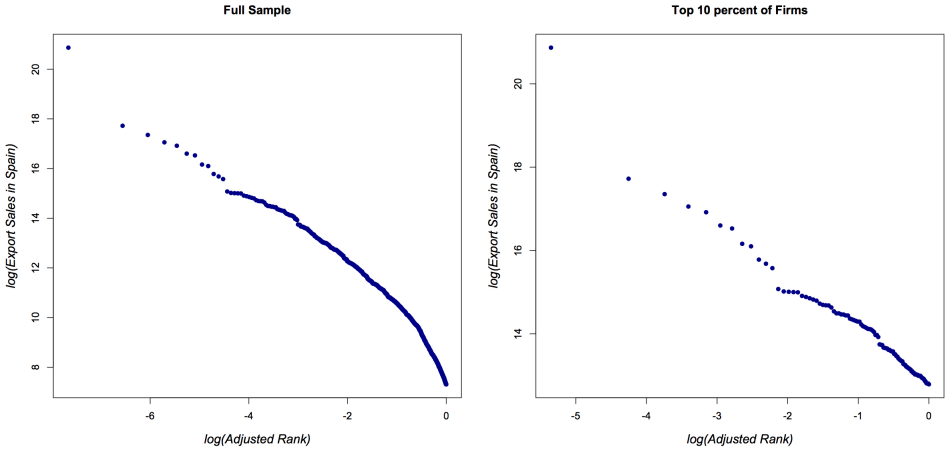
Source: Author's own calculations using firm-level export data from the World Bank's *Exporter Dynamics Database.*

Figure 13: Exporter Size Distribution: Canada



Source: Author's own calculations using firm-level export data from the World Bank's *Exporter Dynamics Database.*

Figure 14: Exporter Size Distribution: Guatemala



Source: Author's own calculations using firm-level export data from the World Bank's *Exporter Dynamics Database.*

Figure 15: Exporter Size Distribution: Spain

	$\hat{a}$	$\hat{b}$	R^2
All Firms (2000)	-2.61^{***} (0.003)	0.378 (0.001)	0.93
Top 1000 (2000)	-1.87^{***} (0.004)	1.02^{***} (0.003)	0.99
All Firms (2004)	-2.49^{***} (0.004)	0.31^{***} (0.001)	0.86
Top 1000 (2004)	-1.83^{***} (0.006)	1.02^{***} (0.004)	0.98
All Firms (2007)	-2.48^{***} (0.004)	0.29^{***} (0.001)	0.84
Top 1000 (2007)	-1.92^{***} (0.004)	1.01^{***} (0.003)	0.99

Standard Errors in Parentheses. '***' denotes significance at the 0.1% level.

Source: Author's own calculations using firm-level export data from the World Bank's *Exporter Dynamics Database.*

Table 13: Estimation of Tail Exponent for Size Distribution of Exporters

the sales distribution as a power law[36] is a better description of the data at the tail end of the distribution than for the full sample. It is also interesting to notice that the tail exponent for the distribution at the upper tail is nearly unity, which implies that the distribution of export sales for the top exporters satisfies Zipf's Law (see Gabaix [2009]).

Despite the approximately linear relationship between $\log(\text{Size})$ and $\log(\text{Rank})$ at the tail end of the distribution, Figures 8 through 15 show that once we consider the distribution of sales across all active exporters there is a noticeable curvature in this relationship. This deviation at the lower end of the distribution from the linear relationship predicted by a Pareto distribution implies that firms at the lower end of the distribution are larger than what would be predicted by

$$\log(\text{Size}_i) = \frac{\hat{a}}{\hat{b}} - \frac{1}{\hat{b}}\log(R_i), \tag{39}$$

where $(\hat{a}, \hat{b})$ are the estimates from Table 13. This result was also found by Eaton et al. [2011] for the distribution of export sales of French firms.[37]

Although productivity is not estimated directly, these results regarding the 'size' distribution of firms is highly suggestive of the shape of the underlying productivity distribution, at least as seen through the lens of the model presented in section 2.1. Thus, as was mentioned earlier, deviations from a Pareto productivity distribution can have practical implications for obtaining estimates of the welfare gains from trade. The most commonly used alternative to the Pareto distribution is the log-Normal distribution that maintains some of the desirable

[36] That is, that $\Pr(\text{Size} > x) \simeq ax^{-b}$, where b is the power law or tail exponent.

[37] Ijiri and Simon [1974] find a similar result for the size distribution of the top 831 industrial firms in the *Fortune* data for 1969.

analytic features of the Pareto, can be generated under equally plausible stochastic processes for firm growth (see Eeckhout [2004]), and provides a better fit to the complete distribution of firm sales rather than just approximating the right tail. Head et al. [2014] show that assuming log-Normality for the distribution of firm-level productivities rather than Pareto can have important consequences for the evaluation of welfare gains from trade. In particular, they show that the share of firms that enter successfully into exporting affects the gains from trade in the log-normal case, but not in the Pareto one. That is, they show that it is not only the behavior in the right tail of the productivity distribution that matters for welfare. This is consistent with the argument in Melitz and Redding [2015]. In the appendix it is shown that log-Normality provides a reasonable approximation to the complete distribution of export sales in the Mexican data, which suggests that log-Normality may be a good approximation to the underlying productivity distribution shaping firm heterogeneity in the economy.

The evidence presented in this section can be interpreted as saying that the distribution of export sales across firms is best described as a distribution that seems to be log-Normal over a broad range, but changes to a power-law (Pareto) distribution for the last few percentiles.[38] This is consistent with the results of Head et al. [2014] who, using data on French exporting firms, find that the log-normal distribution can explain 99.9% of the variation in the empirical quantiles of the sales distribution of exporters, compared to 80% for Pareto.[39] It is only far out in the upper tail of the sales distribution that Pareto provides a better account of the empirical distribution. A similar result is found by Armenter and Koren [2014] for the size distribution of export sales of U.S. firms.

3.2.2 Accounting for the Variation of Exports across Firms

The framework of section 2 not only made predictions regarding the distribution of aggregate exports across firms, but it also provided a framework to understand how each firm's export presence is mediated through the various adjustment margins at its disposal: the number of destinations reached, the number of products exported, and the intensity of each trade relationship the firms is engaged in. In this subsection I quantify the contribution of each of the firm's margins of adjustment in explaining the cross-sectional variation of exports across

[38] Bee et al. [2011] provide support to the theory that distributions with log-normal bodies and Pareto tails can be generated as mixtures of log-normally distributed units.

[39] Similar results were found by Bee et al. [2017] using French firm-level data. These authors reject the Pareto hypothesis for the entire firm size distribution and find that the lognormal distribution provides a good first approximation to the firm size distribution for single-product firms, but that overall the size distribution of firms largely depends on the diversification patterns of firms.

	Destinations	Products	Intensive
2000	9.9%	23.30%	66.80%
2001	10.25%	23.79%	65.96%
2002	10.63%	23.98%	65.39%
2003	10.28%	23.07%	66.65%
2004	9.18%	20.33	70.49%
2005	9.08%	20.20%	70.72%
2006	9.32%	20.09%	70.59%
2007	9.74%	20.60%	69.66%

Source: Author's own calculations using firm-level export data from the World Bank's *Exporter Dynamics Database.*

Table 14: Decomposition of Mexican Exports across Exporting Firms

firms. Total firm exports can be expressed as

$$\ln X_f = \ln M_f + \ln d_f + \ln \hat{x}_f, \tag{40}$$

where X_f are firm $f's$ exports, M_f is the number of products exported by the firm, d_f is the number of destinations reached by the firm and $\hat{x}_f$ are average exports per product per destination. I quantify the contribution of each margin of adjustment according to the decomposition:

$$\underbrace{\rho_{M,X}\frac{sd\left(\ln M_f\right)}{sd\left(\ln X_f\right)}}_{\text{Destinations}} + \underbrace{\rho_{d,X}\frac{sd\left(\ln d_f\right)}{sd\left(\ln X_f\right)}}_{\text{Products}} + \underbrace{\rho_{\hat{x},X}\frac{sd\left(\ln \hat{x}_f\right)}{sd\left(\ln X_f\right)}}_{\text{Intensive Margin}} = 1, \tag{41}$$

where $\rho_{Z,X}$ is the sample correlation between $\ln(Z)$ and $\ln(X)$.

