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Exporters and Their Products: A Collection of Empirical Regularities

Costas Arkolakis* and Marc-Andreas Muendler†

*Yale University, CESifo and NBER. e-mail: costas.arkolakis@yale.edu
†UC San Diego, CAGE, CESifo and NBER. e-mail: muendler@ucsd.edu

Abstract

We present a set of empirical regularities that characterize the export activity of firms. We decompose firm-level exports by product category across destination markets in a consistent manner for four data sets from Brazil, Chile, Denmark, and Norway. We relate the empirical regularities to new trade theories that connect microeconomic activity to aggregate outcomes. Our findings corroborate main motivating facts and may help discipline future theoretical work. (JEL codes: F12, L11, F14).

Keywords: International trade, heterogeneous firms, multi-product firms, firm and product panel data, Brazil, Chile, Denmark, Norway

1 Introduction

The recent surge of empirical research in international trade that uses firm-level data has opened new avenues for theory but also raises challenges. Micro data on exporters, their products, and their destinations offer a number of rich statistics that are useful in disciplining models of international trade and in sharpening our information on the costs of export market access. An important empirical concern with micro-level statistics is their robustness under alternative levels of disaggregation and across countries at different stages of development. The purpose of this article is to establish key features of trade data that are robust across developing and industrialized countries and across levels of aggregation.

We collect a set of empirical regularities that characterize the export activity of firms and their products across foreign destinations. To establish robustness, we apply the same statistical methodology to data from a group of four export countries—Brazil, Chile, Denmark, and Norway—with comprehensive data on export participation, destination markets, and export products among manufacturing firms. We conduct our statistical analysis at varying levels of product aggregation, and compare statistics to earlier findings for France and the USA. Given the success of recent trade theories in explaining export activity at the firm-level, we use our cross-country statistics to validate main insights from international trade models, but also to motivate and potentially discipline future theoretical work.

Our focus lies on patterns of entry and sales at individual export destinations across firms and firm–products from different source countries. For each export country we use three-dimensional data for firms, their destination markets, and their export products. By design, such three-dimensional data cover two extensive margins of export activity, and one remaining intensive margin. The first extensive margin is that of firm entry into a foreign market with the firm's first export product at the destination. The second extensive margin is that of product entry by the same firm at a given foreign market with additional products beyond the first exported good. Related to this second extensive margin of export activity, we call the number of products that an exporter ships to a destination the firm's *exporter scope* at the destination. The remaining intensive margin covers the individual sales per product at the destination.

We use firm–product–destination data, motivated by the widely documented regularity that multi-product firms dominate export–market participation. Bernard et al. (2009) show for US trade data in the year 2000, for instance, that firms that export more than five products at the Harmonized System (HS) 10-digit level make up 30% of exporting firms but account for 97% of all exports. Iacovone and Javorcik (2008) and Arkolakis and Muendler (2010) document related concentration patterns for Mexico and Brazil, for example.

We present two sets of basic statistics: statistics related to the entry and sales of firms, and statistics related to the entry and sales of products by firm. For each of the two sets we document concentration patterns and their relation to country characteristics. We consider these basic statistics as benchmark regularities that any successful model of trade and market structure might want to confront.

Entry and sales statistics at the firm level suggest that exporting is strongly fragmented by national markets. Only a fraction of firms overcomes the barriers to export–market access. Our analysis of these statistics is similar to Eaton et al. (2004) but our contribution is to establish that these regularities persist across source countries with different characteristics. The evidence is consistent with the idea that fixed entry costs per firm as well as per-unit shipping costs keep national markets separate, and it supports conventional assumptions in recent models of international trade.

Entry and sales statistics at the firm-product level show for a destination market such as the USA that there are only a few exporters with wide exporter scope and large sales, but there are many narrow-scope and small-sales firms. This evidence is consistent with the idea that there are also fixed entry costs to a firm's expansion of its product scope in addition to per-unit shipping costs that separate markets. Our analysis of these statistics is similar to Arkolakis and Muendler (2010) and this article establishes that the regularities persist across source countries with different characteristics. To match the regularities, models need to explain the high frequency of exporters that have small sales and ship only a few products as well as the simultaneous dominance of a few wide-scope and large-sales firms in total exports.

For the extensive margin of product entry within firms, gravity-type regressions similar to Bernard et al. (2011) suggest that the average exporter scope across firms in a market is not significantly related to destination–market size, as measured by GDP, but exporter scope is related to distance. The reverse is the case for the remaining intensive margin of sales per firm–product. Sales per firm-product are unrelated to distance but significantly related to destination–market size as measured by GDP. The evidence is consistent with the idea that firms face repeated and similar market-entry costs for their products destination by destination so that average exporter scope is not responsive to local market size.

This article has five more sections. Section 2 presents our data sources for Brazil, Chile, Denmark, and Norway, and our data preparation. Section 3 reports statistics on export–market presence by source country and destination characteristics. Section 4 explores the distributions of exports and exporter scope from our four source countries in a leading export market, the USA. Section 5 relates the exporter scope of a source country's firms, and the complementary margins of bilateral exporting, to destination–market characteristics. We offer concluding remarks in Section 6.

2 Data

We apply consistent methods to the preparation of exporter–product–destination data for Brazil, Chile, Denmark, and Norway, and to the computation of statistics. We also compare our evidence to published statistics for France and the USA.[1] In product space, we restrict the sample to manufactured products. On the firm side, we restrict the sample to manufacturing firms and their direct exports of manufactures. This restriction makes our findings closely comparable to statistics previously published by Eaton et al. (2004) on France and Bernard et al. (2011) on the USA, for example.

The Brazilian exporter data derive from the universe of customs declarations for merchandize exports during the year 2000 at SECEX (*Secretaria de Comércio Exterior*). Transactions of any value and weight are included

1 Results for exporter–destination–product data from Greece (courtesy of Dinopoulos et al. 2012) also exhibit closely related patterns to the ones presented in this article.

in these declarations data. From these customs records, we construct a three-dimensional data set of Brazilian manufacturing exporters, their destination countries, and their export products at the HS 6-digit level. At this disaggregation level, customs codes are identical across countries. In the raw exports data from SECEX, product codes are 8-digit numbers under the common Mercosur nomenclature (NCM), of which the first 6 digits coincide with the first 6 HS digits. We aggregate the original monthly exports data to the HS 6-digit product, firm, and year level for most of our data work, but stay at the NCM 8-digit level for comparisons to the US evidence in gravity equations. We use the formal-sector employer–employee records RAIS (Relação Anual de Informações Sociais from the Brazilian labor ministry) to link the manufacturing exporter data to the universe of Brazilian manufacturing firms for the total firm count.

A similar three-dimensional data set of Chilean exporters derives from the universe of annual customs declarations by Chilean manufacturing firms in 2000. As is the case for the Brazilian data, transactions of any value and weight are included in the Chilean declarations data. Roberto Álvarez kindly shared the Chilean data for 2000 (for a data description see Álvarez et al. 2007). We aggregate the annual data from the HS 8-digit to the HS 6-digit level for cross-country comparison in most of our data work but, similar to Brazil, we stay at the HS 8-digit level for a US comparison in gravity estimation. For Chile, we do not have the total manufacturing firm count in the data. As an estimate, we use export participation among Chilean plants in 2000 from reported statistics in Bergoeing et al. (2011, Table 5).

