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Firm-to-firm trade networks: A focus on Latin America and the Caribbean

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WORKING PAPER N° IDB-WP-1679

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A Focus on Latin America and the Caribbean

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Abstract*

Trade flows are the result of the interaction between buyers and sellers. Understanding how these firm-to-firm relationships form, survive, and evolve over time helps identify how countries can improve their export outcomes. Using a very granular dataset of United States import transactions from all countries around the world, we present a battery of static and dynamic metrics of firm-to-firm relationships. We show how Latin American exporters compare with exporters from other regions across all the metrics. We show that trade costs negatively affect the formation and duration of firm-to-firm networks. Regional differences in these costs partially explain Latin America's performance. The study discusses a series of measures to reduce trade-related costs in the region that, in light of the results, are likely to improve the trade networks of Latin American countries.

JEL classifications: F12, F14, L22

Keywords: Trade networks, Supply chains, Exports

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1 Introduction

Trade flows are the result of buyers and sellers interacting with each other. Understanding how these firms-to-firm relationships are formed, survive, and evolve over time can provide important policy insights, particularly for countries seeking to improve their export outcomes, including participation in global value chains (GVC).

Using a very granular dataset of United States (US) import transactions from all countries around the world, in which each US buyer and each foreign supplier is duly identified, we construct a battery of static and dynamic metrics of firm-to-firm relationships. We present how these metrics vary across countries in Latin America and the Caribbean, and how exporters from this region compare, on average, with exporters from Asia and Europe. We also assemble trade costs data, in particular ad valorem tariffs and freight rates, and measure how these costs affect the formation and duration of these firm-to-firm relationships.

We found that, on average, Latin American exporters underperform exporters from other regions across all metrics. We show how trade costs negatively affect the formation and duration of firm-to-firm networks, with relatively larger impacts due to market access frictions from tariffs rates. We discuss how differences in these costs partially explain Latin America's subpar performance.

The general results from the static and dynamic metrics in this study are in line with a growing literature on the networked nature of cross-border trade that has uncovered a number of insights related to the anatomy of these firm networks and their interactions (with various trade shocks and trade barriers (Egan and Mody, 1992; Volpe et al., 2015; Monarch, 2016; Antràs et al., 2017; Bernard and Moxnes, 2018; Bernard et al., 2018b,a; Carballo et al., 2018; Kamal and Monarch, 2018; Bernard et al., 2022; Monarch, 2022; Monarch and Schmidt-Eisenlohr, 2023; Handley et al., 2024)). The contribution of this study is to calculate these metrics for a broad group of countries in Latin America and the Caribbean and compare the performance of exporters from this region with that of other regions of the world. A second contribution of this analysis is the examination of how trade costs, and in particular tariffs and transport costs, affect the formation and evolution of these trade networks.

The rest of the paper is organized as follows. Section 2 describes the dataset and presents a battery of static and dynamic metrics of firm-to-firm relationships. The comparison between Latin America and other regions is also made in this section when presenting each metric. Section 3 discusses the strategies behind our empirical estimations and introduces the econometric and survival models that relate the firm metrics with tariff and transportation costs. The section also shows the estimations, analyzes the results and discusses the extent to which differences in these trade costs are behind differential performances across regions. Section 4 ends the paper by highlighting the need to address trade costs and discussing a series of trade facilitation and trade support policies that, in light of the results, are also likely to improve the trade networks of Latin American countries.

2 Data Description and Firm-to-firm Metrics

We employ high frequency transaction-level data derived by PIERS, a commercial vendor, using detailed bill of lading (BoL) documents. The dataset is comprised of US imports from vessels from all the countries around the world. The dataset provides a unique identifier for US importers and for exporters in foreign countries. For each transaction there is also information on the date, the product code (at the HS 6-digit level), the country of origin, the weight, and “estimated” value of the shipment.¹ The dataset spans from 2014 to 2020. Due to the potential impact of Covid-19, we present most metrics for the year 2019 and only include the year 2020 for the metrics where we show their entire evolution over time.

Given our interest in the Latin American region, and the fact that the bulk of the Mexican exports to the United States are shipped by land, for this particular country we complement the maritime exports from PIERS with another BoL dataset provided by Panjiva (another commercial vendor), which includes Mexican exports to the US shipped by land. Therefore, for Mexico, the dataset consists of maritime exports derived from PIERS complemented with land exports derived from Panjiva.² Most of the results shown for this country would reflect the combination of these two sources of information.³

All the metrics in this paper are calculated using the entire dataset of US buyers and foreign exporters. As a robustness check, we also repeat the entire analysis after excluding US third-party companies like logistics, warehousing and intermediary firms that are not directly engaged in production.⁴ This reduces the dataset by about 3.8%. All the results remain practically the same after excluding these third-party companies.⁵

As mentioned above, Section 3 examines the impact of trade costs on the firm-to-firm metrics that we calculate. For the construction of the trade costs variables, in particular ad valorem tariff and freight rates, we employ data that come from the US Census Merchandise Trade Imports. The dataset includes the custom duty paid and the maritime transport cost value associated with each US import value at the 10-digit HS system from each country in the world. The dataset is aggregated at the 6-digit HS level to match the PIERS dataset. Ad valorem tariffs and freight rates are calculated by dividing the custom duties and the transport costs by their corresponding import values.

¹PIERS estimates the value of shipments using reference tables by HS code from the US Department of Commerce waterborne values. Accordingly, the results regarding export values should be taken with caution.

²The Panjiva dataset has certain shortcomings. In particular, the transactions by which the US buyer can be properly identified represent around 1/3 of the total value of land exports from Mexico. While this is an important limitation, we still choose to use this dataset to complement PIERS because this gives us at least some coverage of Mexican exports shipped by land.

³To facilitate the comparison of Mexico with the rest of the countries, some results are reported separating maritime exports from land exports.

⁴There is not a straightforward way to identify third-party companies in the PIERS dataset. We employ the following three criteria to drop these companies from the dataset. First, we drop all US major wholesalers and retailers identified by name. These include companies like Costco, Home Depot, Walmart or Target. Second, we drop any company whose name includes words like wholesaler, warehouse or trader. Finally, we drop any company that imports more than 400 different HS6 products during a given year.

⁵Results available from the authors upon request.