Table 14 reports the results for the period 2000-2007. The results show that it is the intensive margin that explains most of the variation in exports sales across firms, accounting for roughly 68% of the observed variation. This result suggests that it is the fact that more productive firms export more of any given product to any given destination what drives the distribution of export sales across firms, rather than the fact that more productive firms export to more countries and export larger shares of their product range. In terms of the extensive margin, it is the variation in number of products what explains more of the variation in export sales rather than the variation in destinations reached.

4 Heterogeneous Firms and Export Dynamics

The previous section explored the firm-level export data along the lines outlined in section 2. It was found that the cross-sectional distribution of Mexican exports across destinations and firms is largely consistent with the heterogeneous firm multi-product multi-destination framework of section 2. In this section I contrast the implications of the dynamic framework presented in section 2, for both firm-level dynamics and aggregate patterns, against the Mexican firm level data for the period 2000-2007. A particular focus of this section is in establishing the patterns that characterize the foreign market evolution of new export entrants.

I begin this section with a simple exercise that decomposes aggregate export growth into intensive and extensive margins of trade along the lines of the decompositions considered in section 3. To this end, let X_t denote the total value of exports in year t, N_t the number of exporters active in year t, M_t the total number of products exported in year t, and let $\hat{x}_t$ denote the average value of exports per product per firm. In this case total exports can be expressed as $X_t = N_t M_t \hat{x}_t$, which forms the basis of the decomposition

$$\%\Delta\text{Value of Exports} = \underbrace{\%\Delta\text{No. of Firms}}_{\text{Extensive Margin 1}} + \underbrace{\%\Delta\text{No. of Products}}_{\text{Extensive Margin 2}} + \underbrace{\%\Delta\text{Average Export Scale}}_{\text{Intensive Margin}}, \tag{42}$$

so that the time-series variation in aggregate exports is accounted for by an extensive margin related to firm participation, an extensive margin related to the number of products being exported, and an intensive margin related to the scale of firm-product export volumes.

Table 15 reports the results of this decomposition and shows that the intensive margin (i.e. expansions in average exporter size per product) is typically more important for export growth than variations in the number of active exporters or changes in the number of products that are being exported, at least in the short-run. It can also be seen that, during the reference period, the intensive margin of trade always makes a positive contribution to aggregate export growth, while the extensive margins of number of active exporters and number of exported products can make either positive or negative contributions to aggregate export growth. The results in Table 15 also show that in the long-run it is also the intensive margin of trade which is more important in accounting for aggregate export growth. The importance of the intensive margin in accounting for the time-series variation in aggregate exports stands in contrast to the results of the previous section, where it was found that the cross-sectional variation of Mexican exports was mostly accounted for by the extensive margin of trade.

$t-1/t$	Export Growth	Firms	Products	Intensive
2000/2001	-6.25%	64.3%	-5.46%	41.16%
2001/2002	3.15%	-235.9%	115.8%	220.1%
2002/2003	2.28%	-176%	-185.4%	461.4%
2003/2004	13.31%	85.9%	-1.8%	15.9%
2004/2005	13.04%	48.5%	4.6%	46.9%
2005/2006	15.38%	-22.2%	-3.7%	125.9%
2006/2007	8.41%	-5.7%	46.7%	59%
2000/2004	12.43%	-30%	-3%	133%
2003/2007	50.12%	27.6%	7.4%	65%
2000/2007	49.21%	-2.7%	7.2%	95.5%

Columns 3-5 sum to one hundred percent as they represent each margin's share in explaining column 2.

Source: Author's own calculations using firm-level export data from the World Bank's *Exporter Dynamics Database.*

Table 15: Decomposition of Export Growth

While the results reported in Table 15 may be of interest in their own right, they do not speak directly to the predictions and implications of the dynamic framework outlined in section 2. In what follows I explore the time-series dimension of the firm-level data along the lines of the benchmark dynamic model of section 2. In this regard I begin by studying aggregate entry, exit, and survival patterns, since an important motivation to extend the static framework of section 2 into a dynamic setting was to understand the time-series variation in the export market presence of firms. Table 16 presents the number of exporting firms per year and the entry, exit, and survival rates according to the following definition: at time t I label firms as

$$
\begin{aligned}
EXP_t &: \text{ any firm that exports in year } t \\
ENTER_t &: \text{ a firm that does not export in year } t-1 \text{ but exports in year } t \\
EXIT_t &: \text{ a firm that exports in year } t-1 \text{ but does not export in year } t \\
CONTINUE_t &: \text{ a firm that exports in both years } t-1 \text{ and } t \\
SURV_t &: \text{ a firm that does not export in year } t-1 \text{ but exports in both years } t \text{ and } t+1,
\end{aligned}
$$

and from this classification of firms I define the entry, exit, and survival rates as

$$
\begin{aligned}
\text{Entry Rate}_t &= \frac{\#ENTER_t}{\#EXP_t} \\
\text{Exit Rate}_t &= \frac{\#EXIT_t}{\#EXP_{t-1}} \\
\text{Survival Rate}_t &= \frac{\#SURV_t}{\#ENTER_t}.
\end{aligned}
$$

	2000	2001	2002	2003	2004	2005	2006	2007
No. of Exporters	36,400	34,975	32,506	31,271	35,068	37,345	36,086	35,915
Entry Rate	-	38.2%	37.2%	36.5%	42.2%	39%	35.8%	36.5%
Exit Rate	-	40.6%	41.6%	38.9%	35.2%	35.1%	38%	36.8%
Survival Rate	-	35.2%	37.5%	41.8%	43.7%	37.3%	36.5%	-

Source: Author's own calculations using firm-level export data from the World Bank's *Exporter Dynamics Database.*

Table 16: Entry, Exit and Survival Rates

Table 16 shows that the number of exporting firms is relatively stable over the sample period, as are the entry, exit, and survival rates of exporters. Notice, however, that there is a slight increase in these numbers starting in 2004. This coincides with a phasing in of tariff reductions with other NAFTA members. Thus, the higher average number of firms, higher average entry rate, higher average survival rates and lower average exit rates post 2004 could be interpreted as the result of a transition to a new steady state with lower trade barriers.

The second important prediction of the framework of section 2 regarding aggregate patterns is that "continuing" firms should account for most of total exports in any given year and for most of the year-to-year variation. Entering firms should account for a higher share of exports than exiting firms, and both should be expected to export less than incumbent exporters. To this end, I now classify the set of firms active in the export market according to the following three year definition: *continuing* firms in t are those that exported in $t-1$, t, and $t+1$; *entering firms* in t are those that did not export in $t-1$, and did export in t and $t+1$; *exiting firms* in t are those that exported in $t-1$ and t, but not in $t+1$, and *single-year exporters* in t are those that exported in t, but not in $t-1$ nor in $t+1$. Notice that in this case "entering" firms are divided into two classes: those that maintain their export status after the initial export year (*entering firms*) and those that do not (*single-year exporters*). The framework of the previous section implies that single-year exporters should represent a relatively small fraction of all the firms that select into exporting at t given the presence of sunk entry costs and the persistence of the shocks faced by the firm.

