Market Structure, Freight Rate Dispersion, and Firm Size Distribution of Importing Firms Over Time *

Adina Ardelean†
Santa Clara University

Volodymyr Lugovskyy‡
Indiana University

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Abstract

Contrary to the common assumption of symmetric trade costs, we document that, even within a narrowly defined product and route, the maritime international freight rates are highly dispersed across importing firms. Specifically, even after controlling for the product price, shipment size, month and carrier, the freight rate decreases in the firm's annual import size: doubling the size corresponds to a 3.5% decrease in the freight rate with the resulting difference between the largest and smallest sizes of up to 19%. The degree of freight rate dispersion depends on the degree of competition among carriers: it decreases in the concentration of carriers on a route and eventually disappears on routes with only one carrier. There is also a varying dynamic 'Walmart' effect. Routes with the greater freight rate dispersion, over time, experience a higher concentration of importing firms. Our findings are robust to multiple robustness checks, including controlling for the exporting firm size.

Keywords: Freight Rates, Bargaining Power, Firm Concentration, market Structure

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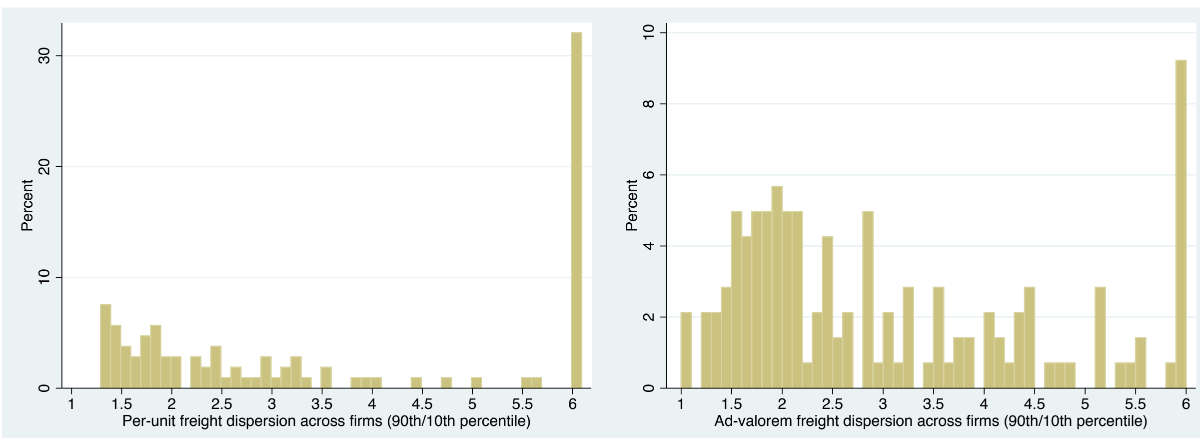
†Department of Economics, Santa Clara University, 500 El Camino Real, Santa Clara, CA 95053-0385, atardelean@scu.edu, Phone: 408-554-6968

‡Department of Economics, Indiana University, 100 S. Woodlawn, Bloomington, IN 47405-7104, vlugovsk@indiana.edu

1 Introduction

Models of international trade tend to assume a perfectly competitive transportation sector with *symmetric* either 'iceberg' (e.g., Krugman, 1980; Eaton and Kortum, 2002; Melitz, 2003) or specific (e.g., Hummels and Skiba, 2004; Feenstra and Romalis, 2014; Irarrazabal et al., 2015) transportation cost. That is, for a given product and country-to-country route, the transportation cost is assumed to be the same—with no trade cost dispersion across either exporting or importing firms or consumers.[1] This assumption is critical for deriving the equilibrium conditions and evaluating welfare gains form trade in most trade models as it implies symmetric access to imports by all importers and consumers in a given country.[2]



(a) Dispersion in the Specific Transport Costs (b) Dispersion in the Iceberg Transport Costs

Figure 1: Distribution of the within route-product freight rate dispersion, 90th-to-10th percentiles, Chilean maritime imports, 2007.

Instead, a simple look at the data shows a significant variation in the port-to-port freight rates within narrowly defined products. For example, the maritime freight rate for men's cotton shirts from Shanghai, China to San Antonio, Chile varies up to 800%. As illustrated by Figure 1, the extent of variation in both specific and ad-valorem freight rates is substantial for many other goods imported by Chile in 2007. Specifically, for over 30% of product-route pairs, the 90th-to-10th

[1]Exceptions are the models with asymmetry in transportation costs due to either different modes of transportation (e.g. Hummels and Schaur, 2010) or internal distance of imports (e.g., Atkin and Donaldson, 2015; Ramondo et al., 2016; Lugovskyy and Skiba, 2019). Even in these models, however, the port-to-port transportation costs for a given product are symmetric.

[2]See, for example, Arkolakis et al. (2012) in addition to the above mentioned models.

percentile specific freight rate dispersion is six times or more.[3]

In this paper, we propose a novel view of international shipping through the prism of two-sided markets in which freight rates are bilaterally negotiated between the importing firms and carriers and thus can be *asymmetric.* Using the firm's annual import size on a given route as the proxy for its bargaining power, we show that 'larger' importing firms face lower freight rates. Interestingly, the magnitude of this effect decreases in the concentration of carriers on a route and completely disappears in the routes with a monopoly carrier. There is also a dynamic 'Walmart' effect. Over time, routes with greater freight rate dispersion experience greater concentration of importing firms. That is, in these routes, larger firms gain even greater market share.

The key to our empirical exercise is a very detailed transaction-level dataset of maritime imports by Chile,[4] which has six, essential for our research, characteristics. First, the dataset contains port-to-port detailed information on freight rates, insurance, and free-on-border (f.o.b.) prices paid by firms at a highly disaggregated 8-digit Harmonized System (HS) product level between 2007 and 2015. Second, for each transaction, we observe the identifiers of an importing firm and a carrier (or a logistic firm). Third, by observing shipment's Clearance Identification Number, we can identify individual shipments, their size, and within-shipment product composition. Fourth, by having the data on almost 200 port-to-port routes, we can examine the relationship between the magnitude of freight rate dispersion and the concentration of carriers. Fifth, for each transaction, we observe both the country of origin and the country of loading. This enables us to use the income per capita of the country of origin as a unique, transaction-level instrument of the product price in freight rate regressions. Finally, using the International Chamber of Commerce's International Commerce Terms (INCOTERMS), we establish that importing firms play a dominant role in arranging international shipping.

We start by showing that, if properly measured, freight rate contains a much smaller ad-valorem component than previously reported which is barely significant at 10% level.[5] By examining individual shipments, we established that, within a shipment, the freight cost for each product is

[3]For readability, we truncate the freight dispersion at 6: all values above 6 are set to 6.
[4]Two-thirds of all Chilean imports by value and over 90% by weight are maritime imports
[5]Recall that the freight rate in our dataset is reported net of transportation insurance charges.

assigned strictly proportionally to its f.o.b. value. Since transportation payment is negotiated per shipment rather than per product, this is the most straightforward method to calculate the tariff base for each product.[6] While convenient, this method generates a pro-iceberg bias in multi-product shipments—overstating the freight rate for more expensive products and understating it for cheaper products. To eliminate this bias, we restrict our sample to single-product shipments and show that the resulting price elasticity of freight rate is 0.38 and it is barely significant at 10% level.