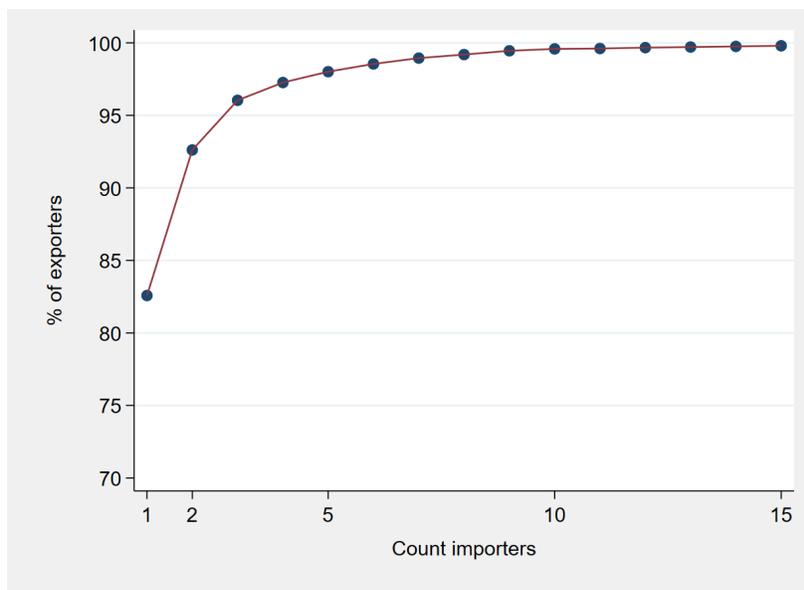
2.1 Static Metrics

In this sub-section we start with a battery of firm-to-firm static metrics, while in the next we add dynamics to these measures. To facilitate the explanation, we present each metric first using the example of one country, Colombia, and then we include the results for all the other countries. All the static metrics are based on the year 2019.⁶

We follow [Monarch \(2016\)](#) and consider a trade relationship a combination of an exporter, an importer and a product—that is, an exporter from country c selling product p (HS 6 digits) to an importer in the United States. This means, for example, that an exporter selling two different products to the same importer in the United States is considered to be involved in two relationships. This provides for a rich definition of a trade relationship that takes into account differences in the products that are traded.

We begin with some basic metrics regarding the number of buyers per exporter. In 2019, for example, there were 3,429 different firms exporting from Colombia to the United States, while there were 3,966 firms in the US importing products from Colombia. In total, 1,379 different products (defined at the HS6 level) were transacted. During this year, there were 10,309 relationships involving an exporter from Colombia, selling a product to an importer in the United States. Of those, 82.6% were monogamous in the sense that the exporter ships the product to only one buyer in the United States (see [Figure 1](#)).

Figure 1: Cumulative Distribution of Number of US Importers per Colombian Exporter



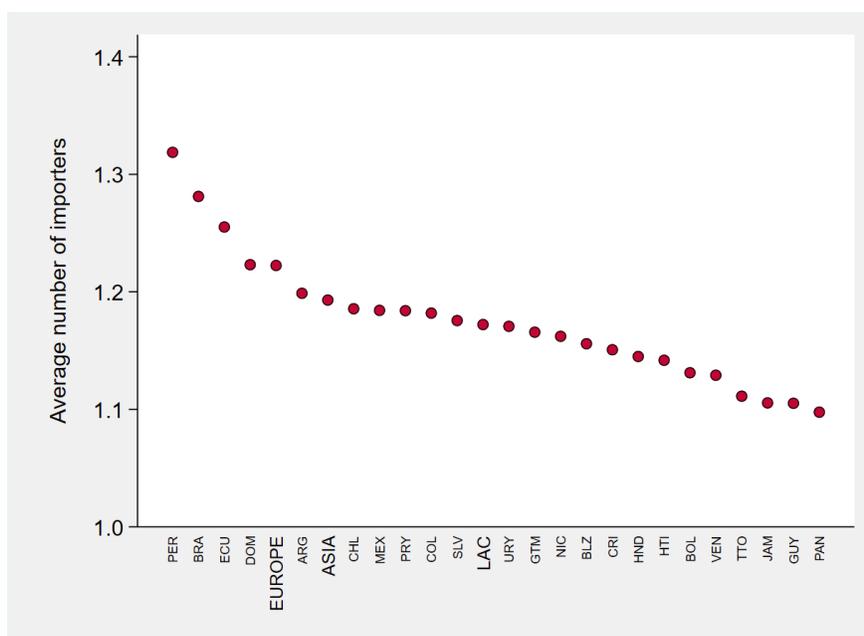
This finding is in line with the well-documented skewness of activity across exporting firms in other studies ([Bernard and Moxnes, 2018](#)). In other words, the majority of exporters sell a product to only one buyer in a particular country, while a small percentage sell the same product to more than one buyer in that country. Since the remainder of the matches between Colombian exporters

⁶We focus on 2019 to avoid affecting the results with the potential impacts of Covid-19. Nevertheless, we employ the entire 2014-2020 period in the dynamic metrics.

and US buyers are polygamous, the average Colombian exporter sells its product to around 1.2 buyers in the US.

Figure 2 presents this average for our group of Latin America and Caribbean countries. For each country, we calculate the average for each sector (HS 4-digits), and then we take the simple average across all the sectors. Figure 2 also shows regional averages from Latin America and the Caribbean, as well as for Asia and Europe.⁷ The skewness of trade relationships in which an exporter ships its product mostly to only one buyer in the United States is observed in all countries, resulting in an average number of buyers that ranges between 1.09 to 1.38.^{8 9} The regional comparison shows that exporters from Latin America have, on average, a slightly smaller number of US buyers (1.16) than those from Asia (1.18) and Europe (1.22).

Figure 2: Average Number of US Importers per Exporter from Country c



While exporters that ship a product to multiple buyers represent a small share of all the exporters, their shares in terms of export values are much larger. Figure 3 illustrates the case for Colombia. The first column in Figure 3 shows the share of Colombian exporters with multiple US buyers (average across all sectors). Again, we calculate this share for each sector (HS 4-digits) and then we take the simple average across all sectors.¹⁰ The second column shows the share of

⁷The countries in each region are as follows, **LAC**: Antigua and Barbuda, Argentina, Aruba, Bahamas, Barbados, Belize, Bolivia, Brazil, Chile, Colombia, Costa Rica, Dominica, Dominican Republic, Ecuador, El Salvador, Grenada, Guatemala, Guyana, Haiti, Honduras, Jamaica, Mexico, Nicaragua, Panama, Paraguay, Peru, Trinidad and Tobago, Uruguay and Venezuela. **Europe**: Austria, Belgium, Bulgaria, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden and the United Kingdom. **Asia**: China, Hing Kong, India, Japan, Korea, Malaysia, Philippines, Singapore, Taiwan, Thailand and Vietnam.

⁸The skewness of trade relationships is also present from the importer side: around 80% of US buyers import a product from only one supplier in the exporting country

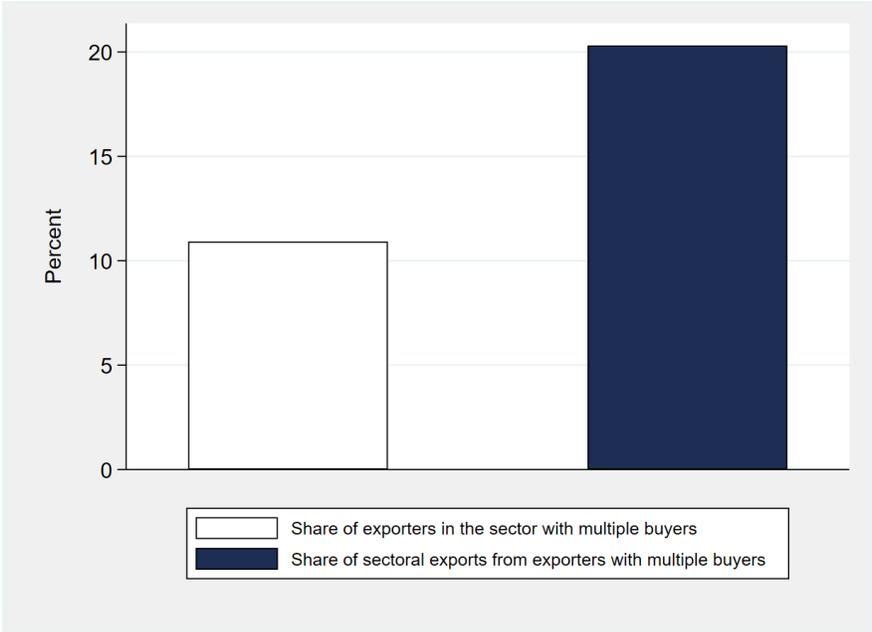
⁹For Mexico, the average number of buyers is equal to 1.16 for maritime exports and 1.6 for land exports.