Evidence on the Danish exports is courtesy of Ina C. Jäkel (Jäkel 2012). The Danish data derive from the Globid data base at the Department of Economics and Business, Aarhus University, and Statistics Denmark. The reporting thresholds are 3000 Danish Krones (approximately 400 US dollars in 2000) and a weight of one ton per monthly transaction total for shipments to destinations inside the European Union, and 7500 Danish Krones (approximately 1000 US dollars in 2000) and a weight of one ton per monthly transaction total for shipments to destinations outside the European Union. Below the threshold, firms may voluntarily report. The final three-dimensional data set of Danish exporters, their respective destination countries, and their export products is at the HS 6-digit level after mapping the Danish product codes to the HS 6-digit level. The Danish data include both domestic and foreign activity of Danish manufacturing firms so that no additional data treatments are required.

Evidence on the Norwegian exporters is courtesy of Andreas Moxnes (Irarrazabal et al. 2010). The Norwegian data are based on customs declarations for an exhaustive sample of Norwegian non-oil exporters in 2000, which are then further restricted to manufacturing firms (NACE sectors 15 through 37). The reporting threshold for inclusion of an exporter in the data is 1000 Norwegian Krones (approximately 125 US dollars in 2000) for the total annual transactions value per firm. The resulting three-dimensional data set of Norwegian exporters, their respective destination countries, and their export products is also at the HS 6-digit level. For further details on the customs data, see Irarrazabal et al. (2010) and (2011). To obtain data on Norwegian manufacturing firms including non-exporters, Moxnes has linked the Norwegian customs data with Norwegian manufacturing firm data. The combined data set excludes a small number of manufacturing exporters from the customs data but statistics on exports to the USA are largely unaffected.

For Brazil and Chile, we also present a set of additional statistics with product–market information by destination country and sector. For this purpose, we map the HS 6-digit codes to ISIC revision 2 at the 2-digit level and link our data to World Trade Flow (WTF) data for the year 2000 (Feenstra et al. 2005) and to *Unido* Industrial Statistics (UNIDO 2005).[2] In gravity regressions, we use CEPII bilateral geographic distance data (the mean distance between Brasília or Santiago de Chile on the one hand and foreign capital cities in Kilometers on the other hand) and the IMF's International Financial Statistics for GDP (in current US$).

3 Export Market Presence

We start our investigation with an assessment of the destinations that exporting firms reach, and the characteristics of the destinations that attract many exporters.

3.1 Frequency of Export market presence

We first take the perspective of the exporting country and its firms. For each of our four source countries we plot the number of firms against the number of destinations to which these firms ship in 2000. The destination count includes the home country so that nonexporters appear as having one market. Figure 1 depicts the plots in log–log graphs, replicating Eaton et al. (2004). The number of firms that reach a given number of destinations declines relatively smoothly and monotonically, from a large number of firms that serve only a single market (their home market) to the point where a handful of firms serves a large number of markets.

[2] Our extended SITC-to-ISIC concordance is available at econ.ucsd.edu/muendler/resource.

To measure the decline in destination reach, we fit a linear regression line to the graphs in Figure 1 by regressing the log number of firms with a given number of destinations on their log number of destinations. For France, Eaton et al. (2004) report the coefficient estimate of this elasticity to be −2.5.[3] Our estimated elasticities are −2.48 for Brazil (standard error 0.065) and −2.35 (0.079) for Chile. In contrast, the economies of Denmark and Norway exhibit less pronounced declines in destination reach, with elasticities of −1.98 (0.054) in Denmark and −1.94 (0.056) in Norway.[4]

The smaller the total number of manufacturing firms in a source country, the smoother the elasticity of the number of firms with respect to the number of markets. Norway exhibits the smallest dropoff between single-destination and two-destination firms, and has only 8688 manufacturing companies in 2000. Denmark has 20 470 manufacturing firms in 2000 and exhibits a somewhat more pronounced dropoff. (Our imputed total number of manufacturing firms for Chile in 2000 is 31 322.) Brazil, in contrast, hosts 697 259 manufacturing firms in 2000—multiple times the manufacturing firm counts even for France and the USA of 234 300 and 191 648 in 1986 and 1987 (Eaton et al. 2004). Only a relatively small fraction of the many Brazilian manufacturing firms exports, contributing to the strong dropoff in the number of Brazilian firms between the first and second destination market.

To summarize the evidence for all these countries (Brazil, Chile, Denmark, Norway, and France), the modal manufacturing firm is a nonexporter. The modal exporter ships to only one foreign destination. And only a small fraction of firms ships to a wide number of destinations. This evidence provides a sense of the difficulty of exporting. Only select firms

3 Our descriptive regression imposes a log-linear relationship between the firm count and the destination count for simplicity. Chaney (2011), in contrast, emphasizes a detectably concave curvature in the relationship.

4 The largely smooth relationship between the number of firms and the number of destinations that they reach exhibits a stark dropoff between one and two destination markets, however. This dropoff is especially pronounced in Brazil and Denmark but is also clearly observable in Chile and Norway. For Brazil, Chile, and Norway, this dropoff is entirely driven by the transition from nonexporters to exporters because we lack information on home-market sales for those countries. For Denmark, the count of firms with sales to a single market could in principle also reflect exporters with a single export market but no domestic Danish sales. In 2000 in Denmark, all exporters in our sample also have Danish domestic sales. One concern with this stark dropoff in the number of firms between the first and second destination market is that the above reported regression coefficients are upward biased compared to estimates for only export destinations (destination counts of two or more). In none of our sample countries, however, the coefficient changes strongly. In Brazil, the country with the strongest dropoff, the elasticity of the number of firms with respect to the number of markets changes from −2.48 including single-destination firms to −2.33 excluding single-destination firms. In Denmark, the country with the second strongest dropoff, the elasticity changes from −1.98 just to −1.96.