Next, using the INCOTERMS variable, we show that, contrary to the common assumption of exporters incurring the transportation cost (e.g., Krugman, 1980; Melitz, 2003), it is mostly the importing firms which arrange the international leg of shipping. Our findings are consistent with those of Teshome (2018) for Colombian exports in 2009-2013: about 80% of shipments were arranged by importing firms, 15%—by exporting firms, 5%—the INCOTERMS are not available. Zooming in on importing firms, we proxy their bargaining power by the size of their annual imports on a given route.[7]

We find strong evidence that freight rates decrease in the (importing) firm's size: doubling the firm's size decreases its freight rate by 3%, with the resulting difference between the largest (95th percentile) and smallest (5th percentile) importers of up to 19%. Importantly, the magnitude of this effect varies across routes depending on the market structure of the carriers. It decreases in the route-specific concentration of carriers on a route, disappearing on the routes with a monopoly carrier. Borrowing the intuition from the literature on two-sided financial markets (e.g., Duffie et al., 2005), firms with greater bargaining power can secure lower freight by threatening otherwise to use a different carrier. This threat gradually loses its credibility as the concentration of carriers increases and becomes ineffective under a monopoly carrier.

Note that our analysis focuses on the price discrimination of a given carrier across importing firms rather than on the effect of assortative matching between larger firms and more efficient carriers. The latter is netted out by carrier fixed effects. Our results are also robust to controlling for the size of the matched exporting firms. We show this by leveraging a similar Colombian imports dataset,

[6]In Chile, as in many other countries, excluding the Commonwealth of Nations and the U.S.A, tariff base for imports includes transportation costs (Feenstra and Romalis, 2014).

[7]The firm size is calculated net of the current shipment to avoid the endogeneity between the freight rate and size.

in which we observe the identities of both importing and exporting firms.[8] We find the freight rate to be several times more sensitive to the importer than to the exporter size, which is consistent with INCOTERMS evidence of importing firms arranging most of the international transportation. Finally, while the price coefficient becomes highly biased, the firm-size results remain virtually unchanged if we use the entire sample including multi-product shipments.

As discussed above, even controlling for the shipment size, type and price of the product, carrier, route and month, larger importers face lower freight rates. If we also consider that larger firms tend to import in larger shipments, the larger/smaller firm freight rate dispersion increases up to 55%. Our findings highlight a substantial asymmetry in access to imports across firms and the importance of firm size for its bargaining power. Furthermore, we find that this asymmetry affects the future distribution of imports across firms. As in Walmart Effect, if larger firms have a cost advantage, the gap between larger and smaller firms will widen over time. More so in the markets (routes) with more pronounced cost advantage. Indeed, routes with greater freight rate dispersion in 2007 experienced a greater decrease in the skewness of the distribution of the logarithms of firm size between 2007 and 2015.

The remainder of the paper is organized as follows: Section 2 describes our contribution to the existing literature, Section 3 provides theoretical background for our empirical analysis, Section 4 introduces the data, describes the empirical methodology and presents the results, Section 5 provides a series of robustness checks, Section 6 concludes.

2 Contributions to the Broader Literature

This paper contributes to several important literatures. First, we contribute to the literature on firm heterogeneity and trade. While the primary reason of firm heterogeneity does not need to be trade-related,[9], trade may contribute to the asymmetry across firms through various channels. For example, exporting firms may become relatively larger through access to foreign markets (Melitz,

[8] The disadvantage of Colombian dataset, though, is that we do not observe port-to-port routes but only country-to-country routes. In order to increase the accuracy of measuring the exact port-to-port freight rates, we chose to use Chilean imports as our main sample.

[9] E.g., larger firms tend to be firms with better management (Bloom et al., 2010)

2003), while importing firms may become more efficient through cheaper foreign intermediates (Amiti and Konings, 2007; Kasahara and Rodrigue, 2008; Topalova and Khandelwal, 2011; Halpern et al., 2015). Larger firms have also been shown to adjust better to trade shocks, such as exchange rate appreciation or restrictive product standards (Berman et al., 2012; Fontagne et al., 2015). Understanding which firms gain more from trade and why is critical for the analysis of redistributive effects of trade and trade policies (Hallak and Levinsohn, 2004). We contribute to this literature by showing that there is another, previously unexplored channel through which trade further increases the asymmetry between large and small firms: large firms face lower freight rates and thus are able to import the same product at lower delivered price.

Second, we contribute to a larger literature on the firm heterogeneity and the evolution of firm distribution over time. In Melitz (2003) and most of its follow-up models, in the steady state, the distribution of firm sizes is constant over time. One of the exceptions is a dynamic version of Melitz (2003) with knowledge spillover by Sampson (2016), where the productivity distribution of incumbent firms gradually shifts upward over time due to selection-induced reallocation. Within the remaining portion of the distribution, however, the relative productivity of firms remains unchanged, [10] while the productivity (and size) dispersion between the most productive and marginal firms decreases over time. We, on the other hand, suggest a different scenario in which the size dispersion of importing firms may increase over time due to the growing differences in the bargaining power across firms.

Third, this paper is closely related to the extensive literature on the determinants and functional form of maritime international transportation costs. Previous literature has examined the importance of trade infrastructure (ports, cite), competition among and size of carriers (Hummels et al., 2009; Asturias, 2019), unit values (Hummels and Skiba, 2004; Hummels et al., 2009; Lashkaripour, 2019), tariffs and total value of trade (Hummels et al., 2009; Asturias, 2019), geography and networks effects (Brancaccio et al., 2017), and haul problem (Wong, 2018). This literature studies the effect of all these factors on the average freight rate on a given route. We contribute to this litera-

[10] In fact, the whole distribution of the productivities of incumbent firms remains constant in the benchmark model. In the extended model with learning by incumbents, the average productivity of incumbents changes over time, but the productivities of all incumbents change at the same rate, which leaves their relative productivities unchanged.

ture by showing that there is a pronounced freight rate dispersion *within* a route, with larger firms facing lower freight rates. Part of this literature focuses on the welfare implications of endogenous transport costs on the overall volume of trade and welfare. For instance, Hummels et al. (2009) and Asturias (2019) show that an increase in tariffs, in addition to the direct negative effect on imports, has an indirect negative effect on trade and welfare since it increases freight rates. By extrapolating our results to this setting, we predict that an increase in tariffs will increase freight rates asymmetrically. Specifically, larger firms will experience a larger increase in freight rates if some carriers leave the market due to smaller trade volumes.[11]

Lastly, we contribute to a fast growing literature on two-sided markets in trade. This literature has focused on the non-price aspects of trade, such as the direction of the assortative matching (Benguria, 2015; Bernard et al., 2018), adjustment to trade shocks (Bernard et al., 2018), value of business connections and trade dynamics (Eaton et al., 2016). We connect trade and finance (Duffie et al., 2005) literatures on two sided-markets and focus on price asymmetry, how it depends on market structure, and the dynamics of firm distribution.

3 Theoretical Background

Theoretically, the extent to which larger firms may face lower freight rates depends on the market structure. In this section, we state predictions stemming from models with different market structures. The predictions consistent with each market structure are presented in Table 1. We also formalize some of these predictions as hypotheses. Namely, we consider:

i. perfectly competitive markets;

ii. competitive markets with heterogenous carriers and search frictions;

iii. price-discriminating carriers and price-taking importing firms;

iv. two-sided markets with both carriers and importing firms having bargaining power;

[11] Recall that an increase in the concentration of carriers decreases the freight rate dispersion between larger and smaller firms. A decrease in the freight rate dispersion would indicate that the freight rate has increased by a greater amount for larger than for smaller firms.

Perfectly competitive markets are characterized by the absence of price discrimination, since none of the parties has market power. Prices increase in costs, so, for a given product and route, the freight rate may increase in the product's price (higher-priced goods may require more expensive packaging and handling) and decrease in the size of the shipment (due to scale effects in transaction costs, loading, and unloading).