Table 17 presents the share of exporting firms in each of the four categories described, while Table 18 presents the share in total exports commanded by each category. The share of firms in each category is relatively stable over time. In line with the predictions of section 2, continuing firms account for the largest share of exports in any given year and entering firms have a higher share in total exports than exiting firms. However, Tables 17 and 18 show that there is a surprisingly large number of firms that select into exporting, export a small volume and immediately exit from exporting. This large number of single-year firms that enter only

Year	Entering	Continuing	Exiting	Single-Year
2001	13.46	44.90	16.91	24.73
2002	13.97	47.14	15.65	23.24
2003	15.24	49.55	13.97	21.24
2004	18.47	46.46	11.32	23.75
2005	14.57	47.47	13.49	24.47
2006	13.07	50.16	14.04	22.73

Source: Author's own calculations using firm-level export data from the World Bank's *Exporter Dynamics Database.*

Table 17: Share of Firms: Entering, Exiting, Continuing and Single-year Exporters

Year	Entering	Continuing	Exiting	Single-Year
2001	2.80	94	2.58	0.62
2002	3.39	95	1.40	0.21
2003	3.58	93.91	2.17	0.34
2004	2.85	95.39	1.58	0.18
2005	1.79	96.85	1.15	0.21
2006	1.60	97.22	0.96	0.22

Source: Author's own calculations using firm-level export data from the World Bank's *Exporter Dynamics Database.*

Table 18: Share of Exports: Entering, Exiting, Continuing and Single-year Exporters

to export a small amount is at odds with the predictions from section 2.

To understand how selection into and out of exporting shape total export growth I decompose total exports to reflect the contributions of continuing firms, entrants, and exiters. To this end, I define

$$\begin{aligned}
CN_{t,t+1} &= \text{firms that export in } t \text{ and } t+1 \ \text{(continuing firms)} \\
EX_{t,t+1} &= \text{firms that export in } t \text{ but not } t+1 \ \text{(exiting firms)} \\
EN_{t,t+1} &= \text{firms that export in } t+1 \text{ but not } t \ \text{(entering firms)} \\
NEX_{t,t+1} &= \text{number of exiting firms} \\
NEN_{t,t+1} &= \text{number of entering firms.}
\end{aligned}$$

	Export Growth	Continuers	Entering Firms		Exiting Firms	
			Added Firms	Exports rel. to Average	Dropped Firms	Exports rel. to Average
2001	-6.25	86.87	-605.82	552.79	670.45	-604.29
2002	3.15	84.01	1081.86	-965.68	-1302.68	1202.49
2003	2.28	-3.78	1519.01	-1345.58	-1683.47	1613.84
2004	13.31	93.33	335.79	-311.34	-249.68	231.88
2005	13.04	96.28	297.88	-281.52	-251.35	238.69
2006	15.38	95.49	207.62	-194.91	-227.86	219.66
2007	8.41	80.48	413.27	-380.35	-418.67	405.25

Source: Author's own calculations using firm-level export data from the World Bank's *Exporter Dynamics Database.*

Table 19: Contribution of Continuing, Exiting, and Entering Firms to Export Growth

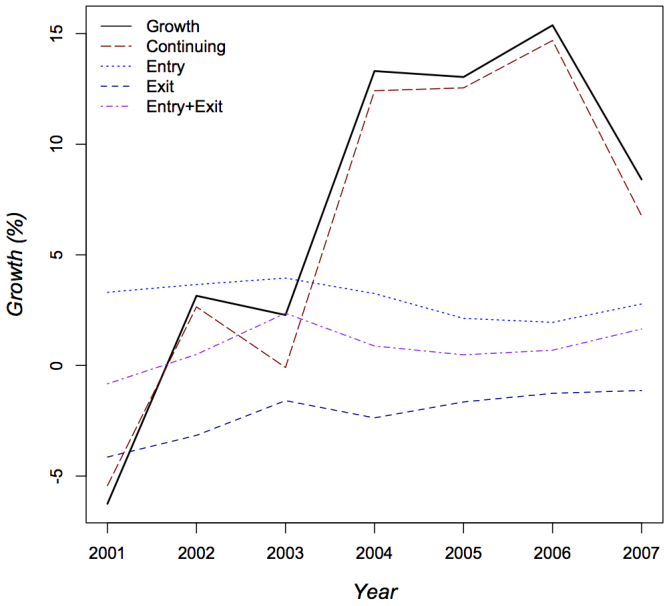
Using these definitions I can decompose export growth as

$$\begin{aligned}\frac{X_{t+1}-X_t}{(X_t+X_{t+1})/2} &= \underbrace{\left(\frac{\sum_{j\in CN_{t,t+1}}\left[X_{jt}+X_{jt+1}\right]/2}{(X_t+X_{t+1})/2}\right)\left(\frac{\sum_{j\in CN_{t,t+1}}\left[X_{jt+1}-X_{jt}\right]}{\sum_{j\in CN_{t,t+1}}\left[X_{jt}+X_{jt+1}\right]/2}\right)}_{=\text{Contribution of Continuing Firms}} \\ &\quad \underbrace{+\frac{NEN_{t,t+1}\bar{x}_t}{(X_t+X_{t+1})/2}+\frac{\sum_{j\in EN_{t,t+1}}\left[X_{jt+1}-\bar{x}_t\right]}{(X_t+X_{t+1})/2}}_{=\text{Contribution of Entering Firms}} \\ &\quad \underbrace{-\frac{NEX_{t,t+1}\bar{x}_t}{(X_t+X_{t+1})/2}-\frac{\sum_{j\in EX_{t,t+1}}\left[X_{jt}-\bar{x}_t\right]}{(X_t+X_{t+1})/2}}_{=\text{Contribution of Exiting Firms}},\end{aligned}$$

where $\bar{x}_t$ denotes average firm exports in year t.

The contribution of continuing firms is equal to their share in exports over the two years active times the growth in their sales over those two years. The contribution of entering firms can be decomposed into two terms: the growth in exports implied by the increase in the number of firms if they had the same size as the average firm the previous period, and the difference between the exports of entrants and those of the average firm the previous period. The contribution of exiting firms can be decomposed into two terms in a similar fashion.

Table 19 and Figure 16 present the growth of aggregate exports and the percentage contribution to growth of total exports of each of the terms in the decomposition above. It is easily seen that, in line with the predictions of section 2, continuing firms account for most of the year-to-year variation in total exports. Entry makes a positive contribution to export growth, exit makes a negative contribution to export growth, but in total entry and exit have only a



Source: Author's own calculations using firm-level export data from the World Bank's *Exporter Dynamics Database.*

Figure 16: Decomposing Export Growth: Continuing, Entering, and Exiting Firms

modest effect on the year-to-year variations in total exports.

Column 4 in Table 19 shows that the contribution of entering firms to export growth arising from the difference between their exports and those of the average firm the previous period is negative, while column 6 shows that the contribution of exiting firms to export growth arising from the difference between their exports and those of the average firm the previous period is positive. This is consistent with the prediction of section 2 that both entering and exiting firms have export volumes that are smaller than the average exports of incumbent exporters.

The results presented in Tables 16 through 19 and Figure 16 concerning aggregate export patterns are largely consistent with the predictions of the framework for export dynamics presented in section 2 and consistent with the findings of Eaton et al. [2008] for Colombian firm-level data. However, in contrast to the predictions of section 2 the data shows that *single-year exporters* constitute a large fraction of the firms selecting into exporting any given year. These firms enter the export market, sell a small quantity, and immediately exit. This is at odds with the predictions of section 2 where the presence of sunk entry costs and the persistence of shocks implied that firms that select into exporting will expect to maintain their export status in the periods immediately following their initial entry into exporting.