¹⁰This explains the slight difference between the results in this figure and those in Figure 1.

exports associated with exporters that have multiple US buyers (average across all sectors). While exporters with multiple buyers typically represent around 11% of exporters in each sector, they account for around 20% of the sector's exports, on average. In other words, the share of exporters with multiple buyers is generally small on average for each sector, but they account for a larger share in terms of the sector's exports.

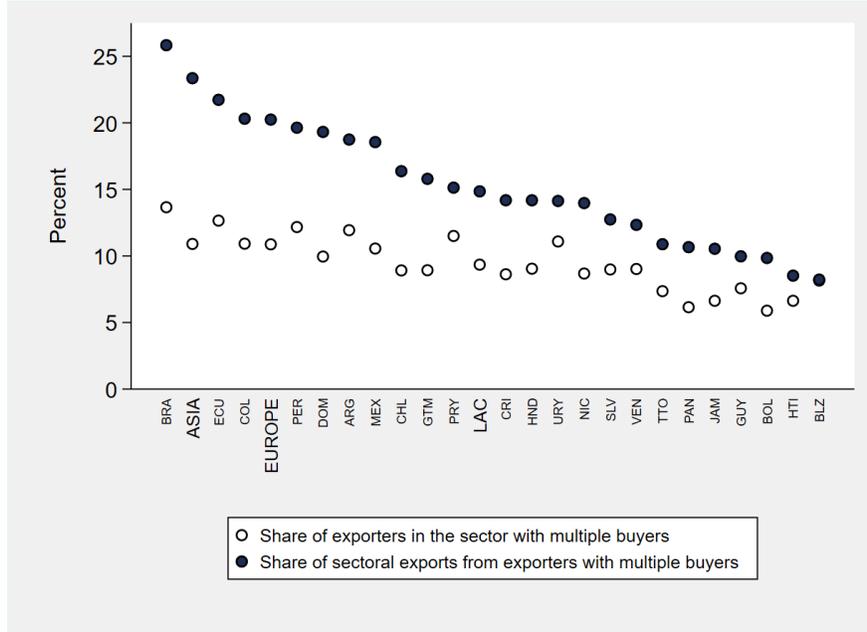
Figure 4 shows that the evidence presented for Colombia is similar with respect to all the other countries of Latin America and the Caribbean. The share of exports from exporters with multiple buyers is always larger than the share of exporters with multiple buyers.¹¹ The regional comparison indicates that the share of exports from multiple buyers is the largest in Asia (24%), followed by Europe (20.5%), and lastly Latin America (15%). In other words, exporters with multiple buyers account for a much larger share of exports in Asia and Europe than in Latin America.

Figure 3: Colombian Exporters with Multiple Buyers, Average across Sectors



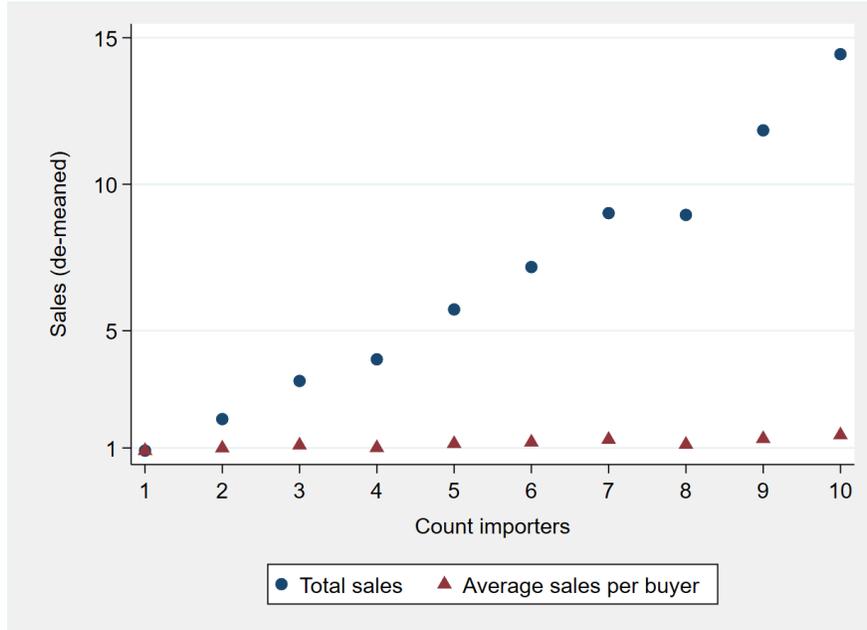
¹¹For Mexico, the share of exporters with multiple buyers is 10.6 for maritime exports and 24.4 for land exports. The share of sectoral exports from exporters with multiple buyers is 18.6 for maritime exports and 48.6 for land exports.

Figure 4: Exporters with Multiple Buyers



The next question that we want to answer is why do exporters with multiple buyers export more than exporters with a single buyer? Is it simply because they have more buyers, or do they also sell more to each buyer? We analyze this by comparing the sales per buyer of exporters that have only one buyer with that of exporters that have multiple buyers. Figure 5 presents the case for Colombian exporters, with triangles showing average sales per buyer. Sales in this figure have been demeaned to present them relative to the industry average. Therefore, a value close to 1 means that the average sales per buyer is very close to the industry average. Note that the red dots lie very close to 1 regardless of the number of importers (buyers). This means that average sales per buyer do not change much with the number of buyers. On the other hand, the dots, which show total sales, increase with the number of buyers. This shows that large Colombia firms are large mostly because they have more buyers (the extensive margin), and much less because they sell more to each of those buyers (the intensive margin). Similar evidence has been shown in analyses for Belgium and Norway (Bernard et al., 2022, 2018b). Note, nevertheless, that the average sales per buyer is slightly less than 1 when the firm has only one importer and slightly more than 1 when the firm has multiple importers. Therefore, large Colombian exporters do sell more per buyer than their counterparts with only one customer, which shows that the intensive margin does play a role. This role, however, is rather small relative to that of the extensive margin, as mentioned before.