Hypothesis 1 *Freight rates may decrease in the shipment size and increases in the price of goods.*

Hypothesis 2 *Ceteris paribus, the firm's annual imports does not affect its freight rate.*

Competitive markets with heterogenous carriers and search frictions. Price dispersion within a route may be observed even if firms behave competitively if information frictions are present (e.g., Jensen, 2007; Aker, 2010; Goyal, 2010; Allen, 2014). The intuition, applied to the shipping market, is as follows. Each carrier on a given route applies competitive pricing to all of its customers, but carriers are heterogenous in terms of their costs. Trading firms face search costs. Finding each of the freight rates is costly for importing firms due to informational costs. With the search costs sufficiently large, many firms would find it suboptimal to check each available freight rate. Thus, we can expect freight rate dispersion across trading firms in such a market.

As in perfectly competitive markets, firms with larger current shipment may search more extensively and find a better freight rate than firms with smaller shipments. In addition, if we extrapolate this market to a dynamic setting with freight rate differences persistent over time, firms with larger annual volumes of imports are likely to search more extensively even if we control for the shipment size. This is because firms will use the current information for their future shipments and larger importing firms stand more to gain from lower freight rates. Importantly, while lowering the expected freight rate for a given firm, its importing size does not affect the freight rate charged by a given carrier. That is, we should not expect any size-related price dispersion within a given carrier.[12]

Hypothesis 3 *If serviced by more efficient carriers, larger importing firms face lower freight rates.*

[12]The shipment size freight rate dispersion is still possible if larger shipment size decreases the underlying marginal cost of shipping.

One-sided markets in which only sellers (in our case carriers) maintain market power have been studied extensively by industrial organization literature. This literature provides detailed exploration of how sellers can price discriminate in order to increase their profits. The most relevant to our case, third-degree price discrimination, is feasible if consumers can be segmented based on observable or unobservable characteristics, and arbitrage across differently-priced goods is impossible.[13] The extent of the third-degree price discrimination increases in the heterogeneity of consumer characteristics (e.g., consumer price elasticity of demand, brand loyalty, etc). Price discriminating based on the size of annual purchases (excluding the current purchase) is not typical for third-degree price discrimination. Furthermore, there is no consensus in the literature on whether the extent of the third-degree price discrimination should increase or decrease with competition. Borenstein (1985) and Holmes (1989) provide formal discussion of both possibilities.[14] As pointed out in the summary of this literature by Stole (2007), the answer depends on the magnitude of the cross-price elasticity. These predictions are consistent with Hypothesis 2 but not with 3.

Another type of discrimination typical for these markets and relevant to our case, is the second-degree price discrimination, when sellers charge different prices for different quantities. In our case, that would correspond to lower freight rates for greater shipment sizes. Specifically, firms tend to discriminate based on the immediate purchasing size (second-degree price discrimination), but not based on the size of other (than the current) purchases by the same buyer. This prediction is consistent with Hypothesis 1.

Two-sided markets have been explored in several areas of economics and finance. We are particularly interested in the price formation in markets with one homogenous (or nearly homogeneous) good or service—in our case, transportation on a given route. Therefore, we focus on the of financial over-the-counter (OTC) markets (e.g., Duffie et al., 2005; Vayanos and Wang, 2011) with one type of asset.[15] In this type of market market, both sides maintain bargaining power. As a result, the

[13]See Stole (2007) for a literature review on the theoretical models describing different types of price discrimination in imperfect markets.

[14]Borenstein and Rose (1994) showed empirically that price dispersion in the passenger airline industry increased with competition.

[15]There are several papers focusing on the two-sided markets in international trade (e.g., Benguria, 2015; Eaton et al., 2016; Bernard et al., 2018) These papers, however, focus on other than price aspects of these markets, such as positive (benguria) and negative (bernard2018) assortive matching, adjustment to trade shocks (bernard), etc.

price—in our case the international freight rate—is determined through the bilateral bargaining process which depends on each side's alternatives. On the one side there are the carriers and on the other side are the trading firms.

Trading firms are heterogenous in the total trade value with larger firms perceived by carriers as more sophisticated firms and thus having more bargaining power.[16] Therefore, with multiple carriers on a given route, the larger firms have stronger bargaining power because they are more likely to incur the fixed cost of approaching another carrier if the freight rate offered by their current carrier is unsatisfactory. Carriers recognize this fact and offer lower freight rates to larger firms—even without larger firms having to search more than smaller firms. This is, of course, if trading firms have alternatives. As the carriers' side becomes more concentrated, the bargaining power of trading firms decreases. In the extreme case of the monopolist carrier, trading firms have no bargaining power, and thus both smaller and larger firms are offered the same freight rate (Duffie et al., 2005).

Trading firms consist of importing and exporting firms. In most models of international trade, transportation costs are incurred by exporting firms (e.g., Krugman, 1980; Melitz, 2003).[17] However, as shown by Teshome (2018) and our own calculations, in most case the international leg of transportation is actually incurred by importing firms.

Hypothesis 4 *Ceteris paribus, freight rate decreases in the firm's importing size. The magnitude of the effect decreases in the concentration of carriers on the route and disappears in the case of the monopolist carrier.*

To summarize, the predictions of all four models are presented in in Table 1.

[16] In Duffie et al. (2005), the more sophisticated firms (investors) are the ones with more frequent transactions. However, since in their model, the transaction size is limited to one unit, more frequent transactions automatically correspond to a larger firm size.

[17] Exceptions are the models of Rauch and Watson (2003) and Antrs et al. (2017) where importing firms play a pro-active role in finding suppliers.

Table 1: The Determinants of Freight Rates: Comparison across Market Structures.

Parameters	Perfectly Competitive Market	Perfect Competition with Information Frictions	One-sided Shippers Market	Two-sided Market
Product Price	+	+	+	+
Shipment Size	-	-	-	-
Firm Importing Size (FIS)	0	-	0	-
FIS controlling for the Shipper	0	0	0	-
(FIS controlling for the Shipper)				
X (Shipper Mkt. Concentration)	0	0	0	+

4 Explaining the heterogeneity in freight - Chile

4.1 Data and Descriptive Statistics

We use transaction firm-level import trade data for 2007-2009 and 2015, from Chilean Customs Office, obtained from Datamyne.[18] For each import transaction, the data include the identity of the Chilean importing firm, date, the Harmonized System 8-digit product category (HS8), f.o.b. ("free on board") and c.i.f. ("customs, insurance, and freight") values of products in US dollars, quantity, unit of measurement (of quantity), freight in US dollars, insurance in US dollars, port of loading (henceforth PoL), port of unloading (henceforth PoU), country of origin, shipment composition, mode of transportation, carrier's or logistic firm's identity, and shipment gross weight.[19] For 2015, we also observe International Chamber of Commerce's International Commerce Terms (INCOTERMS), which define exporter's and importer's responsibilities during the delivery process.

We use data on real GDP per capita of countries of origin obtained from Penn World Tables version 9.0 (Feensta et al., 2015). For the PoL that we can identify (e.g., "Miami" , "Oakland, USA", etc.), we merge the data with port-to-port distances that we have constructed by hand using information from `http://www.ports.com`.[20] We also merge the import data with alternative measures of distance from CEPII (Mayer and Zignago, 2011).

In our analysis, we focus on maritime shipments which represent about two thirds of Chilean

[18]Datamyne is a company which specializes in documenting import and export transactions in Americas. For more detail please see www.datamyne.com.

[19]Gross weight is the weight of each shipment identified by the clearance id, including the containership.