This last feature of the Mexican firm-level data is also found by Eaton et al. for Colombian exporters. These authors find that in Colombia, single-year exporters represent a large share of the firms selecting into exporting any given year, but that they account for a small share of total exports. While this feature of the data is at odds with the sunk entry cost model of section 2, it is consistent with a strand of the literature that emphasizes firm experimentation in new markets. Firms experiment by exporting during brief periods of time and doing so at a small scale (see Rauch and Watson [2003] and Akhmetova and Maritonna [2013]). Experimentation may be motivated by the need to acquire information regarding the foreign market conditions faced by firms. For example, Cebreros [2016] finds that learning about the profitability of exporting to foreign markets is an important mechanism shaping the export dynamics of new export entrants. The option value associated with the acquisition of more precise information regarding foreign market conditions can lead to export entry, but many firms will immediately exit the export market upon receiving information that leads them to believe that they cannot profitably serve the foreign market.

4.1 Firm-Level Export Supply Dynamics

In section 2 the main prediction regarding the dynamics of firm-level export supply was that new exporters should exhibit high initial survival rates, with these rates declining over time, and an immediate adjustment to a full-scale of operation in the export market, with a gradual decrease in export sales as the positive shocks that led to export entry die over time. I now contrast these predictions against the data.

I begin by analyzing the evolution of cohorts of new exporters as they age in the export market. I assign a firm to cohort t if the first report of an export transaction by that firm over the period of study occurs in year t. I then track how cohort t evolves in the years following export entry. During the period 2001-2007, the typical cohort of new export entrants consisted of roughly 13,000 firms. Tables 20 and 21 present the results for the evolution of the fraction of the cohort that is active[40] and the share of the cohort in total exports. Differences across cohorts may be the result of entering into exporting in better (worse) than average years. However, the patterns do not vary substantially across cohorts.

Consistent with the finding on single-year exporters reported in Table 17, Table 20 shows that in every cohort of new export entrants there is a large fraction of entrants that do not maintain their export status in the year following export entry. However, the share in total exports of

[40] By considering the fraction of the initial cohort that is active at t, re-entry is not precluded.

	First year of report between 2001 and 2007						
Year	2001	2002	2003	2004	2005	2006	2007
2001	100	0	0	0	0	0	0
2002	35.24	100	0	0	0	0	0
2003	26.23	36.29	100	0	0	0	0
2004	23.75	29.44	34.90	100	0	0	0
2005	21.83	24.93	27.48	40.50	100	0	0
2006	18.96	21.32	22.78	29.94	34.37	100	0
2007	17.13	19.53	19.27	24.30	25.95	34.15	100

Source: Author's own calculations using firm-level export data from the World Bank's *Exporter Dynamics Database.*

Table 20: Fraction of Cohort Active by Initial Export Year Cohorts

	First year of report between 2001 and 2007						
Year	2001	2002	2003	2004	2005	2006	2007
2001	3.42	0	0	0	0	0	0
2002	5.55	3.50	0	0	0	0	0
2003	5.99	5.01	3.73	0	0	0	0
2004	6.06	5.02	5.97	2.88	0	0	0
2005	5.09	5.14	5.97	5.78	1.86	0	0
2006	4.14	4.72	5.74	6.16	3.35	1.70	0
2007	3.39	4.49	5.33	6.06	3.38	2.92	2.49

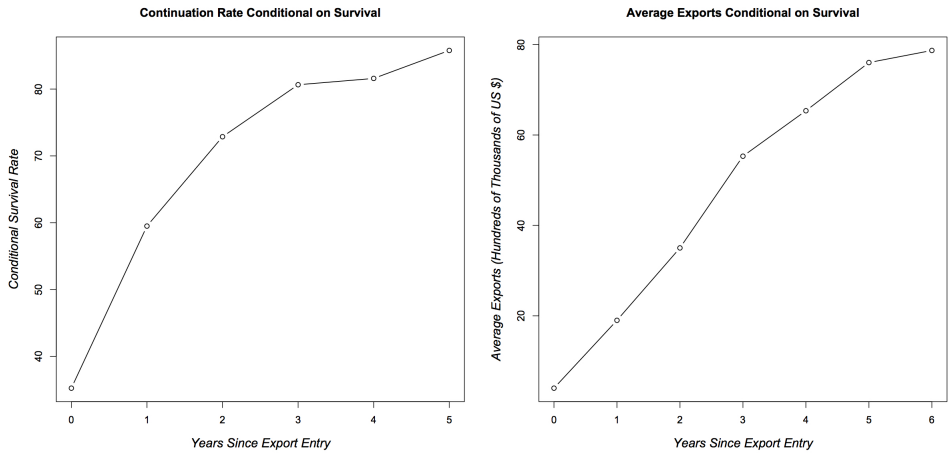
Source: Author's own calculations using firm-level export data from the World Bank's *Exporter Dynamics Database.*

Table 21: Share in Total Exports by Initial Export Year Cohorts (%)

surviving firms grows substantially between entry and the subsequent period as can be seen in Table 21. It can also be seen in Table 20 that there is a gradual thinning of the members of the cohort that are active in the export market, so that attrition from foreign markets continues well past the initial year.

Since Tables 20 and 21 do not control for re-entry into exporting by cohort members that had previously exited, Figure 17 presents the dynamics of new export entrants *conditional on survival*. For brevity I present results for the 2001 cohort, but note that the 2002-2005 cohorts display similar patterns. Figure 17 is strikingly at odds with the predictions of section 2 for the dynamics of firm-level export supply. In the data new export entrants have low initial survival rates that gradually grow over time and their exports also show a gradual increase as they gain experience in the export market. The patterns in the data for firm-level dynamics are exactly the opposite to what is predicted by the framework presented in section 2. This is consistent with the findings of Ruhl and Willis [2017] for Colombian firm-level data.

To see that the growth in average export sales depicted in Figure 17 is not entirely due to

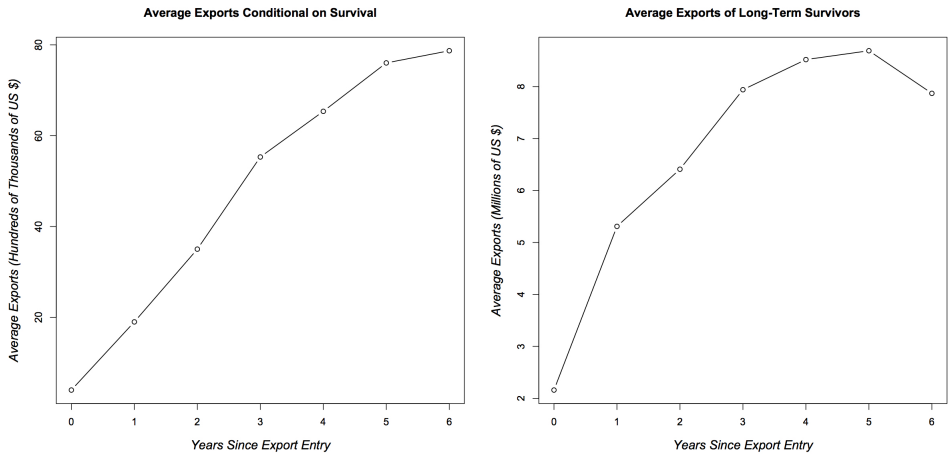


Source: Author's own calculations using firm-level export data from the World Bank's *Exporter Dynamics Database.*

Figure 17: New Exporter Dynamics: Survival and Growth (conditional on survival)

the effect of the selection out of exporting of smaller firms, Figure 18 presents the dynamics of average export sales for a subset of firms that maintained a continued export presence throughout the sample period (i.e. exported every year from 2001 through 2007). I dub this set of exporters "long-term survivors" and Figure 18 shows that even within this subset of firms there is gradual growth in export sales following export entry (for ease of comparison the relevant panel from Figure 17 is also presented in Figure 18). While the predictions of section 2 regarding aggregate patterns are largely confirmed in the data, at the firm-level the dynamics of export supply are strikingly at odds with the predictions of the sunk entry cost model of section 2.