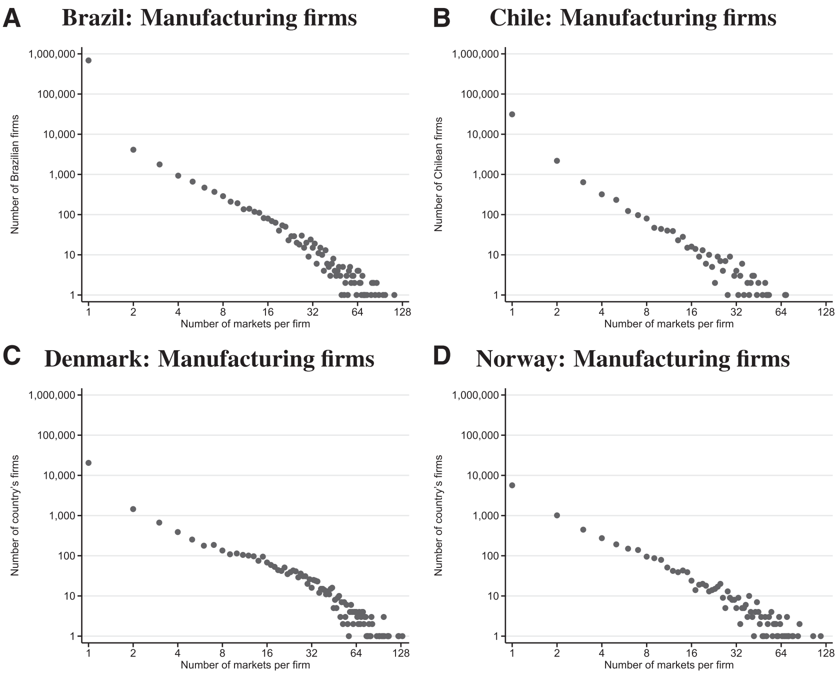

Figure 1 Export market presence. *Sources*: Brazilian *SECEX* 2000, Chilean customs data 2000 (Álvarez et al. 2007), Danish Globid data 2000 (see Jäkel 2012), Norwegian combined customs and manufacturing firm data 2000 (compare to 2004 data by Irarrazabal et al. 2010); manufacturing firms and their manufactured products. *Note*: Graphs for Brazil, Chile, and Norway under the assumption that every manufacturer has sales in the domestic market. For Chile, nonexporters imputed from nonexporting Chilean plants in 2000 (Bergoeing et al. 2011, Table 5).

are able to overcome obstacles to exporting, reflected in a substantive elasticity with which the number of firms declines as additional export destinations are reached.

Trade models can generate selection of firms into exporting based on variable trade costs alone (Bernard et al. 2003; Melitz and Ottaviano 2008). However, models where variable trade costs are the only barrier to trade are typically not able to generate both the observed relative size of exporters, compared to nonexporters, and the strong selection into exporting (Bernard et al. 2003). To come to terms with both these regularities, international trade models typically require additional exporting costs either in the form of fixed costs (Roberts and Tybout 1997; Melitz 2003; Chaney 2008) or in the form of increasing marketing costs to penetrate foreign markets (Arkolakis 2010; Eaton et al. 2011).

3.2 Destination market size

We now relate export market entry to characteristics of the destination country. Among the potentially relevant destination country attributes is market size and the attraction that market size exerts on foreign firms and firm–products. For this exercise, we measure a destination country d's market size X_d as its absorption, defined as gross manufacturing production plus imports minus exports (in billions of US dollars).[5]

Firm entry and market size: a common framework to interpret bilateral trade volumes is the gravity equation, which relates exports T_{sd} between a source country s and a destination d to the market sizes of s and d and geographic distance d_{sd} between the two countries:

$$T_{sd} = \kappa\, X_s X_d / d_{sd}$$

for some constant κ. Following the approach in Eaton et al. (2004) for each of our source countries s, we define a source country's market share in a destination country's absorption simply as $\lambda_{sd} \equiv T_{sd}/X_d$ so that the exports T_{sd} from s to d can be understood as

$$T_{sd} = \lambda_{sd} X_d.$$

The market share λ_{sd} is commonly thought to be partly driven by the distance between s and d.

Using our firm-level data, we can also decompose total exports T_{sd} from source country s to destination d into

$$T_{sd} = M_{sd}\, \bar{t}_{sd}, \tag{1}$$

where M_{sd} is the number of exporters in s with shipments to d, and $\bar{t}_{sd} \equiv T_{sd}/M_{sd}$ are these exporter's mean sales to d (see e.g. Eaton et al. 2004). This decomposition accounts for the (first) extensive margin of market presence by firms. The remaining intensive margin of average export sales per firm subsumes both the (second) extensive margin of product entry and the sales per firm–product into a broad intensive-margin term. We will turn to product entry in the next two sections. For now, we combine the definition of market share λ_{sd} with decomposition (1).

The left panel of Figure 2 depicts the relationship among three of the four elements in the definition and the decomposition: $T_{sd} = \lambda_{sd} X_d = M_{sd}\, \bar{t}_{sd}$. On the horizontal axis is the market size measure

[5] Gross manufacturing production is from *Unido* Industrial Statistics (UNIDO 2005), and exports and imports are from World Trade Flow (WTF) data for the year 2000 (Feenstra et al. 2005). For Brazil's exporters in 2000, we cover 171 destination countries with this absorption measure, for Chile in 2000 we cover 140 countries.

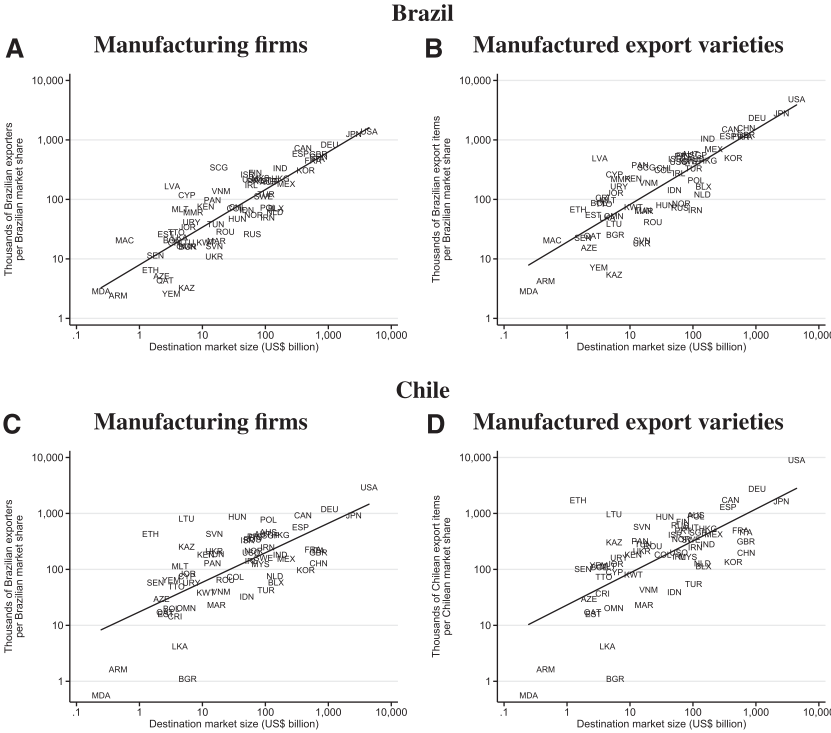

Figure 2 Market size and exporter presence. *Sources*: Brazilian *SECEX* 2000 (A and B), Chilean customs data 2000 (C and D), manufacturing firms (A and C), and manufactured firm-products (B and D) at the HS 6-digit level, linked to *WTF* (Feenstra et al. 2005) and *Unido* Industrial Statistics (UNIDO 2005). *Note*: Market size is absorption by a country's manufacturing sector. Each manufacturing firm's export product is one variety. The slopes of the fitted lines are 0.632 (standard error 0.049) for manufacturing firms from Brazil (A), 0.632 (0.053) for manufactured firm-products from Brazil (B), 0.527 (0.075) for manufacturing firms from Chile (C), and 0.571 (0.075) for manufactured firm-products from Chile (D).

X_d. On the vertical axis is the number of source country s's exporters divided by the source country's market share at d: M_{sd}/λ_{sd}. This division is meant to partly control for the effect of distance between s and d. When normalized by market share λ_{sd}, the number of Brazilian firms (Figure 2A) and Chilean firms (Figure 2C) selling to a destination increases systematically with market size, but with an elasticity less than unity.