[20]Some PoL are not precisely identified (e.g., "Other ports of China" or "Other ports of Asia").

imports by value and over 90% by weight. Data on direct port-to-port measurements of transport costs at shipment-product-date level of aggregation, with information on freight rates separately from insurance costs. For example, U.S. Census Imports data are aggregated at product-month-(district of entry)-(exporting country) level and reports freight combined with insurance.[21] The Economic Commission for Latin America and the Caribbean ECLAC has collected similar data for many years and many Latin American countries, put together in the International Transport Database.[22] Other direct measures of transports are sourced from shipping quotes and freight rates for a standard container (e.g., Limao and Venables, 2001; Hummels, 2007; Wong, 2018; Asturias, 2019) as well as contract prices per ship per day for bulk commodities (Brancaccio et al., 2017). Compared to other datasets, a unique feature of our data is that it contains direct measures of freight rates, separately from insurance costs, at the firm-carrier-product-transaction level. This detailed information permits us a closer examination of the nature of international shipping costs, which represent a significant part of international trade costs (Clark et al., 2004; Anderson and van Wincoop, 2004).

We trim and aggregate the data along several dimensions. First, we found that, within a shipment (defined by clearance ID), freight cost for each product is assigned strictly proportionally to its f.o.b. value. Since transportation payment is negotiated per shipment rather than per product, this is the most straightforward method to calculate the tariff base for each product.[23] While convenient, this method generates a pro-iceberg bias in multi-product shipments—overstating the freight rate for more expensive products and understating it for cheaper products. To eliminate this bias, we restrict our sample to single-product (HS8) shipments.Second, we exclude import transactions in mineral fuels (HS 27). We also screen the import dataset to exclude routes with less than ten importing firms per year to ensure that there is a sensible set of firms importing on a given route every year.[24]

[21]The Army Corps of Engineers (ACE) used Census Imports data to construct port-to-port variant of U.S. imports at somewhat higher product-level aggregation (HS6 instead of HS10), but these data are not available past 2009 (Blonigen and Wilson, 2018, Chapter 16, Footnote 7).

[22]See, for example, Hummels and Skiba (2004); Hummels et al. (2009) for estimating the functional form of transportation cost using this dataset.

[23]In Chile, as in many other countries, excluding Commonwealth of Nations and the U.S.A, tariff base for imports includes transportation costs (Feenstra and Romalis, 2014).

[24]We will use variation across firms on a given route in our specification in section 4.2. and we need to ensure that

Table 2 reports summary statistics of imports, geographic country-to-country and port-to-port distance, number of firms and carriers, firm and carrier concentration measured by the Herfindahl index (henceforth HHI), number of products, and number of countries of origin across routes. We observe that routes differ significantly in the value of imports shipped and trade seems to be heavily concentrated on a few routes.[25] The average firm-HHI and the average number of firms on a given route show that routes are not dominated by only a few importing firms. On the average route, the number of carriers is significantly smaller than the number of importing firms and the average carrier-HHI is three times higher than the average firm-HHI. Importantly, products shipped on an average route originate from 13 countries.

Table 2: Summary Statistics of Maritime Imports across Routes

	2007-2009	2007	2008	2009
No. of routes	269	208	229	218
Average country-to-country distance	9,681	9,634	9,504	9,912
Average port-to-port distance	7,747	7,754	7,620	7,871
Average trade (mil. USD)	58.27	57.20	67.41	49.70
Median trade (mil. USD)	13.41	10.42	16.45	13.05
Sd. Dev. of trade (mil. USD)	109.67	106.45	128.90	88.42
Average no. of firms	203	204	205	201
Average HHI(firms)	0.17	0.17	0.17	0.17
Average no. of carriers	7	7	7	7
Average HHI (carriers)	0.52	0.52	0.52	0.52
Average no. of countries of origin	13	12	12	13
Average no. of products	197	200	197	194

Notes: 1. We exclude import transactions in mineral fuels (HS 27)
2. The port-to-port distance is available only for a subset of routes for which we can identify the names of the ports of loading.

Next, we document some characteristics of Chilean firms that import by sea. We aggregate trade to the firm-level for each year and report summary statistics of the firm's import value, number of products, routes and carriers employed and the average distance travelled. Table 3 shows that the distribution of import values across firms is skewed to the right. That is, there are many small Chilean firms and a small number of large importing firms.

Eyeballing Table 3, we observe that there is considerable variation across firms in number of

we have sufficient variation to identify the coefficients of interest. Results are similar if we vary this threshold.

[25]In 2007, the top five routes were Manzanillo, Mexico - Valparaiso, Hong Kong - Valparaiso, Hamburg-Valparaiso, Houston-Antofagasta and Busan, South Korea - Valparaiso. The value of imports on these routes is around 500 million US dollars each, about 5% of total Chilean imports in 2007.

Table 3: Summary Statistics of Maritime Trade across Firms

	2007-2009	2007	2008	2009
Average country-to-country distance	11,468	11,400	11,443	11,558
Average port-to-port distance	9302	9297	9231	9380
Average firm's imports (mil. USD)	2.58	2.45	3.18	2.08
Median firm's imports (mil. USD)	0.09	0.09	0.10	0.08
Sd. Dev. of firm's imports (mil. USD)	74.65	69.39	96.01	50.86
Average no. of products	4	4	4	4
Sd. Dev. of no. of products	11	12	12	11
Average no. of routes	4	4	4	4
Sd. Dev of no. of routes	6	6	6	6
Average no. of carriers	3	3	3	3
Sd. Dev of no. of carriers	3	3	3	3
No. of firms	20,028	11,515	12,475	12,297

Note: We exclude import transactions in mineral fuels (HS 27)

products, routes and carriers employed. To shed some light on the source of this variation, we run a set of ordinary least square regressions:

$$\ln Y_{ft} = \alpha_1 + \alpha_2 X_{ft} + \alpha_t + \epsilon_{ft}, \tag{1}$$

where Y_{ft} is the average port-to-port distance, average country-to-country distance, total import value, number of 8-digit HS products, number of routes, number of carriers, average specific freight cost and average ad-valorem freight cost (mean-differenced by route-product-year) of firm f's imports in year t. We relate each dependent variable, Y_{ft}, to the log of firm's annual import value, X_{ft}. Since we pool across multiple years, we also include year fixed effects, α_t, to control for differences in firms' trade characteristics across years.

Table 4 reports the results. We are primarily interested in the sign and magnitude of α_2, which reflects the conditional correlation between Y_{ft} and X_{ft} within a year. The second column shows that larger importers are different than smaller importers. Doubling the firm's total imports increases the distance they shipped their product by 1%, the number of 8-digit HS products by 29%, the number of routes by 28% and number of carriers by 25%. We also examine the relationship between specific and ad-valorem freight and firm's import annual imports. Since both measures of freight costs vary across routes, products and years, we first mean-difference by (HS8 product)-route-year. That is, the mean-differenced freight costs show how these costs vary across firms if

Table 4: Firm-level heterogeneity in Trading Activity - 2007-2009

Dependent Variable:	Log of Firm's Imports
Log of Port-to-Port Distance	0.01***
Log of Country-to-Country Distance	0.01***
Log of Number of HS8 Products	0.29***
Log of Number of Routes	0.28***
Log of Number of Carriers	0.25***
Log of Specific Freight	-0.07***
Log of Ad-valorem Freight	-0.33***

Notes: 1. Data are for 2007 to 2009 and are aggregated to firm-year level.
2. Specific and ad-valorem freight rates are mean-differenced by HS8 product, route and year before taking the simple average by the firm-year. Distance measures are also simple-average of distances across routes for a firm in a given year.
3. All results in column (2) are from ordinary least square regressions of firm's characteristics in column (1) on the total value of firm's imports in the same year. All regressions include a constant term and year fixed effects.
4. Robust standard errors. *,**,*** significant at 10,5, and 1 percent, respectively.

they import a 8-digit HS product in a given year and on a given route. Next, we calculate the average of the mean-differenced transports costs at the firm level. We find that doubling the firm's total imports decreases the specific freight rate by 7% and the ad-valorem freight cost by 33%.[26]

4.2 Empirical Methodology

In this section, we examine more carefully whether larger importers pay lower freight rates. The freight rates depend on multiple cost factors, such distance travelled, loading and unloading costs. They also depend on the competition among carriers within a route, and, as described in Section 2, they can also vary across trading firms based on their characteristics. That is, freight rates depend on route(r)-good(g)-year(y)-month(m), carrier(c), and firm (f) -shipment(s) specific factors as follows:

$$FRT_{fs}^{rgym} = f(\alpha^{rgym}, \alpha^{c}, \alpha^{fsym}) \tag{2}$$

where α^{rgy} represents route (r)-good(g) -year(y) -month(m) specific determinants of freight rates, common to all firms and shipments, such as: distance travelled, loading and unloading costs determined by the port infrastructure and efficiency, the market power of carriers on a given route and product's import demand elasticity;

[26]Since both the dependent and independent variables are in logarithm, we interpret the coefficient as elasticities.