As was noted earlier, the simple benchmark framework for the dynamics of export supply that was outlined in section 2 is not comprehensive of all the mechanisms and forces that may shape the dynamics of firm-level export supply. In particular, two mechanisms which are absent from the benchmark model and which are often mentioned as particularly important for young firms (exporters) are *credit constraints* and *learning about demand*. The former mechanism is studied by Kohn et al. [2016] using Chilean data, while the latter has been studied by Cebreros [2016] using Mexican data. While both mechanisms can account for the observed survival and growth patterns of new export entrants, neither can account fully for the dynamics of new exporters (see Albornoz et al. [2012] and Cebreros [2016]). Furthermore, an important distinction between these two mechanisms in terms of matching the patterns observed in the data is that the learning mechanism can generate the curvature observed in the relationships of Figure 17, while the estimated relationships in Kohn et al. are linear. While it



Source: Author's own calculations using firm-level export data from the World Bank's *Exporter Dynamics Database.*

Figure 18: Growth of New Export Entrants

seems that there is evidence to support that both these mechanisms play an important role in shaping the dynamics of new export entrants, more work is needed to determine the relative importance of these two forces in shaping the evolution of the foreign market presence of new export entrants.

4.2 The Rise of Multi-Product, Multi-Destination Firms

In the previous subsection it was shown that, in contrast to the predictions of section 2, firms undergo a gradual process of growth in the foreign market after export entry. In this section I focus on the evolution of new export entrants to understand how firms grow and develop their presence in foreign markets. The three-dimensional nature of the Mexican transaction-level data (covering two extensive margins and one intensive margin) allows me to provide a rich account of the transition of new export entrants as they undergo their process of internationalization. In particular, it allows me to shed light on the evolution of new export entrants into the kind of multi-product, multi-destination firms that dominate aggregate trade.

To emphasize the transition of firms from new export entrants into mature exporters I focus on the evolution of the set of "long-term survivors" from the 2001 cohort. By doing so I am able to abstract from the selection forces that influence cohort dynamics. For this set of exporters I ask: How did the extensive margins (number of products and number of destinations) and intensive margin evolve after export entry?

Table 22 presents results comparing the average long-term survivor against the average active

	2001	2002	2003	2004	2005	2006	2007
$\frac{\text{Average sales LR survivors}}{\text{Average sales cohort}}$	5.42	2.80	2.28	2.21	2.28	2.13	1.96
$\frac{\text{Average products LR survivors}}{\text{Average products cohort}}$	1.90	1.65	1.55	1.65	1.61	1.56	1.45
$\frac{\text{Average destinations LR survivors}}{\text{Average destinations cohort}}$	1.54	1.45	1.41	1.41	1.43	1.40	1.33

Source: Author's own calculations using firm-level export data from the World Bank's *Exporter Dynamics Database.*

Table 22: Long-run Survivors versus their Cohort

Average	2001	2002	2003	2004	2005	2006	2007
No. of Destinations	1.78	2.11	2.19	2.52	2.73	2.79	2.8
No. of Products	3.23	4.79	4.89	8.8	10.9	10.3	10.5
Sales*	2.16	5.31	6.41	7.94	8.52	8.69	7.87
Intensive	217,851	367,518	483,377	368,739	422,607	370,043	310,995
Growth Sales_1	-	84.6%	22.3%	13.1%	11.7%	4.7%	-18.9%
Growth Sales_2	-	57.9%	17.6%	12.9	11.2%	3.5%	-12.9%

* Millions of US dollars. Intensive = Sales per Destination per Product. Growth Sales_1 = $100 * (\ln X_{t+1} - \ln X_t)$. Growth Sales_2 = $100 * \left(\frac{X_{t+1}-X_t}{(X_{t+1}+X_t)/2}\right)$

Source: Author's own calculations using firm-level export data from the World Bank's *Exporter Dynamics Database.*

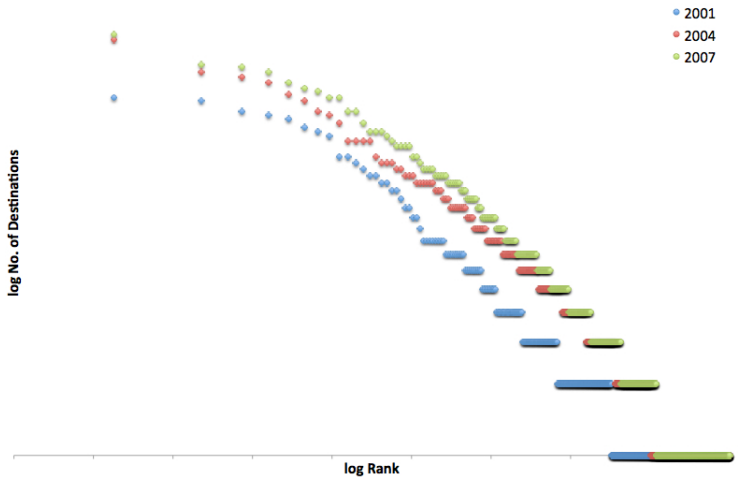
Table 23: Dynamics of Long-term Survivors

firm in the cohort for the duration of the sample period across a number of dimensions.[41] Table 22 shows that even after the strong selection of the first year has kicked in, long-term survivors are significantly bigger than other cohort members: their sales are always at least twice as big, they export to at least 30% more destinations, and they export at least 45% more products.

Table 23 presents the evolution of the 2001 cohort of long-term survivors. After surviving the first export year firms expand rapidly and continue to grow, albeit at decreasing rates. The growth rate in the first year after beginning to export is orders of magnitude greater than subsequent growth. Even if we exclude the first-year growth rate on account of partial year effects (see Bernard et al. [2014]) and consider 2002 as the first-full year of export activity, export growth between 2002 and 2003 is nearly twice that of the subsequent year.

In section 3 it was shown that aggregate exports are mostly accounted for by a relatively small number of multi-product multi-destination firms. Figures 19 and 20 show the evolution of the distributions of number of destinations reached and number of products exported for the group of "long-term" survivors. To visualize the results more clearly, only the distributions

[41] Long-term success in the export market is significantly related to size upon entry. A logistic regression for the outcome of becoming a long-term survivor, regressed on first-year sales, reveals that increasing first-year sales by one-standard deviation is associated with 20% better odds of becoming a long-term survivor.



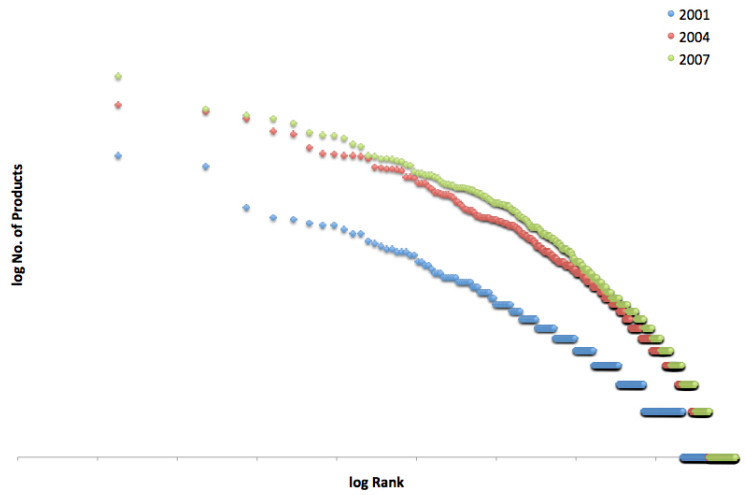
Source: Author's own calculations using firm-level export data from the World Bank's *Exporter Dynamics Database.*

Figure 19: Distribution of Number of Destinations for Long-Term Survivors

for 2001, 2004, and 2007 are plotted. However, the omitted distributions align neatly between the ones depicted and thus, to a first-approximation, the distribution of number of export destinations in $t+1$ first-order stochastically dominates the distribution of number of export destinations in t. The same is true for the distribution of number of products. That is, as long-term survivors gain experience in the export market it becomes increasingly likely that they will export more products and reach more destinations.