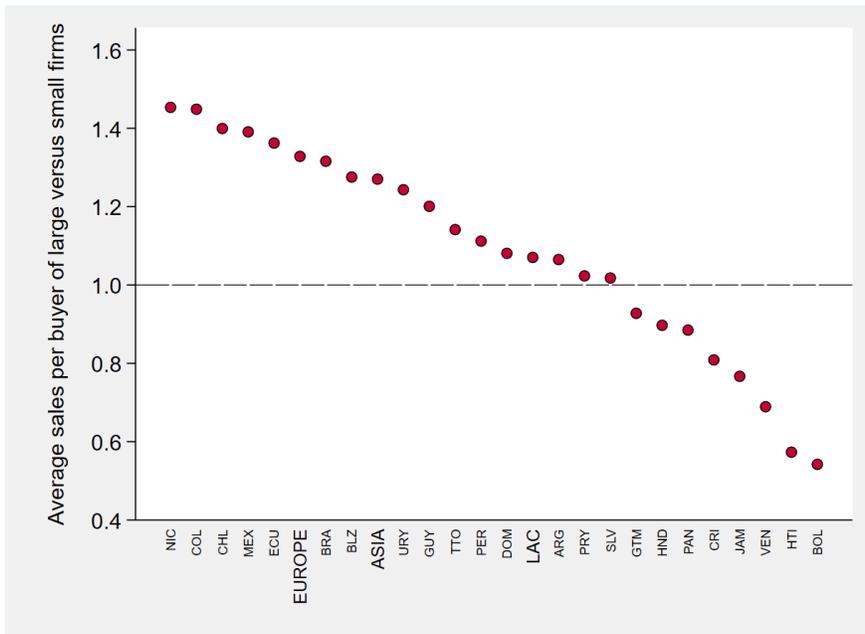
Figure 5: Average Sales per Buyer and Total Sales of Colombian Exporters, by Number of US Importers



To appreciate more clearly the differences in sales per buyer across exporters with different number of buyers, we calculate the ratio of average sales per buyer across two different groups of exporters: i) exporters in the 99th percentile in terms of the number of buyers, and ii) exporters with only one buyer. Figure 6 presents this ratio for our group of Latin American exporters and the regional averages. Countries like Nicaragua, Colombia, Chile and Mexico exhibit the highest ratios. In these countries, the very large exporters (in terms of the number of customers) have average sales per buyer that are around 40% higher than the average sales per buyer of exporters with only one customer. Interestingly, in some countries this ratio is smaller than one, indicating that the average sales per buyer are lower for exporters with many buyers relative to exporters with only one buyer.¹² In Europe, very large exporters have average sales per buyer that are around 35% higher than the average sales per buyer of exporters with only one customer. In Asia, this share is 25%, while in Latin America it is only 6%.

¹²For Mexico, the ratio is equal to 1.4 for maritime exports and 1.13 for land exports.

Figure 6: Average Sales per Buyer of Large Exporters (99th percentile in number of buyers) Relative to Small Exporters (one buyer)



Given the importance of the number of buyers in relation to the size of an exporter, we employ simple regressions to examine how this metric differs when we compare exporters from Latin America with exporters from Europe and Asia. Figure 7 shows the results. The figure presents deviations from the global average level after accounting for differences in product and firm characteristics for each country. To do this, we calculate the number of US buyers for each exporter in country c selling product p in year t . Then, we regress this variable against a region dummy as well as product-time and firm-product fixed effects.¹³ The figure presents the estimated coefficients for the region dummies and their confidence intervals. Exporters from Latin American countries have, on average, fewer buyers than exporters from other regions. In particular, the number of US buyers associated with Latin American exporters is 17% lower than the global average, even after controlling for differences in product specialization and firm characteristics.

2.2 Dynamic Metrics

The previous sub-section presented a series of static metrics of firm-to-firm relationships. In this section we add some dynamics to examine how these relationships evolve over time. We are particularly interested in the rate at which these relationships are formed and perish.

We start once again with the example of Colombia. Table 1 presents the results. In 2014 there were 4,698 relationships comprising an exporter from Colombia selling a product to an importer in the United States. Of these matches at the beginning of the period, only 1,869 made it to the next year. In other words, only 30% of the initial matches made it to 2015. Note, however, that of those

¹³To calculate meaningful regional averages, we use weights so that each country is equally important within each region, regardless of the number of observations the country has in the dataset.

that made it to 2015, 883 or around 47% made it to the next year. Thus, the rate of survival tends to increase. These rates are not very different when compared to other studies. For instance, [Eaton et al. \(2014\)](#) found that only 30% of the initial buyer-seller matches between Colombian exporters and US importers survived to the second year, and of those that survived, around 50% persist to the next year. Table 1 also illustrates the beginning of new relationships. For example, from the total of 7,287 relationships in 2015 (last column), the majority of them, or 5,418 relationships, started that year.

Table 1: Number of Buyer-Seller-Product Relationships by Start Cohort, Colombian Exporters

	2014	2015	2016	2017	2018	2019	2020	Total
2014	4,698							6,161
2015	1,869	5,418						7,287
2016	883	1,020	5,562					7,465
2017	542	400	965	5,860				7,767
2018	395	201	406	1,105	6,473			8,580
2019	256	102	205	386	1,148	7,694		9,791
2020	112	44	63	109	250	1,453	7,745	9,776

We can express the information from the matrix in Table 1 in terms of rates. For this, we follow the work in Davis et al. (1998) on job creation and destruction. The authors note that at any point in time there are jobs being created (the start of a relationship between a worker and an employer) and jobs being destroyed (the termination of a relationship between a worker and an employer). We apply these concepts to our setting. As we saw in Table 1, in any given year, there are many relationships between exporters and importers being created (birth) and many relationships that cease to exist (death). Accordingly, we can denote the total number of relationships in the current period t by R_t and the total number of relationships in the previous period, $t - 1$, as R_{t-1} . The difference in the two periods is the change in the total number of relationships, which is given by $\Delta R_t = (R_t - R_{t-1})$. Denote the gain in the number of relationships between $t - 1$ and t by $\Delta^+ R_t$, and the loss in the number of relationships by $\Delta^- R_t$. We can write the birth, death, and net birth rates as follows:

$$birth_t = \frac{\Delta^+ R_t}{0.5 \cdot (R_t + R_{t-1})} \quad (1)$$

$$death_t = \frac{\Delta^- R_t}{0.5 \cdot (R_t + R_{t-1})} \quad (2)$$

$$net\ birth_t = birth_t - death_t = \frac{\Delta R_t}{0.5 \cdot (R_t + R_{t-1})} \quad (3)$$