α^c represents the carrier(c)-specific determinants of freight rates, common to all routes, goods, and firms.

α^{fsym} represents the firm (f)-shipment(s) -year (y) - month(m) specific determinants of freight rates such as: the price of the product they import[27], the value of the shipment, and firm's annual imports - carriers offer lower specific freight rates to larger importers.

Estimating equation (3) represents our baseline empirical model of the determinants of freight rate. Suppose that the freight rate faced by importing firm f for its shipment s on route r for good g in year y -month m can be written as:

$$\begin{aligned} \ln FRT_{fs}^{rgym} &= \alpha_0 + \alpha_1 \ln Price_{ofs}^{rgym} + \alpha_2 \ln FirmImports_{f(-s)}^{y} \\ &+ \alpha_3 \ln ShipmentV_{fs}^{rgym} + \alpha^{rgym} + \alpha^c + \nu_{fs}^{rgym}, \end{aligned} \tag{3}$$

where $Price_{ofs}^{rgym}$ is the corresponding price of the good for which subscript o denotes its country of origin;

$FirmImports_{f(-s)}^{y}$ is the annual U.S. dollar f.o.b. import value of firm f, measured as a dollar sum of the firm f's imports on all sea routes from an exporter[28] in a given year, excluding the current shipment s;[29]

$ShipmentV_{fs}^{rgym}$ is the U.S. dollar f.o.b. import value of the current shipment s;

ν_{fs}^{rgym} is the idiosyncratic component, which we assume to be independent and identically distributed (i.i.d.).

Based on our theoretical Hypothesis 1, we expect the $Price$ to have a positive effect and $ShipmentV$ to have a negative effect on the freight rate. $FirmImports$ can have either no effect (Hypotheses 2 and 3) or a negative effect (Hypothesis 4) on the freight rate.

By including route-product-year-month and carrier fixed effects, we identify the coefficients using variation across firms that import the same product on a given route, year, and month. The fixed effects also wash out any route-product-year-month characteristics that can affect specific freight

[27]Studies using country-level trade data have found that specific freight rates are higher for higher unit value products.

[28]In the robustness check section, we show that the results are robust to other definitions of firm's size

[29]The current shipment is excluded to avoid the endogeneity with the left-hand side variable. We also estimated the same specification including the firm's current shipment and the results are similar.

rates such as: distance, costs associated with port infrastructure or cost associated with waiting more in customs along the way, competition among carriers on a given route, product-specific import demand elasticity, volatility in the bilateral exchange rate, etc. as well as carrier characteristics common to all firms, routes, products and years. Thus, we can eliminate any omitted-variable bias concerns by controlling for all route-product-year-month and carrier specific variables that affect specific freight and can be correlated with our regressors.

Hummels and Skiba (2004) have shown that countries ship more expensive products when the specific freight rate is higher, also known as the Alchen-Allen effect. To control for this potential reverse causality between price and specific freight, we estimate equation (3) using two-stage least squares (2SLS) in which we instrument the product's price with the real GDP per capita of the product's country of origin. As described in Table 2, there is sufficient variation in product's country of origin on a given route so that our instrument is not collinear with route-product-year-month fixed effects. Our choice was guided by previous theoretical and empirical studies that found a positive correlation between product prices and exporter's per capita real GDP (e.g., Schott, 2004; Hummels and Klenow, 2005; Lugovskyy and Skiba, 2015). We also expect that real GDP per capita of the country of origin is not correlated with the error term, ν_{fs}^{rgym}, once we control for route-product-year-month fixed effects.

Larger importers also ship higher-valued individual shipments and thus excluding the current Shipment Value can introduce omitted variable bias. To correct for that, we also estimate the above specifications including the log of the current Shipment Value. Since the value of the current shipment and the specific freight rate can be jointly determined, we instrument the log of current shipment with the log of the average of firm's value of other shipments on the same route. Once we control for route-product-year-month fixed effects and the price of the product shipped, we expect that the log of the firm's average value of other shipments on the same route is not correlated with the error term, ν_{fs}^{rgym}.

Our results show that the instrument is also statistically valid based on first-stage F-stats, under-identification, and weak identification tests.[30]

[30]We also provide OLS estimation results. See Table 15.

Next, we augment estimating equation (3) by introducing an interaction term between the trading firm annual imports on sea routes from an exporter-country and the route-specific Herfindahl index, constructed using the carrier shares on a given route:

$$\begin{aligned} \ln FRT_{fs}^{rgym} &= \alpha + \alpha_1 \ln Price_{ofs}^{rgym} + \alpha_2 \ln FirmImports_{f(-s)}^{y} + \alpha_3 \ln ShipmentV_{fs}^{rgym} \\ &+ \alpha_4 \ln FirmImports_{f(-s)}^{y} * RoutecarrierHHI + \alpha^{rgym} + \alpha^{c} + \nu_{fs}^{rgym} \end{aligned} \tag{4}$$

Hypothesis 4 predicts the interaction term to have a positive effect on the freight rate, as it counteracts the negative effect of the $FirmImports$ on the freight rate. We estimate both equations (3) and (4) using 2SLS as described above. Our results show that the instrument is also statistically valid based on first-stage F-stats, under-identification, and weak identification tests.

4.3 Results

Table 5 reports estimates of equations (3) for 2007-2009. We use two different definitions of prices: value divided by quantity (columns 1 and 3) and value divided by the gross weight (measured in kilograms for all shipments) of the shipment (columns 2 and 4). Since units can have different weights and heavier items can have a higher price, we also control for the log of the weight per unit in the regressions where we measure quantity in units. The first two columns show the estimates for all available sea routes, even if some ports of departure are not precisely identified (e.g., “Other ports of China” or “Other ports of Asia”), while the last two columns show the estimates only for the clearly defined port pairs (e.g., “Miami” as a port of departure and “San Antonio” as a port of landing). We estimate all specifications by excluding commodities that are more likely to be dry bulk shipped such as grains, iron ore, coal, alumina ore, chemicals/fertilizers, wood and sands because the determinants of the freight rates for these commodities can differ from those for products shipped on containerships as discussed in Brancaccio et al. (2017).

Our results suggest that specific freight rates decrease in the annual import value of the importing firm, measured as a dollar sum of the firm’s imports on all sea routes in a given year from an exporter country, excluding the current shipment. To avoid potential simultaneity, we first exclude the current shipment because the freight rate determines the value of the current shipment but it is

Table 5: The effect of firm's annual imports on the specific freight rate, 2007-2009.