In 2001, 77% of exporters started their export experience by serving only one market, 15% started by serving 2 or 3 markets, and 8% started exporting with 4 or more destinations. These numbers are similar to those found by Albornoz et al. [2012] for first-time Argentinean exporters. Within the group of single-destination first-time exporters, 84% started their export experience by exporting to the US, 2% by exporting to Guatemala, and 1.7% by exporting to Canada. These numbers are consistent with findings elsewhere in the literature that find that firms that only serve a small number of export markets tend to sell to the most popular ones, with less popular export destinations served almost exclusively by firms that export very widely. By 2007, only 60% of these "long-term" survivors remained single destination exporters, 22% served 2 or 3 destinations, and 18% served 4 or more destinations. Similarly, in 2001 48% of firms started their export experience by exporting one product, 28% by exporting 2 or 3 products, and 14% by exporting 4 or more products. By 2007, only 28% of "long-term" survivors were single-product exporters, while 20% now exported 2 or 3 products, and 52% exported 4 or more products.

To gain insight into the pattern of expansion of firms in export markets I investigate the way



Source: Author's own calculations using firm-level export data from the World Bank's *Exporter Dynamics Database.*

Figure 20: Distribution of Number of Products for Long-Term Survivors

in which "long-term" survivors expand their presence in foreign markets by classifying their transactions into four categories: (i) *old products in old destinations*: these are transactions that the firm carried out both at $t-1$ and t (i.e. these are transactions that are carried over from the previous period); (ii) *old products in new destinations*: these are transactions in which firms, at time t, introduce products that they were selling at $t-1$ into destinations where these products were not being sold at $t-1$; (iii) *new products in old destinations*: these are transactions in which firms, at time t, introduce into destinations which had been reached at $t-1$ products that they were not selling in those destinations at $t-1$, and (iv) *new products in new destinations*: these transactions correspond to products which the firm was not selling anywhere at time $t-1$ and doing so in destinations the firm did not reach at $t-1$.

Table 24 present the results for the participation of each category in the total number of transactions. These numbers show that after the initial export year, the extensive margin for "long-term" survivors adjusts rapidly with over 60% of transactions being new transactions for the firm. In particular, after surviving the initial export year firms expand rapidly through the introduction of new products into destinations served during the initial year of the firm's export tenure: in the second year of a "long-term" survivor's tenure the introduction of new products into old destinations accounts for 40% of all transaction and 10% of export value.

The results in Table 24 also show that young exporters engage in some *"experimentation"* in foreign markets (see Akhmetova and Mitaritonna [2013]) by introducing *new products into new destinations* (i.e. transactions in which they have no previous experience). These

Contribution of	2001	2002	2003	2004	2005	2006	2007
Old Products in Old Destinations	-	38.66	50.48	34.59	45.86	51.99	49.01
Old Products in New Destinations	-	13.07	13.01	13.01	14.61	13.84	13.69
New Products in Old Destinations	-	40.26	31.51	45.64	34.32	30.71	33
New Products in New Destinations	100	8.01	5.00	6.76	5.21	3.46	4.3

Source: Author's own calculations using firm-level export data from the World Bank's *Exporter Dynamics Database.*

Table 24: Sources of Exports for Long-Term Survivors (% of no. of transactions)

type of transactions represent a negligible share of export value, and is consistent with the idea advanced by Rauch and Watson [2003] that firms may start out small in unfamiliar environments.

To gain further insight into how these different types of transactions contribute to the expansion of "long-term" survivors in foreign markets, for firm i at time t I define

$$
\begin{aligned}
X_{it} &: \text{exports} \\
T_{it} &: \text{no. of transactions} \\
x_{it} &: \text{average value of a transaction} \\
o_{it} &: \text{old transactions of firm} \\
p_{it} &: \text{transactions where new products are introduced in old destinations} \\
d_{it} &: \text{transactions where old products are introduced in new destinations} \\
n_{it} &: \text{new products introduced in new destinations}
\end{aligned}
$$

Using this notation firm exports can be expressed as $X_{it} = T_{it}x_{it}$ and its transactions as $T_{it} = o_{it} + p_{it} + d_{it} + n_{it}$, which forms the basis for the following decomposition of export growth:

$$
\begin{aligned}
X_{it+1} - X_{it} &= T_{it+1}x_{it+1} - T_{it}x_{it} \\
&= [o_{it+1} + p_{it+1} + d_{it+1} + n_{it+1}]\, x_{it+1} - T_{it}x_{it} \\
&= o_{it+1}\,[x_{it+1} - x_{it}] + p_{it+1}x_{it+1} + d_{it+1}x_{it+1} + n_{it+1}x_{it+1} - \delta_{it}x_{it},
\end{aligned}
$$

where $\delta_{it} = T_{it} - o_{it+1}$ denotes the number of relationships of firm i that ended at time t.

Using the above decomposition I account for the contribution of each of these kinds of trans-

$t+1$	2002	2003	2004	2005	2006	2007
Old Products in Old Destinations	31.88	53.98	-70.02	-120.84	15.43	63.56
Old Products in New Destinations	9.42	39.89	41.32	141.24	458.58	-91.99
New Products in Old Destinations	78.99	206.01	239.40	521.02	1568.67	-316.08
New Products in New Destinations	3.16	11.53	14.49	26.48	59.81	-17.38
Transaction Death	-23.45	-211.39	-125.19	-467.91	-2002.50	461.88

Source: Author's own calculations using firm-level export data from the World Bank's *Exporter Dynamics Database.*

Table 25: Contribution of Different Transactions to the Export Growth of Long-Term Survivors (%)

actions in total export growth.[42] The results are reported in Table 25. The introduction of new products into destinations that the firm had already served in previous years is quantitatively the most important source of growth for "long-term" survivors. This implies that firms do not enter an export market with the full range of products that, conditional on survival, they will eventually sell in that destination: the product mix of exporters in a given destination evolves over time. Furthermore, changes in the product mix of new export entrants are not necessarily due to trade liberalizations that would reduce trade barriers leading firms to expand their product range in destinations they were already serving: both in 2002 and 2003 -before the phasing in of the trade liberalization with other NAFTA members that Mexico experienced- the margin of "new products in old destinations" was quantitatively the most important source of export growth for "long-term" survivors. These results, together with the results presented in section 3, highlight the importance of the extensive margin of number of products exported as a key margin of adjustment defining a firm's engagement with foreign markets.

The fact that young exporters keep adding products to destinations they already served suggests that they face constraints that restrain their export presence in these markets. This pattern of gradual growth can be consistent with both the idea of financial frictions that become less important over time as the firm accumulates assets and with the idea that young firms undergo a process of self-discovery in the export market and that as they gather information regarding their ability to profitably serve the foreign market they gradually expand.