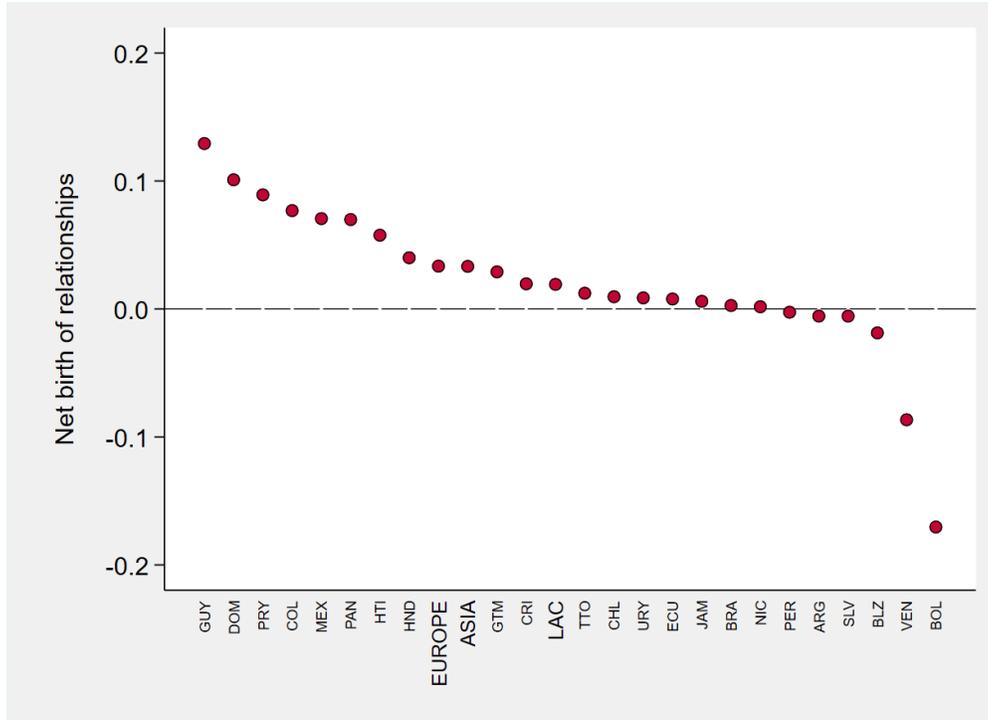
The results of applying these rates to the example of Colombia are reported in Table 2. Looking at 2015, for example, the birth, death and net birth rates were 80.6%, -63.8% and 16.8%, respectively. This means that 63.8% of the relationships that existed in 2014 ceased to exist in 2015 (death) while 80.6% of the relationships in 2015 were new (birth). This resulted in a net growth rate of relationships (net-birth) of 16.8% in 2015. It is very useful to present the information in this way because, while the net birth rate shows the average annual growth rate of relationships, the birth and death rates indicate that there is much churning behind this rate. A significant number of relationships are born and die each year. In other words, the birth and death rates (in absolute values) are larger than the net birth rates by several orders of magnitude.

Table 2: Net and Gross Rates of Relationships, Colombian Exporters

	Birth	Death	Net birth
2015	0.8058	-0.6383	0.1675
2016	0.7541	-0.7299	0.0241
2017	0.7694	-0.7298	0.0397
2018	0.7919	-0.6925	0.0995
2019	0.8376	-0.7058	0.1318
2020	0.7916	-0.7932	-0.0015
Mean 2015-2020	0.7917	-0.7149	0.0768

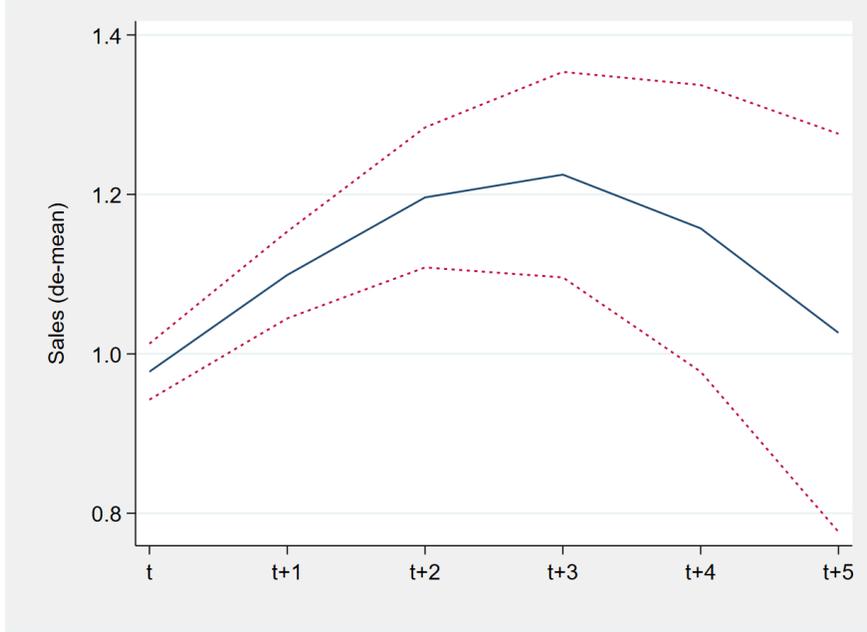
The large level of churning observed in Table 2 is not a feature exclusive to Colombia. This is a pervasive result that is present in all countries of Latin America and the Caribbean. In Figure 7 we show the net birth rate (average for the period 2015-2020) for each country in Latin America and the Caribbean. In most countries the birth rate is higher than the death rate (in absolute value), resulting in a positive net gross rate of relationships during this period.¹⁴ In only a few countries was this average net growth rate negative. The regional comparison reveals that the net growth rate of relationships between Latin American exporters and US buyers was lower, on average, than between the European exporters and US buyers or between Asian exporters and US buyers.

Figure 7: Net Gross Rate of Relationships



¹⁴The results for Mexico combined both maritime and land exports.

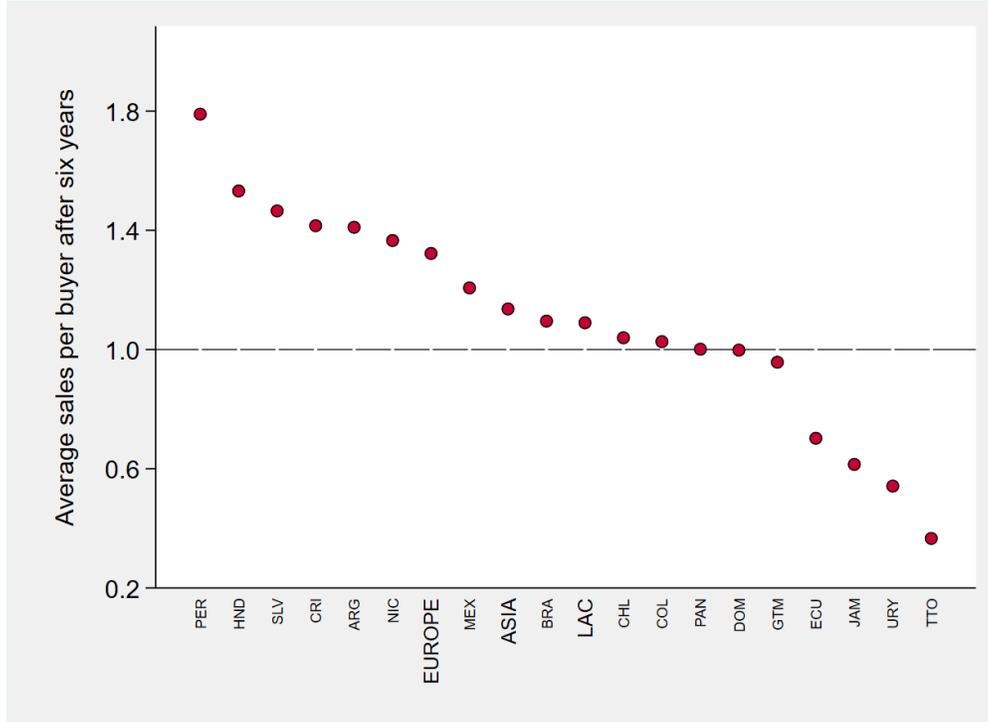
Figure 8: Average Sales per Buyer by Length of Relationship, Colombian Exporters



Another important dynamic metric to examine is the evolution of the average sale of a relationship (the intensive margin) as the relationship matures. The result is presented in Figure 8 for the case of Colombia. Once again, we use de-meaned sales with respect to industry averages. Accordingly, numbers below (above) 1 imply sales per buyer below (above) the industry average. The figure uses the information from Table 1. In year t , the figure shows the average sales per buyer of all new relationships; in year $t+1$, it shows the average sales per buyer of all relationships that survived to the first year, and so on. Note that the 95% confidence interval widens with time as the number of relationships that survive decreases with each year. The figure shows clearly that the average sales of a new relationship starts small and then grows as the relationship matures. For instance, in Colombia the average sales per buyer of a new relationship is approximately 10% below the industry average, but as the relationship matures, this value grows.