	All Ports		Only Identified Ports	
Quantity measured as:	Units	Gross Weight	Units	Gross Weight
Log(Price)	0.52*	0.52*	0.38*	0.38*
	(0.26)	(0.26)	(0.21)	(0.21)
Log(Shipment value)	-0.12***	-0.12***	-0.17***	-0.17***
	(0.05)	(0.04)	(0.05)	(0.04)
Log(Firm's imports)	-0.03***	-0.03***	-0.03***	-0.03***
(excludes current shipment)	(0.01)	(0.01)	(0.01)	(0.01)
Log(Weight/unit)	0.50**		0.63***	
	(0.24)		(0.19)	
Under-identification test	5.15	5.21	4.27	4.29
Under-identification p-value	0.02	0.02	0.04	0.04
Weak identification test	28.01	26.66	39.29	36.5
No. Routes	269	269	168	168
No. Obs	486,770	486,770	348,521	348,521

Notes: IV regressions. Standard errors are clustered by route and country of origin. All variables are mean-differenced by product, route, year and month and we also include carrier fixed effects. *, **, *** significant at 10, 5, and 1 percent, respectively.

less likely to determine the value of other shipments. Based on the value of the estimated elasticities, doubling the size of imports by a given firm, would result in a decrease in specific freight rates by 3%, holding other factors constant.

Table 6: The economic significance of the firm size effect.

	$\hat{\alpha_2} = -0.03$			$\hat{\alpha_2} = -0.03$, $\hat{\alpha_3} = -0.17$		
Annual Firm's Imports	2007	2008	2009	2007	2008	2009
95th/5th	-19%	-19 %	-19 %	-51%	-53 %	-55%
90th/10th	-15 %	-15 %	-15 %	-38%	-49%	-46%
80th/20th	-10 %	-10 %	-10%	-63%	-24%	-43%
75th/25th	-8 %	-8%	-8%	-23%	-21%	-20%
95th/50th	-10 %	-11 %	-10%	-24%	-26%	-22%
50th/5th	-9 %	-10 %	-10%	-36 %	-36%	-42%

Notes: 1. The specific freight rate paid by the firm with x annual imports compared to the firm with y annual imports is lower by $(1 - \frac{x}{y}^{\hat{\alpha_2}})) * 100$ %, where $x > y$.
2. The effects in column (1), (2), and (3) are calculated using $\hat{\alpha_2} = -0.03$ from Table 5
3. The effects in column (4)-(6) are calculated using both $\hat{\alpha_2} = -0.03$ and $\hat{\alpha_3} = -0.17$ from Table 5

The magnitude of the effect is notable: for a given port-to-port route and product (defined at Harmonized System 8-digit level), we find that the 90th (95th) percentile firm in our sample imports at 15% (19%) lower freight rate than the 10th (5th) percentile firm. Table 6 reports the negative gap in freight rates paid by 80th/20th, 75th/25th, 95th/50th, and 50th/20th percentile firms. Larger firms also tend to import in larger shipments, and, from Table 5, doubling the value of the current shipment decreases the specific freight rate between 12% and 17%. If we take this factor into consideration, the predicted negative gap in freight rates paid by 95th/5th percentile firms reaches a stunning 55% in 2009 (last column of Table 6).

For completeness, we also report the results of the OLS with fixed effects of the estimation equation (3) in the Appendix Table 15. The OLS estimates of α_1 are larger than the IV estimates, confirming that the OLS estimates are upward biased because of the Alchen-Allen effect.

Table 7: The effect of the carriers HHI on a given route on the specific freight rate.

	All Ports		Only Identified Ports	
Quantity measured as:	Units	Gross Weight	Units	Gross Weight
Log(Price)	0.53**	0.53**	0.38*	0.38*
	(0.26)	(0.26)	(0.21)	(0.21)
Log(Shipment value)	-0.12***	-0.12***	-0.17***	-0.17***
	(0.04)	(0.04)	(0.04)	(0.04)
Log(Firm's imports)	-0.05***	-0.05***	-0.04***	-0.04***
(excludes current shipment)	(0.01)	(0.01)	(0.01)	(0.01)
Log(Firm's imports)*RouteShipperHHI	0.04**	0.04**	0.04**	0.04**
(excludes current shipment)	(0.02)	(0.02)	(0.02)	(0.02)
Log(Weight/unit)	0.49**		0.63***	
	(0.23)		(0.19)	
Under-identification test	5.11	5.17	4.26	4.27
Under-identification p-value	0.02	0.02	0.04	0.04
Weak identification test	29.36	28.08	38.7	35.92
No. Routes	269	269	168	168
No. Obs	486,770	486,770	348,521	348,521

Notes: IV regressions. Standard errors are clustered by route and country of origin. All variables are mean-differenced by product, route, year, and month and we also include carrier fixed effects. *, **, *** significant at 10, 5, and 1 percent, respectively.

Table 7 reports estimates of equation (4) which are consistent with our estimates in the previous specification. In addition, we find that, everything else constant, firms face higher freight discrimination on routes with more intense competition among carriers. Or, as the route carrier-HHI increases, the bargaining power of trading firms decreases. As the route carrier-HHI approaches 1, trading firms have no bargaining power (no outside option), and thus the freight rates paid by large and smaller firms are identical for a given product and on a given route. This result is consistent with two-sided markets as discussed in section 2. [31].

[31] Borenstein and Rose (1994) found a similar result in the airline industry.

Table 8: The effect of firm's annual imports on the ad valorem freight rate, 2007-2009.

	All Ports		Only Identified Ports	
Quantity measured as:	Units	Gross Weight	Units	Gross Weight
Log(Price)	-0.49*	-0.49*	-0.62***	-0.62***
	(0.25)	(0.26)	(0.22)	(0.21)
Log(Shipment value)	-0.12***	-0.12***	-0.17***	-0.17***
	(0.05)	(0.05)	(0.05)	(0.04)
Log(Firm's imports)	-0.03***	-0.03***	-0.03***	-0.03***
(excludes current shipment)	(0.01)	(0.01)	(0.01)	(0.01)
Log(Weight/unit)	0.51**		0.64***	
	(0.23)		(0.19)	
Under-identification test	5.11	5.18	4.24	4.26
Under-identification p-value	0.02	0.02	0.04	0.04
Weak identification test	32.46	31.09	43.47	40.62
No. Routes	269	269	168	168
No. Obs	489,993	489,993	350,136	350,136

Notes: IV regressions. Standard errors are clustered by route and country of origin. All variables are mean-differenced by product, route, year, and month and we also include carrier fixed effects. *, **, *** significant at 10, 5, and 1 percent, respectively.

Finally, Table 8 presents estimates of equation (3) where the dependent variable is firm's ad-valorem cost. Consistent with other empirical studies, the elasticity of ad-valorem shipping cost with respect to the product price is negative suggesting that the ad-valorem freight rates decrease for more expensive goods. Similarly to previous results, doubling the size of imports by a given firm, would result in a decrease in the ad-valorem freight rates by 3%, holding other factors constant. This finding suggests that large importing firms pay both lower specific and ad-valorem shipping rates than smaller firms.

4.4 Predicted Freight Dispersion and Changes in Trade and Firm's Distribution over time

Our results suggest that the freight dispersion between large and small importers varies across routes based on the distribution of the logarithms of importer firm size as well and the degree of competition between carriers. In this section, we investigate whether the predicted freight dispersion on a given route, measured as the 90th percentile to 10th percentile predicted freight rates, affect trade and the distribution of the logarithm of importer firm size on the same route in 2015. More specifically, we regress the 2007-2015 trade growth, number of firms growth, and long changes in the firm distribution skewness for each route on the predicted freight dispersion in 2007.

Table 9: Trade and Firm Distribution Changes on each route from 2007 to 2015

	Trade Growth	No. Firms Growth	Δ Skewness
2007 Predicted Freight Disp	-0.91**	-0.15	-0.32***
	(0.41)	(0.16)	(0.10)
2007 Firm Distrib Skewness			-0.84***
			(0.10)
R-squared	0.01	0.00	0.41
No. Obs	194	194	192

Notes: OLS regressions. Robust standard errors. *, **, *** significant at 10, 5, and 1 percent, respectively.