Finally, I consider the entry process of "long-term" survivors into new destinations. In section

[42]The accounting is based on the identity

$$\frac{\sum_{i=1}^{N} o_{it+1}\left[x_{it+1}-x_{it}\right]}{\sum_{i=1}^{N}\left(X_{it+1}-X_{it}\right)}+\frac{\sum_{i=1}^{N} p_{it+1}x_{it+1}}{\sum_{i=1}^{N}\left(X_{it+1}-X_{it}\right)}+\frac{\sum_{i=1}^{N} d_{it+1}x_{it+1}}{\sum_{i=1}^{N}\left(X_{it+1}-X_{it}\right)}+\frac{\sum_{i=1}^{N} n_{it+1}x_{it+1}}{\sum_{i=1}^{N}\left(X_{it+1}-X_{it}\right)}-\frac{\sum_{i=1}^{N} \delta_{it}x_{it}}{\sum_{i=1}^{N}\left(X_{it+1}-X_{it}\right)}=1.$$

3 it was advanced that, in principle, the "barriers to exporting" could result in a *hierarchy* for export destinations in the sense that, more often than not, any firm selling to the $k+1^{th}$ most popular destination necessarily sells to the kth most popular destination. Eaton et al. [2011], using data for French exporting firms, find evidence for such a *hierarchy* for export destinations, and the evidence presented in section 3 was consistent with this idea in that it was shown that the proposed proxy measure for the "barriers to exporting" faced by Mexican exporters in a given destination are strongly correlated with that market's share in Mexican exports. On the other hand, the evidence presented in Table 23 and Figure 19 shows that firms gradually add destinations to their export portfolio.[43] This suggests that new export entrants enter new destinations sequentially and they do so according to the hierarchy defined by the barriers to exporting.

From the group of "long-term" survivors I now consider the subset of exporters that started as single destination exporters and track their entry process into new export markets.[44] Table 26 shows the average barriers to exporting for newly added destinations as firms gain experience in the export market. It is clear that destinations that are added later on in the firm's tenure are, on average, destinations that are harder to breach. These results are consistent with the idea that firms enter markets sequentially and they do so according to the market hierarchy defined by the barriers to exporting. Furthermore, Figure 21 reports the average first-year growth rate, conditional on survival, for sequential markets being served by the firm. From the second period onwards, the reported growth rate groups the sales to *all* destinations added in that period (i.e. the first-year growth rate for the "second destination" corresponds to the average growth of export sales to all the destinations added by the firm on the second year).[45] A striking feature of Figure 21 is that first-year growth rates, conditional on survival, are decreasing for export destinations that are added later in the firm's tenure as an exporter.

Albornoz et al. [2012] find a similar pattern to that presented in Figure 21 for Argentinean exporters. This pattern, together with the general decrease in the growth rates of export sales for surviving firms is taken by these authors as suggestive of the importance of learning, through the resolution of uncertainty that occurs when a firm decides to engage in international trade,

[43]Eaton et al. [2008a], using data for Colombian exporters, also find that new export entrants typically begin in a single foreign market and, conditional on survival, gradually expand into additional destinations.

[44]Out of these first-time single destination exporters, 84% started in the United States, Mexico's top export destination. The rest started in either Canada or Guatemala that are also top export destinations for Mexican exporters.

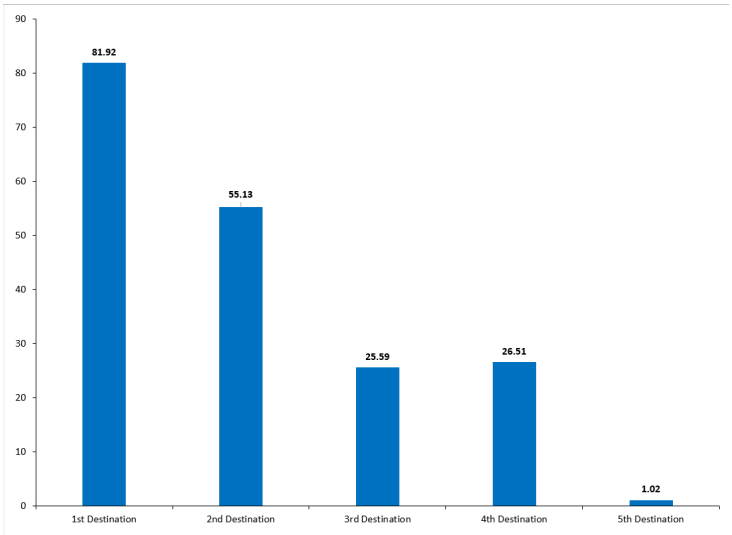
[45]On average, this subset of firms only add 1 or 2 destinations at a time. This implies that, for some firms that are included in the sample used to construct 21, "second destination" may correspond to multiple destinations reached for the first time in the second year of the firm's export tenure. And similarly for "third destination", "fourth destination", etc.

Years since Export Entry	Average Barriers to Exporting for Newly Added Destinations
0	104.19
1	128.20
2	131.44
3	131.53
4	133.93
5	134.96
6	135.19

Note: Using the "Barriers to Exporting" index discussed in section 3, the second column reports the average for this index for those markets that were reached for the first time after *s* years since export entry.

Source: Author's own calculations using firm-level export data from the World Bank's *Exporter Dynamics Database.*

Table 26: Sequential Exporting and Market Hierarchy



Average First-year Growth Rates, Conditional on Survival

Source: Author's own calculations using firm-level export data from the World Bank's *Exporter Dynamics Database.*

Figure 21: Sequential Exporting

as an important force shaping the dynamics of firm expansion into new foreign markets.

Figures 17, 19, 20, and 21 depict a process of gradual expansion in foreign markets for successful export entrants. These features of the data suggest that learning in export markets can be an important determinant of the export supply decisions of new export entrants. This mechanism is explored in Cebreros [2016], where it is found that indeed learning about demand can account for the process of gradual growth of new export entrants observed in the data. However, the results presented Table 26 and Figure 21 also suggest that learning is not necessarily market specific, but that there may be a common component to learning such that when firms learn about their profitability in one market this is also informative about their profitability in other markets. As such, firms can enter new markets closer to their steady-state level of operation as there is less to learn about demand conditions in these new markets, relative to the first destinations breached by the firm.

5 Conclusions

This chapter provides a dissection of the role that firms play in mediating Mexican exports. The three-dimensional nature of the data, two extensive margins and one intensive, allow for a rich characterization of the participation of Mexican firms in international markets. The data is contrasted against the predictions of models of export supply featuring heterogeneous firms. It is shown that in the cross-section, the distribution of exports across export destinations and across firms is consistent with the multi-product, multi-destination frameworks developed by Bernard et al. [2011] and Mayer at al. [2014]. However, concerning the dynamics of export supply featuring heterogeneous firms, it is shown that the data largely supports the predictions of the benchmark model for aggregate patterns, but that the model's predictions for the dynamics of firm-level export supply find less support in the data. In particular, the data reveal that firms that select into exporting only to immediately exit are more prevalent than what the model would suggest.

A contribution of this paper lies in providing a richer account of the dynamics of new export entrants than what is available in the literature. Currently there are two robust stylized facts concerning new export entrants: 1. their continuation rates in the export market, conditional on survival, are increasing with export tenure, and 2. conditional on survival, the growth rate of export sales are decreasing with export tenure (see Besedes and Prussa [2011], Ruhl and Willis [2017], and Kohn et al. [2016]). I confirm these patterns in the Mexican firm-level data

and in addition document the gradual expansion of surviving entrants in terms of the number of products exported and the number of destinations served, and quantify the importance of these margins in explaining the growth of new export entrants in foreign markets.