Both Figures 1 and 2 illustrate the rarity of prolific exporters. Figure 1 documented that a few firms reach many markets, and Figure 2 shows that only large markets sustain many exporters from a given source country. Taken together, this evidence is consistent with the explanation that only a few firms reach small markets whereas most firms ship to a limited number of large markets. These patterns indicate that exporters face substantial entry costs and support the emphasis on the importance of extensive margins in explaining overall trade. The robustness across countries is consistent with the idea that the nature of entry costs (though not necessarily their levels) may be similar across countries.

Several explanations are consistent with the robust positive association between destination market size and exporter presence from any source country. As a market's size increases, it becomes more likely that firms from any source country can expect earnings that exceed the entry costs of accessing the destination market (see e.g. Arkolakis 2010; Eaton et al. 2011). Another consistent explanation is that richer countries demand a broader set of vertically differentiated varieties under non–homothetic demand, attracting more entrants with quality-differentiated products from any source country (see e.g. Fajgelbaum et al. 2009; Simonovska 2010). Yet another theory consistent with this evidence is that larger markets promote the formation of trading networks, which in turn facilitate the entry of firms from any source country (see e.g. Rauch 1999; Chaney 2011). Note, however, a flip side of the positive association between market size and market entry with an elasticity of less than unity is a positive association between the average size of exporters and market size with an elasticity of more than unity. Matching the latter association quantitatively essentially requires the explicit modeling of an entry cost as in Eaton et al. (2011).

Variety entry and market size: prior to the availability of individual firm–product data, much empirical research has considered export goods as classified by product category. Under this perspective, firms can be viewed as providing their brand, and the brand in turn provides the platform for specific products to be launched. A decomposition of total exports T_{sd} related to this view of the product space is:

$$T_{sd} = V_{sd}\,\bar{a}_{sd}, \tag{2}$$

where $V_{sd} \equiv \sum_{\omega\in\Omega_{sd}} G_d(\omega) = M_{sd}\,\bar{G}_{sd}$ is the number of branded products (or ''varieties'') shipped to d, and ω denotes the individual firm or brand within the set $\mathbf{\Omega}_{sd}$ of firms that ship from s to d. The average scale of the branded products is $\bar{a}_{sd} = [\sum_{\omega\in\Omega_{sd}} t_d(\omega)]/[\sum_{\omega\in\Omega_{sd}} G_d(\omega)] = \bar{t}_{sd}/\bar{G}_{sd}$ (similar to Broda and Weinstein 2006, identical under the convention that every source country is a single exporter $M_{sd}=1$). For empirical implementation, we define a branded export variety as a manufacturing firm's export product at the HS 6-digit level.

Figure 2B and D depicts firm–product entry using the relationship among three of the four elements in the definition of exports and decomposition (2): $T_{sd} = \lambda_{sd} X_d = V_{sd} a_{sd}$. On the horizontal axis is the market size measure X_d. On the vertical axis is the number of source country s's firm–products divided by the source country's market share at d: V_{sd}/λ_{sd}. When normalized by market share λ_{sd}, the number of Brazilian firm–products (Figure 2B) and Chilean firm-products (Figure 2D) selling to a destination increases systematically with market size, but with an elasticity less than unity.

Overall, elasticities of firm–product entry with respect to market size are similar to the earlier elasticities of just firm entry. For Brazil, the slopes of the regression lines in Figure 2 are statistically indistinguishable. For Chile, the elasticity of firm–product entry with respect to market size is somewhat larger than the elasticity of just firm entry. We will return to a discussion of this elasticity after investigating the distribution of exporter scope and the response of mean exporter scope to foreign market size in the following two sections.

A comparison between the right and left panels of Figure 2 suggests that there is a potentially separate role for within-firm product differentiation. Put differently, there appears to be a (second) extensive margin of product entry by the firm. The similarity of firm–product entry with firm entry suggests that the nature of firm–product entry costs is comparable to that of firm entry costs discussed earlier. Firm–product entry costs have been modeled by Bernard et al. (2011) and Arkolakis and Muendler (2010). Allowing for both increasing marginal cost by product as in Eckel and Neary (2010) and for local fixed entry costs that depend on the number of products, Arkolakis and Muendler (2010) analyze the quantitative nature of firm–product entry costs.

4 Sales and Product Distributions Across Firms

The exporter scope and sales decisions conditional on entry are the main points of interest in this and the next section. To look underneath the surface of firms' entry and sales decisions, in this section we analyze the size and product scope distributions across firms. We focus on a single large destination market to emphasize the evidence in the cross section of firms from a common source country. The destination country at the top right extreme of the graphs in Figure 2 is the USA, so we use the USA as the destination market for our data exploration in this section.[6]

[6] For Brazil and Chile as source countries we report sales and product distributions also for other destination markets beyond the USA in a comprehensive online Data Appendix to Arkolakis and Muendler (2010) at econ.ucsd.edu/muendler/papers/abs/braxpmkt.html.

4.1 Sales distribution

We first investigate the variation of exports among exporters that ship to the USA. For each source country—Brazil, Chile, Denmark and Norway—we rank the exporters according to their total sales in the USA in 2000. For each percentile of the firm's total sales distribution, we then compute the total sales at that percentile and plot the sales against the percentile using a log scale on the vertical axis. Figure 3 displays the graphs. Especially in the more advanced countries Denmark and Norway, the total sales distribution exhibits an approximate power law behavior. The distributions deviate from power law behavior in the lower tail, however. Especially in Brazil and Chile, but also to some degree in Norway, sales at small firms decline more than proportionally with the percentile. In summary, there are a few large-sales firms but many small-sales firms.

For an explanation of deviant small-firm behavior in the lower tail see Arkolakis (2010). That paper explains the existence of many exporters with minor sales in the low tail by introducing increasing marketing costs, which firms incur when they reach additional consumers within a destination market. Additional heterogeneity of sales of firms can be attributed to random variation across markets as discussed in detail by Eaton et al. (2011).

The distributions are similarly concentrated in the high tails between source countries, and the plots for our four source countries look similar to the one for France reported in Eaton et al. (2011).

The robustness of the sales distribution across our source countries, but also its robustness across destinations for any given source country (Arkolakis and Muendler 2010), presents a regularity that theory needs to come to terms with. Trade volumes and the gains from trade depend on the concentration of the sales distribution. In frameworks with heterogeneous firms, imposing a Pareto distribution on productivity turns out to be a sufficient distributional assumption to generate stable sales distributions across source countries for a wide range of demand functions (see Arkolakis et al. 2012). The Pareto distribution is closed under truncation so that, conditional on entry, the productivity distribution remains Pareto. A CES demand system with symmetric elasticities can generate export sales with a Pareto distribution in the upper tail that is robust across source–destination country pairs (see e.g. Chaney 2008; Arkolakis and Muendler 2010; Eaton et al. 2011).