The results are presented in Table 9. An increase one standard deviation in predicted freight dispersion decrease trade growth by 0.08 standard deviations. The predicted freight rate has no statistically significant effect on the number of firms growth from 2007 to 2015 on a given route. However, the predicted freight rate decreases the skewness of the distribution: increase in predicted freight rate dispersion by one standard deviation, decreases the skewness of the distribution of firm import size on a route by 0.10, holding the skewness in 2007 constant across routes . That is, the distribution of logarithm of firm sizes will have longer left tails in 2015 on routes with more freight discrimination in 2007.

5 Robustness Checks

5.1 Robustness Checks using Chilean data

In this section, we perform several robustness exercises to check the sensitivity of our results using Chilean data. The first set of exercise will re-estimate (3) with other definitions of firms' size that can affect ability to bargain or obtain lower freight rates. Table 11 and 12 report results when we define the firm's size as the the annual import value of the importing firm on a given route and the annual import value of the importing firm on all routes, respectively. The results are consistent with our main estimates. Additionally, we also account for the possibility that carriers discriminate based on the firm's previous year import value $ImpValue_f^{y-1}$:

$$\ln FRT_{fs}^{rgym} = \alpha + \alpha_1 \ln Price_{ofs}^{rgym} + \alpha_2 \ln FirmImports_f^{y-1} + \alpha_3 \ln ShipmentV_{fs}^{rgym} + \alpha^{rgym} + \nu_{fs}^{rgym}. \tag{5}$$

using the previous year's value of imports by firm f as the right-hand-side variable: doubling the previous year's imports on all routes would results in a decrease in specific freight rates by 4%.[32] Our results are also robust to estimating the main specification (3) on both bulk and non-bulk commodities as well as separately for each year in our sample.

5.2 Including Exporting Firm Size, Colombian Imports

We do not have exact information on whether carriers negotiate the freight rates with importing or exporting firms. Since in the Chilean Imports data we do not observe the identity of the exporting firms, it is possible that importing firm's size captures some characteristics of the matching exporting firm. Indeed, previous research suggests assortive (large exporter—large importer) matching between exporting and importing firms.[33] If it is indeed exporters which negotiate the freight rates with carriers and large-to-large matches prevail for Chilean imports, the main message of our paper—larger importing firms enjoy lower freight rates—is still preserved. The explanation of this pattern would be different though: larger importing firms enjoy lower freight rates not due to their own bargaining power, but thanks to the bargaining power of their larger trading partners (exporting firms).

Bernard et al. (2018), on the other hand document the negative degree assortativity among exporting and importing firms using the data on Norwegian exporting firms and their foreign trading partners (importing firms). While their findings do not directly contradict previous evidence on the assortative matching, they show that more connected (presumably larger) exporters are more likely to match with a less connected (presumably smaller) importing firm. If, again, the freight rates are negotiated between exporters and carriers, their findings would suggest that our estimates on

[32]Table 13 panel (a) reports the results of the IV regressions with the price being instrumented by the income per capita of country of origin of the imported product.

[33]For example, assortive matching was found by Blum et al. (2010) for Chile and Colombia as well as Argentina and Chile firm-to-firm matches; by Benguria (2015) for Chile and France firm-to-firm matches.

the importing firm size are biased downward, since many smaller firms may import from larger exporting firms. To address these concerns, we use Colombian Imports data to check the sensitivity of importing firm's size estimates to including exporting firm size.

The Colombian dataset also contains transaction firm-level trade data for 2007-2013, from Colombian Customs Office, obtained from Datamyne. This dataset contains all the variables we observe in the Chilean dataset but it does not provide detailed information on the port of loading and port of unloading as in the Chilean data. Since we only observe the country of departure, we define a route as departure country-to-Colombia. In addition to the variables we observe for Chile, we also observe the identity of the exporting firm. This allows us to control for the trade value on a given route of the exporting firms. We find that the median exporting firm on a given route is roughly of the same size as a median Colombian firm, and the overall distributions of exporting and importing firms are also very similar.

Our empirical specification for the Colombian dataset differs from that performed on the Chilean dataset in three ways: (i) assuming that the importing firm buys goods of a given quality from an exporter country, the price of the good is instrumented by trade-weighted average of the proportional price deviation of each transaction from the average import price of that good purchased by all firms from the same exporter country, where the trade weights exclude current transaction value; (ii) we use country-to-country rather than port-to-port routes, (iii) we include the size of the exporting firm in our specification and (iv) our sample contains more years. Table 10 presents the results. Consistent with the results we obtained on the Chilean dataset, the firm's annual imports decrease the specific freight rate whether we control for the exporting firm's annual trade or not. Moreover, the size of the importing firm matters much more for the determination of the freight rate than the size of the exporting firm. The results are similar for ad-valorem freight rates, shown in Table 16.

6 Conclusion

Related to the literatures on firm-level heterogeneity and two-sided markets, we found that freight costs systematically decrease in firm's annual imports. On a given port-to-port route, product, year, and month, we find that the 95th percentile firm in our sample imports at 19% lower freight rate

Table 10: The negative effect of the value of importing and exporting firm's trade on the specific freight rate, ID3, IV Regressions - Colombia.

Dependent variable:	Quantity measured as:					
Specific Freight rate		Units			Gross Weight	
Log(Price)	0.57***	0.58***	0.48***	0.18	0.21**	0.09
	(0.01)	(0.04)	(0.03)	(0.12)	(0.10)	(0.14)
Log(Shipment value)	0.09***	0.09	0.04	0.01	0.02	-0.02
	(0.00)	(0.06)	(0.06)	(0.04)	(0.04)	(0.04)
Log(Firm's imports)	-0.06***	-0.07***		-0.04***	-0.05***	
	(0.00)	(0.01)		(0.00)	(0.01)	
Log(Partner's exports)	-0.01***		-0.02***	-0.01***		-0.02***
	(0.00)		(0.00)	(0.00)		(0.00)
Underidentification test	4241.28	1.76	1.58	2.76	2.70	2.07
Underidentification p-value	0.00	0.18	0.21	0.10	0.10	0.15
Weak identification test	2135.84	45.43	25.69	50.17	58.52	132.73
No. Routes	133	133	133	133	133	133
No. Obs	550394	563061	550397	550395	563062	550398

Notes: Standard errors are clustered by route. All variables are mean-differenced by product, route, year, and month. *, **, *** significant at 10, 5, and 1 percent, respectively.

than the 5th percentile firm—even when controlling for the shipment size. This difference increases up to 55% when we recognize that larger importers tend to import in larger shipments. The results are robust to several alternative specifications, including when controlling for the exporting firm's size. Importantly, the degree of freight rate dispersion depends on the degree of competition among carriers: it decreases in the concentration of carriers on a route and eventually disappears on routes with only one carrier. Our findings suggest that larger firms are likely to pay lower delivered prices for imported inputs, potentially increasing the larger firms' productivity and the probability of becoming an exporter. Indeed, we document a (varying) dynamic 'Walmart' effect. Routes with greater freight rate dispersion, over time, experience a higher concentration of importing firms.

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7 Appendix

Table 11: The effect of firm's annual route imports on the specific freight rate, 2007-2009.