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Appendix - The Size Distribution of Export Sales: Pareto vs Log-Normal

In the main text it was mentioned that a common alternative to assuming Pareto distributed productivity is to assume that firm-level productivity has a log-Normal distribution, which maintains some of the desirable analytic features of the Pareto and can be generated under equally plausible stochastic processes for firm growth (see Eeckhout [2004]). Assuming log-Normality for the distribution of firm productivity provides a better fit to the complete distribution of observed firm sales rather than just approximating the right tail. To see this last point, assume that $\varphi = \exp(z)$ where $z \sim N(0,1)$ so that productivity is log-Normal. Figure 22 presents the relationship between $\log(\varphi)$ and $\log(\text{Rank})$ for 100,000 draws from a log-Normal distribution. As can be easily seen, the relationship between $\log(\text{"Size"})$ and $\log(\text{Rank})$ is approximately linear at the tail end, but showcases the curvature observed in Figures 8 through 15 for the full sample. That is, the log-Normal distribution provides a better fit than Pareto to the overall shape of the 'size' distribution, not just the tail.

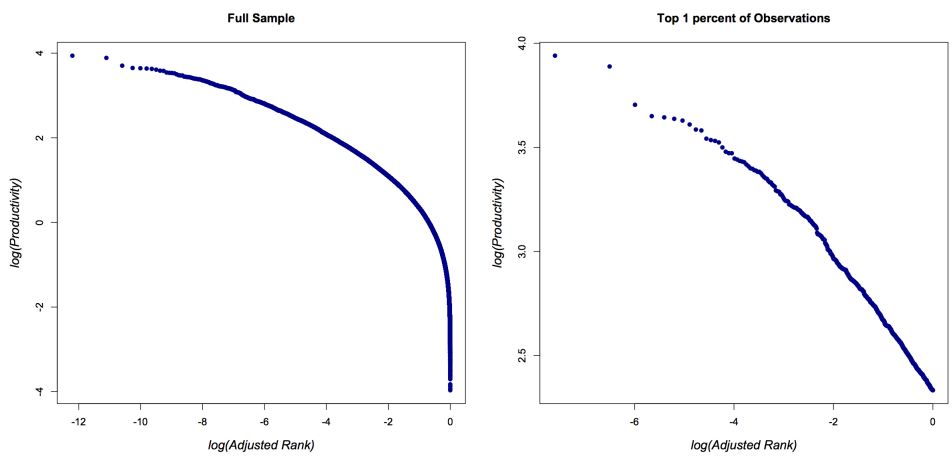
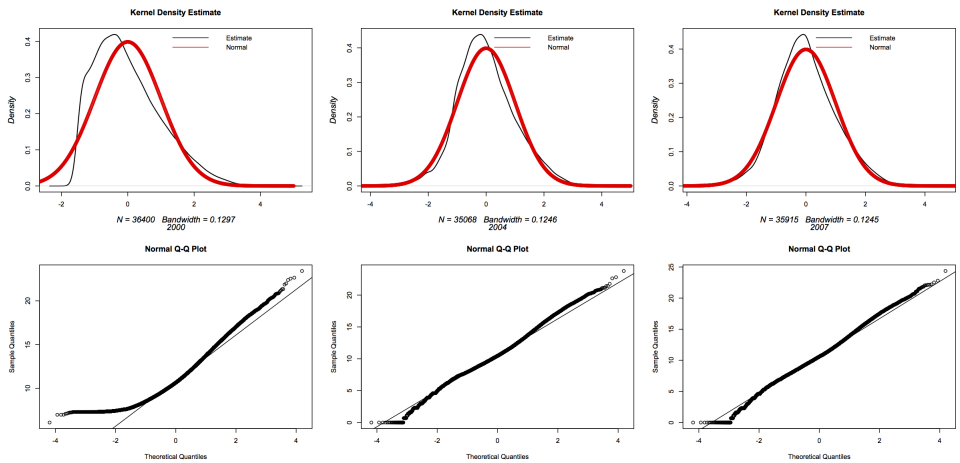


Figure 22: The Size Distribution for a log-Normal $(N = 100,000)$

Since assuming log-normal productivity rather than Pareto has consequences beyond the "fit" of the sales distribution, as argued by Melitz and Redding [2015], I now look more closely at the idea that export sales are distributed log-Normal rather than Pareto. I test for the Normality of $\log(\text{Size})$ by "standardizing" the variable "size" (i.e. subtract its mean and divide by its standard deviation) and then comparing the empirical distributions of the standardized

data to the standard Normal distribution.[46]

Figures 23 and 24 compare the empirical distribution for $\log(\text{Size})$ against the standard Normal distribution and presents the Q-Q plot for $\log(\text{Size})$, which plots the empirical quantiles against the theoretical quantiles of the Normal distribution. Figure 23 presents the results based on the full sample, while Figure 24 presents the results based on the sample that only includes the top 1% of firms. For brevity, I present the results for the initial, midpoint, and final years of the sample.



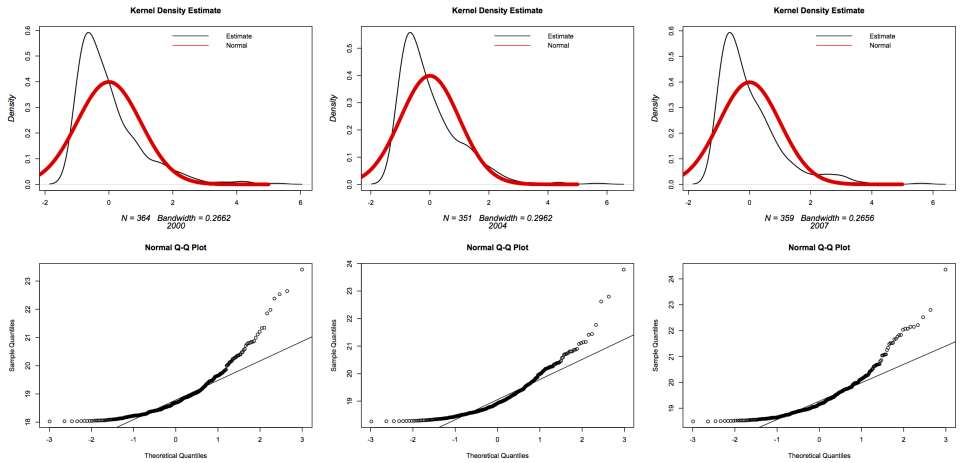
Going from left to right, the panels depict the distribution for the years 2000, 2004, 2007.

Source: Author's own calculations using firm-level export data from the World Bank's *Exporter Dynamics Database.*

Figure 23: Testing for Log-normality: Full Sample.

[46]To construct the empirical pdf I use a kernel density estimate of the distribution. The estimation of the kernel density is performed using the "Normal Reference Rule" (see Silverman [1986]): assuming that the density to be estimated is smooth, then if a Normal kernel is used, set the bandwidth to $h_n = 1.06\hat{\sigma}n^{-\frac{1}{5}}$, where

$$\hat{\sigma} = \min\left\{\text{standard deviation}, \frac{\text{interquartile range}}{1.34}\right\}.$$



Going from left to right, the panels depict the distribution for the years 2000, 2004, 2007.

Source: Author's own calculations using firm-level export data from the World Bank's *Exporter Dynamics Database.*

Figure 24: Testing for Log-normality: Top 1% of Firms.

Figure 23 shows that log-Normality provides a "reasonable" approximation to the complete distribution of firm export sales. Performing the same exercise on the subset of the top one percent of firms, Figure 24 shows a deviation from log-Normality at the tail end of the distribution. Thus, log-Normality provides a better approximation to the observed size distribution of export sales than Pareto along the entire distribution, although the Pareto hypothesis for the size distribution is a very good approximation for the tail of the distribution where we find the largest exporters.