Similar patterns are observed in other exporting countries of Latin America and the Caribbean where the average sales per buyer starts below or very close to the industry's average and becomes larger as the relationship matures. In Figure 9 we show, for our group of Latin American countries, the average sales per buyer after six years of the relationship. In most countries the average sales per buyer are higher than the industry average, but there are exceptions where the average is the same. In addition, in five countries that figure is lower than the industry average. It should also be noted that, relative to Europe and Asia, the average sales per buyer after five years tends to be lower in Latin America and the Caribbean.

Figure 9: Average Sales per Buyer after Six Years of the Relationship



We employ simple regressions again to compare the regional averages, after controlling for firm and product characteristics. In all regions, these mature relationships show average sales per buyer that are larger than the respective industry averages. The findings underscore the importance of sustaining existing trade relationships. Note, however, that the average sales per buyer of Latin American exporters are slightly smaller than those of their counterparts in Europe or Asia.

3 Econometric Estimations

The previous section presented a number of metrics to characterize trade relationships between US importers and exporters from other countries. In this section, we employ the same data to examine trade costs affects some of these metrics. From the point of view of an exporter from country c selling product p to the US, there are two ways it can increase its total exports to this market, by increasing the number of buyers that it reaches in the US, or by increasing the average export value sold to each buyer (or both). In this section we first estimate an econometric model to measure the impact on these variables of arguably the most important trade costs, tariff rates and transport costs.

We employ the following empirical specification:

$$Y_{icpt} = \beta_1 \cdot T_{cpt} + \beta_2 \cdot F_{cpt} + \bar{X}_{it} \cdot \gamma + \theta_{ct} + \theta_{pt} + \theta_{icp} + u_{icpt} \quad (4)$$

where Y_{icpt} is the trade outcome (number of buyers or average sales per buyer) of an exporter i , from country c , selling product p at time t ; T_{cpt} is the US tariff applied to product p of country c ; F_{cpt} is the average ad valorem freight rate of shipping product p from country c to the United States; \bar{X}_{it} is a vector of firm i 's characteristics at time t , (e.g., age)¹⁵; θ_{ct} is a country-time fixed effect that controls for all other country characteristics that may impact the export outcomes, including country size, GDP per capita, wages, distance to the United States, etc; θ_{pt} is a product-time fixed effect that controls for time-variant product characteristics, like the elasticity of substitution; and θ_{icp} is a firm-country-product fixed effect that controls for time-invariant exporter characteristics from country c as well as for time-invariant country-product factors. We employ robust standard errors clustered by country-product level. We are primarily interested in coefficients β_1 and β_2 .

As mentioned before, the export outcomes, Y_{icpt} , are: i) the number of buyers in the United States that exporter i from country c selling product p has at time t (the extensive margin of the exporter), and ii) the average sales per buyer of exporter i from country c selling product p at time t (the intensive margin of the exporter).

Data for the ad valorem tariff and freight rates come from the US Census Merchandise Trade Imports. The dataset includes the customs duty paid and the maritime transport cost value associated with each US import value at the 10-digit HS system from each country in the world. The dataset is aggregated at the 6-digit HS level to match the PIERS dataset. Ad valorem tariffs and freight rates are calculated by dividing the custom duties and the transport costs by their corresponding import values.

The results from estimating equation (4) are shown in Table 3. The first three columns show the results for the number of US buyers. The number of buyers is negatively correlated with the ad valorem tariff rate. The results in column (3), for example, indicate that doubling the tariff rate is associated with a reduction in the number of buyers of around 7%. We do not find a statistically significant relationship between the number of buyers and the ad valorem freight rate. The last three columns present the results for the average exports per buyer. Both the tariff and the freight rates are negatively associated with this variable. In particular, column (6) shows that doubling the tariff and the freight rates are associated with a reduction in average exports per buyer of around 23% and 5%, respectively. The results also show that the age of the exporter (calculated as the difference between year t and the first year that we observe the exporter in the dataset) is positively associated with the number of buyers and the average exports per buyer.¹⁶

¹⁵Age is calculated as the difference between year t and the first year that we observe the exporter in the dataset.

¹⁶The last result is in line with the evidence presented in Figures 9 and 10.

Table 3: Regression Results

	number of buyers			exports per buyer		
	(1)	(2)	(3)	(4)	(5)	(6)
Tariff	-0.0687** (0.0269)		-0.0687** (0.0269)	-0.2279*** (0.0466)		-0.2256*** (0.0466)
Freight		-0.0012 (0.0158)	0.0001 (0.0159)		-0.0568** (0.0225)	-0.0524** (0.0225)
Age	0.1656*** (0.0033)	0.1656*** (0.0033)	0.1656*** (0.0033)	0.3283*** (0.0056)	0.3283*** (0.0056)	0.3283*** (0.0056)
R2	0.686	0.686	0.686	0.804	0.804	0.804
Obs	4,881,333	4,881,333	4,881,333	4,881,333	4,881,333	4,881,333

Notes: Each column reports results from regressions over the period 2014-2020. The dependent variable in columns (1)-(3) is the number of US buyers (in logs), and the dependent variable in columns (4)-(6) is the average exports per buyer (in logs). The explanatory variables are the ad valorem tariff rate (in logs), the ad valorem freight rate (in logs), and the age of the firm, which is calculated as the difference between year t and the first year we observe the firm in the dataset. Additional controls are fixed effects for country-year, product-year, and firm-country-product. Robust standard errors in parentheses are clustered by country-product level.

*** ; ** ; * significant at the 1%, 5% and 10% level respectively

The results in Table 3 clearly show the negative impacts of trade policy. Facing high tariff rates in destination markets limits the exporter's number of buyers in that market, which is the most important channel by which exporting firms can grow total exports. High tariff and transportation costs, in turn, also constrain total exports by limiting the value of exports per buyer.

The econometric analysis so far has investigated the determinants of an exporter's network size (number of buyers) and its intensity (sales per buyer). We are also interested in analyzing what factors determine the length of the relationships in terms of time. Recall from Section 2 that new relationships tend to start small in terms of sales per buyer, and as the relationship matures, sales per buyer grows considerably. This implies that maintaining an existing trade relationship overtime is the key to grow that relationship. We now estimate a series of survival models to examine the main factors behind the survival of a firm-to-firm trade relationship.