	All Ports		Only Identified Ports	
Quantity measured as:	Units	Gross Weight	Units	Gross Weight
Log(Price)	0.52**	0.52**	0.37*	0.37*
	(0.26)	(0.26)	(0.20)	(0.20)
Log(Shipment value)	-0.11**	-0.11**	-0.15***	-0.15***
	(0.04)	(0.04)	(0.04)	(0.04)
Log(Firm's imports)	-0.03***	-0.03***	-0.03***	-0.03***
(excludes current shipment)	(0.00)	(0.00)	(0.01)	(0.01)
Log(Weight/unit)	0.49**		0.63***	
	(0.23)		(0.19)	
Under-identification test	5.12	5.18	4.24	4.26
Under-identification p-value	0.02	0.02	0.04	0.04
Weak identification test	26.53	25.22	38.80	35.97
No. Routes	269	269	168	168
No. Obs	486,770	486,770	348,521	348,521

Notes: IV regressions. Standard errors are clustered by route and country of origin. All variables are mean-differenced by product, route, year and month and we also include carrier fixed effects. *, **, *** significant at 10, 5, and 1 percent, respectively.

Table 12: The effect of firm's annual all routes imports on the specific freight rate, 2007-2009.

	All Ports		Only Identified Ports	
Quantity measured as:	Units	Gross Weight	Units	Gross Weight
Log(Price)	0.54**	0.54**	0.39*	0.39*
	(0.27)	(0.27)	(0.22)	(0.22)
Log(Shipment value)	-0.16***	-0.16***	-0.21***	-0.21***
	(0.05)	(0.05)	(0.05)	(0.05)
Log(Firm's imports)	-0.02***	-0.02***	-0.02*	-0.02*
(excludes current shipment)	(0.01)	(0.01)	(0.01)	(0.01)
Log(Weight/unit)	0.49**		0.63***	
	(0.24)		(0.20)	
Under-identification test	5.17	5.23	4.29	4.31
Under-identification p-value	0.02	0.02	0.04	0.04
Weak identification test	30.05	28.60	39.15	36.42
No. Routes	269	269	168	168
No. Obs	486,770	486,770	348,521	348,521

Notes: IV regressions. Standard errors are clustered by route and country of origin. All variables are mean-differenced by product, route, year and month and we also include carrier fixed effects. *, **, *** significant at 10, 5, and 1 percent, respectively.

Table 13: The effect of lagged firm's annual imports on the specific freight rate, 2007-2009.

	All Ports		Only Identified Ports	
Quantity measured as:	Units	Gross Weight	Units	Gross Weight
Log(Price)	0.53*	0.53*	0.39	0.39
	(0.30)	(0.30)	(0.26)	(0.26)
Log(Shipment value)	-0.14***	-0.13***	-0.18***	-0.18***
	(0.04)	(0.04)	(0.04)	(0.03)
Lag Log(Firm's imports)	-0.04***	-0.04***	-0.03***	-0.03***
	(0.01)	(0.01)	(0.01)	(0.01)
Log(Weight/unit)	0.50*		0.62***	
	(0.27)		(0.23)	
Under-identification test	4.78	4.82	4.03	4.05
Under-identification p-value	0.03	0.03	0.04	0.04
Weak identification test	25.25	25.62	43.73	44.12
No. Routes	241	241	155	155
No. Obs	283,434	283,434	208,460	208,460

Notes: IV Regressions. Standard errors are clustered by route and country of origin. All variables are mean-differenced by product, route, year and month and we also include carrier fixed effects. *, **, *** significant at 10, 5, and 1 percent, respectively.

Table 14: The negative effect of firm's annual imports on the specific freight rate (including bulk and non-bulk commodities).

	All Ports		Only Identified Ports	
Quantity measured as:	Units	Gross Weight	Units	Gross Weight
Log(Price)	0.54**	0.54**	0.40*	0.40*
	(0.27)	(0.28)	(0.22)	(0.22)
Log(Shipment value)	-0.12***	-0.12***	-0.16***	-0.16***
	(0.04)	(0.04)	(0.04)	(0.04)
Log(Firm's imports)	-0.03***	-0.03***	-0.03***	-0.03***
(excludes current shipment)	(0.01)	(0.01)	(0.01)	(0.01)
Log(Weight/unit)	0.47*		0.61***	
	(0.25)		(0.20)	
Under-identification test	5.11	5.16	4.24	4.26
Under-identification p-value	0.02	0.02	0.04	0.04
Weak identification test	28.53	27.23	39.85	37.03
No. Routes	269	269	168	168
No. Obs	527,433	527,433	376,408	376,408

Notes: IV regressions. Standard errors are clustered by route and country of origin. All variables are mean-differenced by product, route, year and month and we also include carrier fixed effects. *, **, *** significant at 10, 5, and 1 percent, respectively.

Table 15: The effect of firm's annual imports on the specific freight rate, OLS Regressions.

	All Ports		Only Identified Ports	
Quantity measured as:	Units	Gross Weight	Units	Gross Weight
Log(Price)	0.52***	0.52***	0.51***	0.51***
	(0.02)	(0.02)	(0.02)	(0.02)
Log(Shipment value)	-0.08***	-0.08***	-0.09***	-0.09***
	(0.01)	(0.01)	(0.01)	(0.01)
Log(Firm's imports)	-0.03***	-0.03***	-0.03***	-0.03***
(excludes current shipment)	(0.00)	(0.00)	(0.00)	(0.00)
Log(Weight/unit)	0.49***		0.50***	
	(0.02)		(0.02)	
Constant	-0.00*	-0.00*	-0.00***	-0.00***
	(0.00)	(0.00)	(0.00)	(0.00)
Adj. R-squared	0.60	0.26	0.60	0.26
No. Routes	269	269	168	168
No. Obs	510,435	510,453	364,695	364,695

Notes: Standard errors are clustered by route. All variables are mean-differenced by product, route, year and month and we also include carrier fixed effects. *, **, *** significant at 10, 5, and 1 percent, respectively.

Table 16: The negative effect of the value of importing and exporting firm's trade on the ad-valorem freight rate, IV Regressions - Colombia.

Dependent variable:	Quantity measured as:					
Ad-Valorem Freight rate		Units			Gross Weight	
	(Units)	(Weight)	(Units)	(Weight)	fg1	fg2
	b/se	b/se	b/se	b/se	b/se	b/se
Log(Price)	-0.776***	-0.752***	-0.875***	-0.814***	-0.787***	-0.906***
	(0.015)	(0.077)	(0.114)	(0.118)	(0.103)	(0.140)
Log(Shipment value)	0.022***	0.023	-0.019	0.015	0.016	-0.024
	(0.002)	(0.048)	(0.047)	(0.041)	(0.042)	(0.043)
Log(Firm's imports)	-0.041***	-0.049***		-0.039***	-0.047***	
	(0.001)	(0.007)		(0.004)	(0.006)	
Log(Partner's exports)	-0.013***		-0.022***	-0.014***		-0.023***
	(0.000)		(0.003)	(0.002)		(0.003)
Log(Weight/unit)	0.735***	0.714***	0.835***			
	(0.013)	(0.059)	(0.090)			
Underidentification test	3992.65	2.48	1.92	2.76	2.70	2.07
Underidentification p-value	0.00	0.12	0.17	0.10	0.10	0.15
Weak identification test	2009.71	110.04	91.39	50.17	58.52	132.73
No. Routes		133	133	133	133	133
No. Obs	550394	563061	550397	550395	563062	550398

Notes: Standard errors are clustered by route. All variables are mean-differenced by product, route, year, and month. *, **, *** significant at 10, 5, and 1 percent, respectively.

8 Technical Appendix: Cleaning the Identities of the carriers

Utilizing the information on the identity of the carriers delivering Chilean and Colombian imports is a critical part of our empirical exercise. Unfortunately, the names of carriers in neither Chilean nor Colombian Imports datasets are standardized. As a result, there are instances when the same firm is recorded differently due to using or not using abbreviations, capital and lower-case letters, spaces, dots, other special characters.