4.2 Exporter scope distribution

We now turn to a main new variable that can be computed from firm–product–destination data following Arkolakis and Muendler (2010): a firm's exporter scope at a given destination, which we define as the

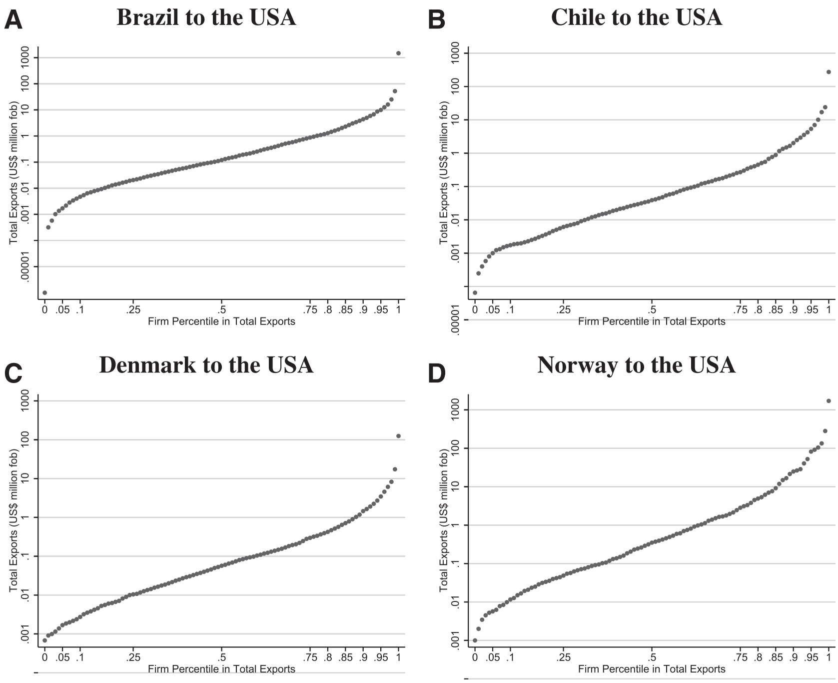

Figure 3 Total sales distributions in the USA. *Sources*: Brazilian *SECEX* 2000, Chilean customs data 2000, Danish Globid data 2000, Norwegian combined customs and manufacturing firm data 2000; manufacturing firms and their manufactured products.

number of products at the HS 6-digit level shipped by an exporter to a destination.[7] For each source country we now rank the country's exporters according to their exporter scope in the USA in 2000. For each percentile of the firm's exporter scope distribution, we then compute the exporter scope at that percentile and plot the scope against the percentile using a log scale on the vertical axis. The graphs are shown in Figure 4.

Exporter scope is a discrete variable but the overall shapes of the distributions approximately resemble those of power-law distributed variables. The median exporter from Brazil and Chile in 2000 ships just one product to the USA. The median exporter from Denmark and Norway, in contrast, ships two products to the US market. Even in the largest export market, the United States, the exporter scope of the typical (median) firm is just one or two products. Interestingly, the breadth of exporter scope is

[7] We turn to robustness checks with finer levels of product disaggregation in the following section and in a comprehensive online Data Appendix to Arkolakis and Muendler (2010) at econ.ucsd.edu/muendler/papers/abs/braxpmkt.html.

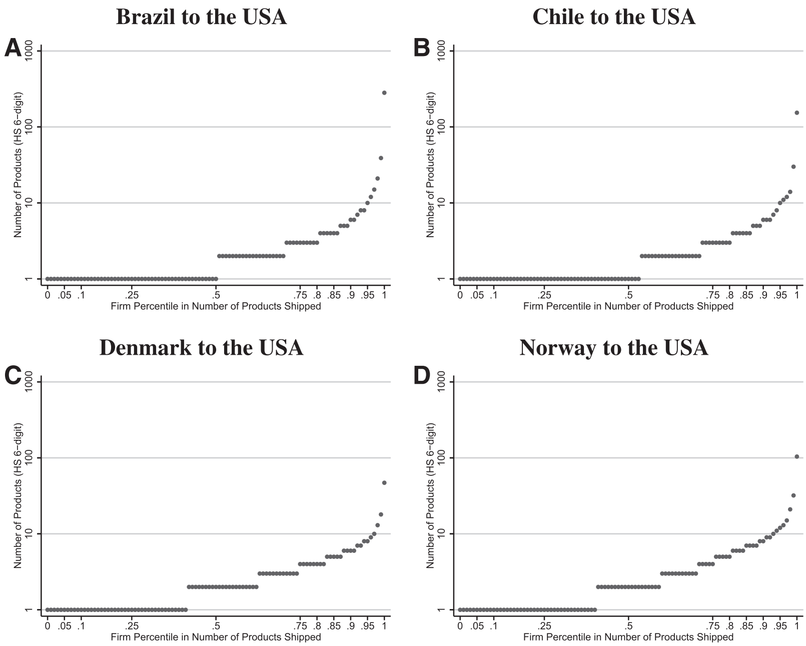

Figure 4 Exporter scope distributions in the USA. *Source*: Brazilian *SECEX* 2000, Chilean customs data 2000, Danish Globid data 2000, Norwegian combined customs and manufacturing firm data 2000; manufacturing firms and their manufactured products. Products at HS 6-digit level.

reversed between the two country groups, Brazil–Chile on the one hand and Denmark–Norway on the other hand, at the high end of exporter scope. The Brazilian manufacturing exporter with the widest exporter scope in the USA ships 273 products at the HS 6-digit level, and the widest-scope Chilean exporter sells more than 100 products. In contrast, the widest-scope Norwegian exporter to the USA ships just a little more than 100 products, and the top Danish exporter even fewer products.

In summary, there are only a few wide-scope and large-sales firms, but there are many narrow-scope and small-sales firms at a given destination. Models that strive to explain the role of multi-product exporters therefore need to explain the high frequency of exporters that have small sales and ship only a few products and the simultaneous dominance of a few wide-scope and large-sales firms in total exports. Conceptually, a combination of the models by Arkolakis (2010) and Arkolakis and Muendler (2010) could simultaneously generate these relationships: the least productive firms would pay a low marketing cost to reach only a few consumers at a destination but would also typically choose to sell only a few products to those consumers.

5 Product Exports and Market Characteristics

We now look behind the distribution of exporter scope and investigate more closely product entry, its relation to the other two margins and its relation to destination–market characteristics. Beyond the (first) extensive margin of firm presence, in this section we decompose destination by destination an exporter's sales into the (second) extensive margin of the firm's number of products at a destination—the *exporter scope*—and the remaining intensive margin of the exporter's average sales per product at the destination, which we call *exporter scale*.

5.1 Export margins and gravity

As a start, we relate back to the common framework of the gravity equation to describe the multilateral export data. There is a natural extension of the two earlier decompositions (1) and (2) in Section 4 to the case of three jointly known export dimensions in firm, product, and destination data. Departing from decompositions (1) and (2), an extended margin decomposition can account for the newly observable extensive margin of firms' exporting products and also consider the average number of products per firm, or mean exporter scope:

$$T_{sd} = M_{sd}\,\bar{G}_{sd}\,\bar{a}_{sd}, \tag{3}$$

where $\bar{G}_{sd} \equiv \sum_{\omega\in\Omega_{sd}} G_d(\omega)/M_{sd}$ is the exporter's mean scope, and $\bar{a}_{sd} \equiv \bar{t}_{sd}/\bar{G}_{sd}$ is these exporter's mean scale. This decomposition generalizes both decompositions (1) and (2) and naturally accounts for the firm's average exporter scope $G_d(\omega)$.[8] Exporter scope is a central variable in recent theories of multi-product exporters, including Feenstra and Ma (2008), Eckel and Neary (2010), Bernard et al. (2011), Nocke and Yeaple (2006), Dhingra (2010), Mayer et al. (2011), Arkolakis and Muendler (2010).