A fundamental part of any survival analysis is to measure the length of a relationship. In the context of this paper, this is the length (in years) that an exporter i , from country c , is selling product p to a US importer j . The key step involves converting the raw data into spells of service for each relationship. For instance, if the foreign firm exports the same product to the same US buyer during 5 years, we take this as one spell of service with a length of 5. Also, if the firm exports the same product to the same US buyer in two distinct non-overlapping spells of service, for example, during 2014-2015 and then again during 2019-2020, we treat this as two independent spells. Our data consist of a total of 9,009,119 spells.

Once the data are converted into spells, the duration of a trade relationship can be modeled as a sequence of conditional probabilities that a trade relationship continues after t periods given

that it has already survived for t periods. This is the essence of the survivor function. In a similar fashion, the hazard function is the probability that the trade relationship fails after t periods given that it has survived up to that point. For example, a non-parametric estimation of the hazard function is given by the ratio of spells who fail, $d(icpj)$, to the number of spells at risk in a given period t , $n(icpj)$:

$$\hat{h}_t = \frac{d_{icpj}}{n_{icpj}} \quad (5)$$

The survivor and the hazard functions are alternative ways to express the same underlying process. Regression models with survival data are used to measure the impact that different factors in the duration of these trade relationships. The regression models are normally specified around the hazard function, as these models are more easily grasped by observing how covariates affect the hazard. In particular, we use the semiparametric Cox proportional hazards model proposed by [Cox \(1972\)](#), which is based on the following form:

$$h(t, \mathbf{x}, \boldsymbol{\beta}) = h_0(t) \cdot e^{\mathbf{x}(t)\boldsymbol{\beta}} \quad (6)$$

where \mathbf{x} denotes a vector of explanatory variables and $\boldsymbol{\beta}$ is a set of parameters to be estimated. In the Cox model the baseline hazard, $h_0(t)$, is left unestimated. This is an advantage of the Cox model, as no assumptions about the shape of the hazard have to be made. The Cox model is by far the most popular of choices in regressions models for survival data.

Following the survival literature on trade ([Besedes and Prusa, 2006a,b](#)), we start by including in the model standard gravity-like variables. In particular, we include the GDP and GDP per capita of the exporting countries, while variables like distance, common border and common language are controlled by country fixed effects. We also include product fixed effects to control for time-invariant product characteristics, and year fixed effects to account for common shocks to all the countries. Because of the size of the data and the nature of the survival model, we cannot include country-time and product-time fixed effects, nor individual exporter and importer fixed effects.¹⁷ We control for firm characteristics using the size of importer and the exporter, which are measured, respectively, as total imports (of all products from all exporters in all countries) and total exports (of all products to all US buyers).

We also include the value of the exports of the trade relationship between exporter i and importer j of product p during the first year of service. Very often trade relationships begin in a state of uncertainty where there is some doubt about the prospect of success. Empirical evidence indicates that, in such an environment, the partners tend to start small ([Egan and Mody, 1992](#); [Rauch and Watson, 2003](#)). Our findings, reported in Figures 9 and 10, are consistent with this evidence. According to [Rauch and Watson \(2003\)](#), buyers placing large orders with new suppliers usually need to make substantial investments in training them so they can meet the buyer's requirements. Therefore, by starting with a small relationship, the buyer can discover the

¹⁷Ideally, we would like to include country-time and product-time fixed effects, as in the previous regression model, as well as exporter and importer fixed effects. Unfortunately, the sheer size of the dataset applied to the semiparametric estimation of the Cox hazard model makes this strategy unfeasible, as convergence cannot be achieved due to the large number of fixed effects.

supplier’s capability and willingness to learn to deliver a good to the buyer’s specifications on time before incurring the costs of training. The main cost of starting small, however, is the delay for the buyer in realizing the profits from larger orders, as larger orders normally generate greater surplus for the buyer. This implies that relationships that start with large orders are likely to be those in which a considerable amount of trust is established by both partners from the start. In such an environment, the buyer is willing to make investments in training, thereby making the relationship more lasting. Accordingly, we expect initial size to be negatively correlated with the hazard.

Table 4: Cox Estimates

	(1)	(2)	(3)	(4)	(5)
Initial value	-0.0474*** (0.0005)	-0.0474*** (0.0005)	-0.0474*** (0.0005)	-0.0474*** (0.0005)	-0.0474*** (0.0005)
Size of importer	-0.0084*** (0.0002)	-0.0084*** (0.0002)	-0.0084*** (0.0002)	-0.0084*** (0.0002)	-0.0084*** (0.0002)
Size of exporter	-0.0036*** (0.0002)	-0.0036*** (0.0002)	-0.0036*** (0.0002)	-0.0036*** (0.0002)	-0.0036*** (0.0002)
Age of importer	-0.0675*** (0.0013)	-0.0675*** (0.0013)	-0.0675*** (0.0011)	-0.0675*** (0.0013)	-0.0675*** (0.0013)
Age of exporter	-0.0472*** (0.0012)	-0.0476*** (0.0011)	-0.0478*** (0.0011)	-0.0476*** (0.0011)	-0.0478*** (0.0011)
GDP		-0.1438 (0.1599)	-0.0101 (0.1597)	-0.1422 (0.1602)	-0.0100 (0.1599)
GDP per capita		0.2748 (0.1972)	0.0719 (0.1562)	0.2731 (0.1978)	0.0722 (0.1563)
Tariff			0.1995*** (0.0451)		0.1981*** (0.0448)
Freight				0.0410* (0.0224)	0.0287 (0.0214)
Obs	7,585,435	7,585,435	7,585,435	7,585,435	7,585,435

Notes: Each column reports results from the semiparametric Cox proportional hazards estimation over the period 2014-2020. The dependent variable is the hazard, or the probability that the trade relationship fails. The explanatory variables are the value of the relationship in the first year (in logs), the size of the US importer (measured as the log of its total imports), the size of the foreign exporter (measured as the log of its total exports), the age of the importer and the exporter, the GDP and GDP per capita of the exporting country (in logs), the ad valorem tariff rate (in logs), and the ad valorem freight rate (in logs). Additional controls are fixed effects for country, product and year. Robust standard errors in parentheses are clustered by country-product level.

*** ; ** ; * significant at the 1%, 5% and 10% level respectively

Finally, similar to the previous regression model, we include ad valorem tariffs and freight rates. We expect that these trade costs are positively correlated with the hazard. We employ robust standard errors clustered at the country-product level.