While (3) is one natural generalization of the earlier decompositions from Section 4, it is not the only possible extension. Total exports T_{sd} can also be decomposed into:

$$T_{sd} = M_{sd}\,\hat{G}_{sd}\,\hat{a}_{sd}, \tag{4}$$

where $\hat{G}_{sd} \equiv \sum_{\omega\in\Omega_{sd}} G_d(\omega)$ now is the total number of products exported from s to d by any firm (the HS-6 digit categories filled by anyone), and $\hat{a}_{sd} \equiv \bar{t}_{sd}/\hat{G}_{sd}$ is the 'average value of exports per product per firm' (Bernard et al. 2007; p. 121). This decomposition

[8] Note that a_{sd} is the weighted arithmetic mean of $a_d(\omega)$ over all firms ω, with weights $G_d(\omega)$: $\bar{a}_{sd} = \sum_{\omega\in\Omega_{sd}} G_d(\omega)\,a_d(\omega)/(\sum_{\omega\in\Omega_{sd}} G_d(\omega)) = \bar{t}_{sd}/\bar{G}_{sd}$.

generalizes decomposition 1 but does not naturally generalize decomposition 2 because $\hat{a}_{sd} \equiv (\bar{G}_{sd}/\hat{G}_{sd})\,\bar{a}_{sd}$. Moreover, the total number of products $\hat{G}_{sd}$ exported by any firm from s to d is not directly related to the (second) extensive margin of average product entry within firms.

So as to accommodate both possible extensions (3) and (4), Bernard et al. (2011) propose an all-encompassing quadruple decomposition of total exports T_{sd} into

$$T_{sd} = M_{sd}\,\hat{G}_{sd}\,\mu_{sd}\,\bar{a}_{sd}, \tag{5}$$

where $\hat{G}_{sd} \equiv \sum_{\omega \in \Omega_{sd}} G_d(\omega)$ is the total number of products exported from s to d, μ_{sd} is the share of firm–product combinations with positive product exports, which Bernard et al. (2011) call the 'density of trade', and $\bar{a}_{sd} \equiv \bar{t}_{sd}/\bar{G}_{sd}$ is the average exporter scale of the firm-products at the destination. This quadruple decomposition can be transformed back into our triple decomposition (3) by setting $\bar{G}_{sd} = \hat{G}_{sd}\,\mu_{sd}$ (as in Arkolakis and Muendler 2010). Once transformed back, the number of exporters M_{sd} reflects the (first) extensive margin of firm entry, the average exporter scope $\bar{G}_{sd} = \hat{G}_{sd}\,\mu_{sd}$ reflects the (second) extensive margin of product entry by a firm at the destination, and a_{sd} covers the remaining intensive margin of the exporter's mean exporter scale. Alternatively, one can set $\hat{a}_{sd} = \mu_{sd}\, a_{sd}$ and get back to the triple decomposition by Bernard et al. (2007).

Table 1 presents the results from relating the quadruple margin decomposition of (5) to two foremost gravity equation variables: market size at the destination and distance between source and destination country. For the USA, Bernard et al. (2011) present gravity evidence for the quadruple decomposition using GDP and distance between capital cities, and we follow their specification for comparability.[9] Table 1 reports the coefficients from an OLS regression of the log of each of the four variables in (5) on both log GDP and log distance. By the properties of OLS, we can add all four coefficients in a row to arrive at the total gravity coefficient from a regression of T_{sd} on log GDP and log distance. Rounding error aside, the sum of the coefficients in Columns (2)–(5) is equal to the coefficient in Column (1). We can also add pairs of coefficients in the quadruple regression behind Table 1 to recover results for the alternative triple

[9] Log GDP differs from the absorption-based market size measure of Section 3 in two main regards: absorption is based on gross manufacturing production (for a derivation see Eaton et al. 2011), whereas GDP is a value-added measure for the whole economy, and absorption corrects for trade imbalances.

decompositions (3) and (4). Importantly, the sum of the coefficients in Columns (3) and (4) is the estimate for the contribution of the (second) extensive margin of average product entry by the firms at a destination.

Several striking facts emerge from a comparison of the USA to Brazil and Chile in Table 1. Results for the USA in Bernard et al. (2011) are reported at the HS 10-digit level only (a unique level of disaggregation). For Brazil and Chile, we report results both at the finest possible level for these two countries (NCM-8 for Brazil and HS-8 for Chile), and for the HS 6-digit product classification. The HS is identical across countries around the world at the 6-digit level. First and perhaps most importantly, signs of all coefficients are identical between all three countries. This is true both for the fine product classification at the 8-digit level and for the HS 6-digit product classification for Brazil and Chile, which makes results most widely comparable across countries. Moreover, the pattern of statistical significance is identical between all three countries and both levels of aggregation, with only the distance coefficient in the mean exporter scale regression (column (5)) lacking statistical significance at the 1% level.

The magnitude of coefficients is quite similar across countries and levels of product classification, too. The coefficients on log GDP are so close that their equality cannot be rejected between the USA and Brazil for total exports T_{sd}. Neither can the equality of coefficients on the total number of products $\hat{G}_{sd}$ be rejected between the USA on the one hand and Brazil at the HS 6-digit level or Chile at either level of aggregation on the other hand. As emphasized before, this striking robustness across countries is consistent with the idea that the nature of entry costs (though not necessarily their levels) may be similar across countries. For the regressor log distance, however, magnitudes of coefficients vary more strongly across countries. A reason is perhaps that other gravity-related measures of trade barriers—such as language, lacking contiguity, customs-related trade costs, and other policy barriers—covary in important ways with distance but in different ways for different source countries (Anderson and Van Wincoop 2004).

The decomposition of bilateral trade flow components in Table 1 allows us to focus on the (second) extensive margin of product entry by firms more closely. The sum of coefficients in Columns (3) and (4) returns the gravity coefficients for the (second) extensive margin of product entry by firm ($\ln \bar{G}_{sd} = \ln \hat{G}_{sd} + \ln \mu_{sd}$). For both log GDP and log distance, the coefficients in columns (3) and (4) have the same sign across all three countries. The coefficients in Columns (3) and (4) also have the same sign for any level of product classification in Brazil and Chile, respectively. Most strikingly, for the log GDP regressor the total coefficient sum across all columns is close to zero in all five specifications. Under a triple decomposition following (3), the regression of $\bar{G}_{sd}$ on log GDP and log distance

Table 1 Gravity and the quadruple exports decomposition

	Log Total exports $\ln T_{sd}$ (1)	Log # Firms $\ln M_{sd}$ (2)	Log # Total products $\ln \hat{G}_{sd}$ (3)	Log share Pos. Prod. exp. $\ln \mu_{sd}$ (4)	Log sales/# prod./firm a_{sd} (5)
US exports 2002 (HS 10-digit level)					
Log GDP	1.01	0.71	0.55	−0.48	0.23
	(0.04)*	(0.03)*	(0.03)*	(0.03)*	(0.02)*
Log distance	−1.37	−1.17	−1.10	0.84	0.05
	(0.17)*	(0.15)*	(0.15)*	(0.13)*	(0.10)
Obs.	175	175	175	175	175
R^2	0.82	0.76	0.68	0.66	0.37
Brazilian exports 2000 (HS 6-digit level)					
Log GDP	0.97	0.56	0.59	−0.56	0.38
	(0.05)*	(0.04)*	(0.04)*	(0.04)*	(0.03)*
Log distance	−2.03	−1.95	−2.37	1.95	0.34
	(0.26)*	(0.18)*	(0.20)*	(0.18)*	(0.16)
Obs.	174	174	174	174	174
R^2	0.67	0.63	0.64	0.63	0.48
Brazilian exports 2000 (NCM 8-digit level)					
Log GDP	0.97	0.56	0.60	−0.56	0.38
	(0.05)*	(0.04)*	(0.04)*	(0.04)*	(0.03)*
Log distance	−2.03	−1.95	−2.40	1.95	0.37
	(0.26)*	(0.18)*	(0.20)*	(0.18)*	(0.16)
Obs.	174	174	174	174	174
R^2	0.67	0.63	0.65	0.63	0.47
Chilean exports 2000 (HS 6-digit level)					
Log GDP	0.85	0.51	0.54	−0.51	0.30
	(0.09)*	(0.05)*	(0.05)*	(0.05)*	(0.05)*
Log distance	−1.05	−1.22	−1.59	1.22	0.54
	(0.41)	(0.23)*	(0.26)*	(0.23)*	(0.25)
Obs.	160	160	160	160	160
R^2	0.39	0.47	0.45	0.47	0.21
Chilean exports 2000 (HS 8-digit level)					
Log GDP	0.85	0.51	0.54	−0.51	0.30
	(0.09)*	(0.05)*	(0.05)*	(0.05)*	(0.05)*
Log distance	−1.05	−1.22	−1.60	1.22	0.55
	(0.41)	(0.23)*	(0.26)*	(0.23)*	(0.25)
Obs.	160	160	160	160	160
R^2	0.39	0.47	0.45	0.47	0.21

Sources: Bernard et al. (2011) for US 2002 manufacturing firms, Brazilian *SECEX* 2000, Chilean customs data 2000; manufacturing firms and their manufactured products. Products at the HS 10-digit level for the USA; at HS 6-digit and NCM 8-digit levels for Brazil; at HS 6-digit and 8-digit levels for Chile.

Note: Total exports T_{sd} are decomposed into $T_{sd} = M_{sd}\ \hat{G}_{sd}\ \mu_{sd}\ a_{sd}$, where M_{sd} is the number of exporters in s with shipments to destination d, $\hat{G}_{sd} \equiv \sum_{\omega \in \Omega_{sd}} G_d(\omega)$ is the total number of products exported from s to d by any firm, μ_{sd} is the fraction of firm–product combinations with positive exports which Bernard et al. (2011) call the 'density of trade', and $\bar{a}_{sd} = [\sum_{\omega \in \Omega_{sd}} t_d(\omega)]/[\sum_{\omega \in \Omega_{sd}} G_d(\omega)]$ is the mean exporter scale. Results from country-level ordinary least squares regressions for the dependent variable noted at the top of each column projected on the covariates listed in the first column. Estimates of the constant suppressed. Standard errors in parentheses: * marks statistically significant difference from zero at the 1% level.

results in a GDP coefficient between 0.03 and 0.04 for Brazil and Chile at either level of product aggregation (see Table A1) and that coefficient is not statistically different from zero at the 1% significance level, contrary to the individual coefficients in Table 1. We conclude that the partial correlation between log average exporter scope $G_d(\omega)$ and log GDP is close to zero, conditional on log distance. In contrast, log distance is significantly negatively related to log exporter scope $G_d(\omega)$, conditional on log GDP.

In summary, gravity-style regressions suggest that the (second) extensive margin of product entry by firms is not significantly related to destination–market size, as measured by GDP, but product entry is related to distance. The reverse is the case for the remaining intensive margin of sales per firm–product. Sales per firm–product are unrelated to distance but significantly related to destination–market size as measured by GDP. Inasmuch models of multi-product exporting strive to match this pattern, they will need to decouple the response of exporter scope to destination–market characteristics at the second extensive margin from the response of exports per firm–product at the remaining intensive margin. Models with flexible fixed product-entry cost functions, such as Arkolakis and Muendler (2010) but conceivably also several others, can achieve the decoupling under specific parameter restrictions.

The absence of a statistical association between sales per firm–product and distance complements recent findings on the relationship between unit prices and distance (Bastos and Silva 2010; Manova and Zhang 2012; Martin 2012; Görg et al. 2010).[10] Martin (2012), for instance, finds for French exporters that doubling the distance to the destination country is associated with an average increase in a firm–product's unit price by 3% for a given firm–product. For Chinese exporters, Manova and Zhang (2012) find in a comparable regression that firms charge a 1% higher unit price for a given firm–product when the destination–country distance doubles. In light of those unit-price regression results, our finding of no response of sales per firm–product to increasing distance may imply that sold quantities decline by roughly the same percentage as prices increase for the same firm–product when distance doubles.

5.2 Mean exporter scope and market size

We now investigate further the relationship between the (second) extensive margin of product entry by firms and destination–market characteristics. In particular, we revisit the earlier finding that the partial correlation

[10] We thank an anonymous referee for pointing out this connection.

between log average exporter scope $G_d(\omega)$ and market size is close to zero. We use manufacturing absorption as a more rigorous measure of market size, consistent with our earlier evidence in Section 3 and in line with the preferred market-size measure in Eaton et al. (2004, 2011). Accordingly, we pursue a new graphical representation here and plot mean exporter scope per destination against the destination's manufacturing absorption. Figure 5 depicts the relationship between exporter scope and the destination country's market size.

Figure 5 confirms graphically that there is no relevant association between average exporter scope $G_d(\omega)$ and market size, now using manufacturing absorption in the place of GDP as our market size measure. In the left panel of Figure 5A and C, the scatter plot shows mean exporter scope at the destination on the vertical axis against market size on the horizontal axis, without conditioning on any distance proxy. While the linear fit suggests a slightly positive slope for Chile, the slope coefficient is not statistically different from zero at the 5% significance level for either Brazil or Chile.

Figure 5B and D repeats the scatter plot but uses mean exporter scope divided by the source country's market share at the destination country ($\lambda_{sd} \equiv T_{sd}/X_d$) on the vertical axis. The source country's market share is thought to be associated with the distance between source and destination and thus serves as a rudimentary control for geography, similar to the approach in Figure 2. The slope coefficient is again not statistically different from zero at the 5% significance level for either Brazil or Chile.