The results, shown in Table 4, indicate that the size of the trade relationship during the first

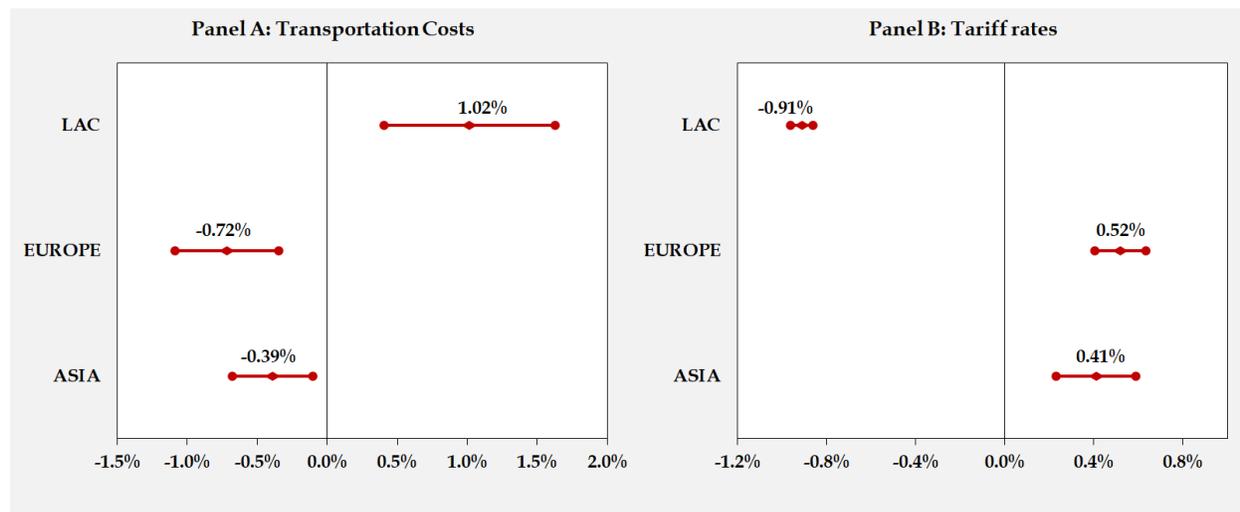
year of service is negatively correlated with the hazard, as expected. That is, trade relationships that start out large have a higher chance of survival than trade relationships that start out small. Exporting to a large buyer also increases the probability of survival (reduces the hazard), while exports from large exporters also tend to have a higher probability of survival. Our country-level variables, GDP and GDP per capita, are not statistically significant.

Trade costs reduce the probability of survival. For instance, the results in column (5) of Table 4, indicate that doubling the tariff rate increases the hazard by around 18%, a significant impact. The effect of transport costs is more modest. Doubling the ad valorem freight rate, for example, increases the hazard by around 4%, according to column (4), while the effect is still positive but less precisely estimated in column (5).

The results from Tables 3 and 4 indicate that high tariff rates in the destination market and high transportation costs negatively affect relevant metrics of a firm’s trade network: the number of buyers (negatively affected by tariffs), the exports per buyer (negatively affected by tariffs and freights) and the length of the relationship (negatively affected by tariff and freights). It is worth closing this section by discussing to what extent differences in tariff rates and transportation costs between Latin America and Europe and Asia explain the subpar performance of Latin American exporters reported in Section 2.

Figure 10 presents some evidence. After accounting for differences in product and firm characteristics, the transport costs associated with Latin American exports to the United States are larger than the transport costs associated with European and Asian exports to the United States. As shown in panel A of Figure 10, Latin American freight costs to the United States are 1.02% larger than the transport costs of the world average exporter to the United States, while those from Europe and Asia are smaller by 0.72% and 0.39%, respectively. Latin American exports, however, do not face larger tariff rates in the United States, on average, than exports from Europe or Asia. As shown in panel B of Figure 10, the average tariff rates for the three regions are all very close to the average US tariff rates faced by world exporters and, if anything, marginally smaller for Latin America.

Figure 10: Trade Costs, Regional Averages: Deviation from Global Levels)



Overall, the results in this section indicate that trade costs negatively affect the formation and duration of firm-to-firm networks. Regional differences in these costs, particularly in transportation costs, are likely to be behind some of the subpar performance of Latin American exporters relative to those in Europe and Asia. In the next section, we discuss a series of trade facilitation and trade support policies that, in light of the results, are also likely to improve the trade networks of Latin American countries.

4 Concluding Remarks

Trade flows are mainly the result of transactions between firms. Understanding the nature of these relationships can help identify ways in which countries can improve their export performance, including participation in global value chains (GVCs).

One of the main results of the paper, supporting previous findings in the literature, is that large exporting firms are large mostly because they have more buyers. In many cases, large firms also export more to each of its buyers, and while this adds to their size, large firms grow their total exports primarily by expanding their networks of buyers. This points to the importance of policies that assist exporters in finding new buyers. We show that trade costs, particularly market access barriers like tariffs, limit the size of the exporter's network. Firms exporting from countries that face high tariff rates in the destination market can find it difficult to grow their network in that market. The evidence in this study, for example, shows that doubling the tariff rate is associated with a reduction in the number of buyers of around 6%. Negotiating lower tariff rates with destination markets is thus fundamental to increasing the size of trade networks.

Information frictions are also normally seen as potential barriers to establish new trade relationships. The information required to match a buyer and a supplier can be vast, particularly in international supply chains: a supplier might need to customize its production to the requirements of particular buyers, while buyers need to convey this information to the potential suppliers and make sure they are capable of delivering the product with the correct specifications. Lack of information regarding the capabilities of potential suppliers can keep them on the sidelines, with buyers relying on a few known providers. Policies for addressing information problems in international trade traditionally fall on the shoulders of export promotion agencies. They can implement different policies, such as organizing trade fairs or assisting with certification programs, to improve the visibility of potential exporters. Empirical evidence shows that export promotion can boost firms' export performance, particularly when the promotion consists of bundles of service policies (Volpe, 2010; Volpe and Carballo, 2010).

Another important result from our analysis is that maintaining an existing trade relationship is key to growing that relationship. New relationships tend to start small in terms of sales per buyer, typically at 10% below the industry's average. As the relationship matures, however, sales per buyer grow. After five years, sales per buyer tends to be 10-20% higher than sales per buyer in new relationships. This result has a number of policy implications. The first is again related to trade costs. We show that firms exporting from countries that face high tariff rates in the destination market and high transport costs can find it more difficult to maintain their trade relationships in that market than firms facing lower trade costs. For instance, evidence from survival regressions shows that doubling the ad valorem tariff rate increases the hazard by around 18%, while doubling

the ad valorem freight rate, while less precisely estimated, increases the hazard by around 3-4%. Since maintaining a relationship is key to its growth, this speaks to the importance of addressing large trade and logistics costs.

There are other factors that may help sustain an existing trade relationship once it has been established. From the point of view of the exporter participating in a GVC, for example, this might require an ongoing process of adapting capabilities. While a great deal of preparation from the supplier might be required to gain initial access to a buyer, the GVC literature indicates that the ability to succeed as a member of an international supply chain might depend on the supplier engaging in a continuous process of adaptation and acquisition of capabilities to meet the demands of the buyers and the changing conditions of the supply chain (Blyde, 2014). The lack of adequate access to finance could potentially hinder the acquisition of these capabilities.

More generally, to the extent that market failures—such as externalities, coordination failures, or the inability of the market to provide a public good—decrease the survival rate of trade relationships, there are additional avenues for public intervention.

By examining some fundamental metrics of firm-to-firm interactions and their relationship to various trade costs, the analysis in this study provides useful information to governments in Latin America and the Caribbean on how they can support trade networks and, consequently, the export performance of firms in their countries.

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