We have seen evidence in Section 3 (Figure 2 for Chile) consistent with the idea that large markets may attract the entry of individual firm–products at a somewhat higher elasticity than the entry of firms. We now have assembled additional evidence on exporter scope to revisit that idea. Note that the evidence in Section 3 does not imply that market size raises exporter scope for a given firm. As we have seen in Section 4, the median firm ships just one or two products even to the largest market (the USA). In this section, we have seen that the mean scope per exporter, too, is insensitive to destination-market size. Together, these findings suggest that market size drives firm entry but does not meaningfully alter the subsequent product entry decision of firms. The insensitivity of exporter scope to a destination's market size also reinforces the earlier conclusion from Section 4 (Figure 4) that the scope distribution is similar across destinations. As previously mentioned, models with flexible fixed product-entry cost functions, such as Arkolakis and Muendler (2010) but conceivably also several others, can generate the insensitivity of exporter scope to market size under specific parameter restrictions.

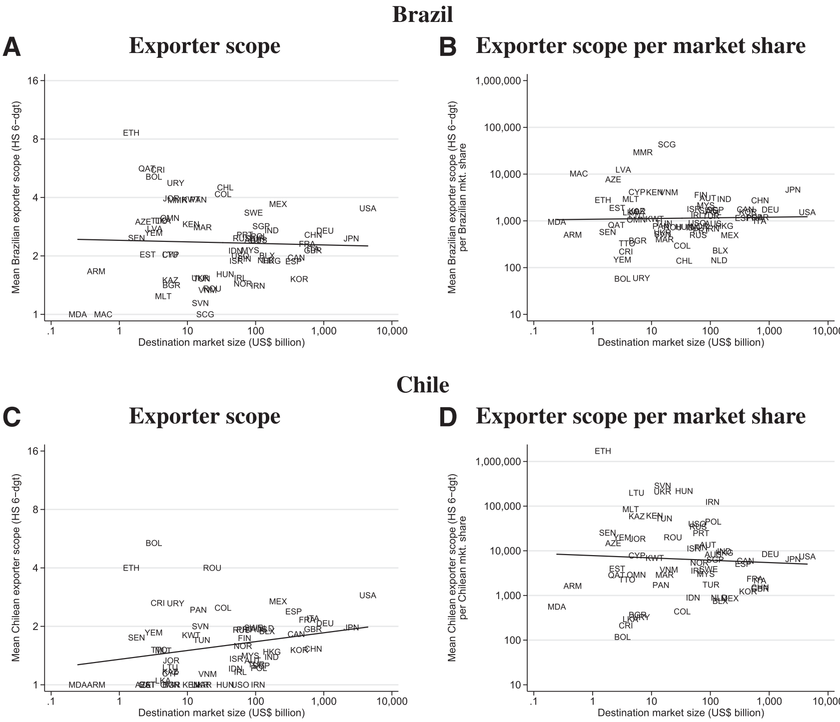

Figure 5 Mean exporter scope and absorption by destination. *Source*: Brazilian *SECEX* 2000, Chilean customs data 2000; manufacturing firms and their manufactured products at the HS 6-digit level, linked to *WTF* (Feenstra et al. 2005) and *Unido* Industrial Statistics (UNIDO 2005). *Note*: Market size is absorption by a country's manufacturing sector. The slopes of the fitted lines are –0.0079 (standard error 0.026) for Brazilian firm's mean exporter scope (A), 0.015 (0.072) for Brazilian firm's mean exporter scope per market share (B), 0.046 (0.023) for Chilean firm's mean exporter scope (C), –0.052 (0.023) for Chilean firm's mean exporter scope per market share (D).

6 Concluding Remarks

We have compared a series of firm-level statistics on product exports across export data sets for four countries. We find a remarkable similarity of the statistics across the four countries, two of which are developing countries and two industrialized. This robustness suggests that these and related firm-level statistics on export products may serve as potential anchors for future theoretical work.

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Appendix

Table A1 presents short gravity regressions for the three main export margins and their relationship to log GDP and log distance. There are

Table A1: Gravity and the triple exports decomposition

	Log Total exp. T_{sd} (1)	Log # Firms M_{sd} (2)	Log # Products /firm $\bar{G}_{sd}$ (3)	Log sales/# prod. /firm a_{sd} (4)
Brazilian exports 2000 (HS 6-digit level)				
Log GDP	0.97	0.56	0.03	0.38
	(0.05)*	(0.04)*	(0.01)	(0.03)*
Log distance	−2.03	−1.95	−0.42	0.34
	(0.26)*	(0.18)*	(0.07)*	(0.16)
Obs.	174	174	174	174
R^2	0.67	0.63	0.19	0.48
Brazilian exports 2000 (NCM 8−digit level)				
Log GDP	0.98	0.57	0.04	0.38
	(0.05)*	(0.04)*	(0.01)	(0.03)*
Log distance	−2.01	−1.93	−0.46	0.38
	(0.26)*	(0.18)*	(0.07)*	(0.16)
Obs.	175	175	175	175
R^2	0.67	0.63	0.21	0.48
Chilean exports 2000 (HS 6−digit level)				
Log GDP	0.86	0.52	0.03	0.31
	(0.08)*	(0.05)*	(0.01)	(0.05)*
Log distance	−1.02	−1.21	−0.37	0.56
	(0.41)	(0.22)*	(0.06)*	(0.25)
Obs.	161	161	161	161
R^2	0.40	0.47	0.19	0.22
Chilean exports 2000 (HS 8−digit level)				
Log GDP	0.86	0.52	0.03	0.31
	(0.08)*	(0.05)*	(0.01)	(0.05)*
Log distance	−1.02	−1.21	−0.38	0.57
	(0.41)	(0.22)*	(0.06)*	(0.25)
Obs.	161	161	161	161
R^2	0.40	0.47	0.19	0.22

Sources: Brazilian *SECEX* 2000, Chilean customs data 2000; manufacturing firms and their manufactured products. Products at the HS 6-digit and NCM 8-digit levels for Brazil; at HS 6-digit and 8-digit levels for Chile.

Note: Total exports T_{sd} are decomposed into $T_{sd} = M_{sd}\,\bar{G}_{sd}\,\bar{a}_{sd}$, where M_{sd} is the number of exporters in s with shipments to destination d, $\bar{G}_{sd} \equiv \sum_{\omega\in\Omega_{sd}} G_d(\omega)/M_{sd}$ is the exporter's mean exporter scope, and $\bar{a}_{sd} \equiv \bar{t}_{sd}/\bar{G}_{sd}$ is their varietie's mean exporter scale. Results from country-level ordinary least squares regressions of the dependent variable noted at the top of each column on the covariates. Estimates for the constant suppressed. Standard errors in parentheses: * marks statistically significant difference from zero at the 1% level.

two extensive margins of export activity: first firm entry at a given destination, and second product entry by the same firm at a given destination. The second extensive margin gives rise to a firm's *exporter scope* at a destination. The remaining third, intensive margin captures individual firm–product sales at a destination. A related three-way decomposition of total exports to a destination (see Equation (3)) breaks export sales down into the number of firms shipping to the destination, their average exporter scope, and their average exporter scale (their mean firm–product sales). Those are the three dependent variables in Table A1. Following Bernard et al. (2011), the companion Table 1 in the text considers a quadruple decomposition (see Equation (5)).