INTERNATIONAL TRANSPORT COSTS AND THE MARGINS OF INTRA-LATIN AMERICAN MARITIME TRADE

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ABSTRACT

This paper focuses on the analysis of the relationship between maritime trade and transport cost in Latin America. The analysis is based on disaggregated (SITC 5 digit level) trade data for intra Latin maritime trade routes over the period 1999-2004. The research contributes to the literature by disentangling the effects of transport costs on the range of traded goods (extensive margin) and the traded volumes of goods (intensive margin) of international trade in order to test some of the predictions of the trade theories that introduce firm heterogeneity in productivity, as well as fixed costs of exporting. Recent investigations show that spatial frictions (distance) reduce trade mainly by trimming the number of shipments and that most firms ship only to geographically proximate customers, instead of shipping to many destinations in quantities that decrease in distance. Our analyses confirm these findings and show that the opposite pattern is observed for ad-valorem freight rates that reduce aggregate trade values mainly by reducing the volume of imported goods (intensive margin).

Keywords: Transport costs; Maritime trade; Latin America; Sectoral data; Competitiveness

INTRODUCTION

How do international transport costs affect countries' ability to participate in the global economy and what impact do changes in the cost of trade have on a country's trade and real income? This paper is devoted to partially answer these questions. While the gains from trade are widely accepted, less is known about the magnitude of the penalty faced by countries for which trade is costly. Reducing trade costs has direct and indirect benefits; it promotes trade and also leads to industrial restructuration in the economy; higher specialisation, and changes in factor prices and real income. We focus on international maritime transport costs as a key component of trade costs. How do these effects operate, and how large might they be?

The analyses use import and export data from Latin America and the Caribbean countries[1], representing a total of 224 maritime trade routes over a period of six years (1999-2004). Import values (USD) at CIF and FOB prices and freight rates as well as volumes (metric tonnes) are obtained from the International Transport Database (BTI) from United Nations Economic Commission for Latin America and the Caribbean (UNECLAC). The database allows calculating the actual transport cost (paid freight by definition from INCOTERMS) per ton paid for the export of a certain good between countries *i* and *j* excluding loading costs. An advantage of these dataset is that the data represent are disaggregated at product level and precisely define origin-destination and the mode of transport for shipments.[2] This data allow us to decompose bilateral trade values into several components and to investigate how well the variability of each component is explained by freight rates.

The relationship between trade and transport costs is effectively investigated by Limão and Venables (2001). In their seminal paper, they analyse empirically the dependency of transport costs on geographical and infrastructural variables and estimate an elasticity of trade with respect to transport costs in the range 2-5. These authors also find that distance and landlocked status positively affect transport costs, but the effect of distance can be lessened by improving the infrastructure of the origin, transit and destination countries. More recently, Martínez-Zarzoso and Suárez-Burguet (2005) and Martínez-Zarzoso et al. (2007) found similar results using disaggregated data.

In marked contrast to other studies on maritime trade, we decompose total trade into two margins: the range of shipments (extensive margin) and the average value of shipments (intensive margin). The decomposition allows showing why transport costs matter in maritime trade and isolating which of the trade components they most affect. We find that the range of products shipped between origin and destination pairs does co-vary with distance. Even

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[1] Importing countries: Argentina, Brazil, Chile, Colombia, Ecuador, Peru and Uruguay. Exporting countries: Anguila, Antigua and Barbuda, Argentina, Aruba, Bahamas, Barbados, Belize, Bermuda, Brazil, Chile, Colombia, Costa Rica, Cuba, Dominica, Dominican Republic, Ecuador, El Salvador, French Guiana, Grenada, Guatemala, Guyana, Honduras, Jamaica, Mexico, Nicaragua, Panama, Peru, Puerto Rico, Suriname, Trinidad and Tobago, Uruguay and Venezuela.

[2] For details see (http://www.eclac.cl/cgi-bin/getProd.asp?xml=/Transporte/noticias/noticias/6/34756/P34756.xml&xsl=/Transporte/tpl/p1f.xsl&base=/Transporte/tpl/top-bottom.xsl)

more extreme, once freight rates are added as an explanatory variable of the different decomposed trade components, distance still explains both of them. This result underlines previous findings (Martinez et. al. 2005) that geographical distance is a proxy for trade determinants different from transport costs. Thus distance as a variable rather captures determinants of bilateral trade such as information costs, business networks and cultural barriers.

Recent studies have found that distance is imperfectly correlated with maritime transport costs (Wilmsmeier and Hoffmann, 2008; Wilmsmeier and Martinez 2009). Clark (2007) and Martinez-Zarzoso and Nowak-Lehmann (2007) find that distance is a poor proxy for transport costs. Distance may be a proxy for other types of trade costs and has the advantage of being truly exogenous of the volume of trade in goods. In light of these findings, a number of investigations have underlined the importance of obtaining better data on transport costs (Martinez and Wilmsmeier 2009.

However, this evidence suggesting that transport costs are only vaguely related to distance should not be confused with findings that distance is correlated with trade flows. Hillberry and Hummels (2008) note that roughly a quarter of world trade takes place between countries sharing a common border and half of world trade occurs between partners less than 3,000 kilometres apart. It is not clear however whether the effect of distance on trade volumes can be ascribed either to transport costs or to other trade determinants such as historical ties, cultural proximity or business networks or the combination and interrelation between both.

The data allow observing the range of products shipped and the number of origins from which the commodities are imported in the period from 1999 to 2004. For intra Latin American trade we find that the number of products shipped increases over time, while the number of origins from which products are shipped is relatively stable over the years.

The paper contributes to the existent literature in several respects. Unlike previous work, we decompose intra-Latin American maritime trade flows into multiple components in an effort to study what margins of trade freight rates act upon. Also, we are able to compare the effect of distance with the effect of transport costs and can show that spatial friction in maritime trade has less impact than transport costs..

The remainder of this paper is organized as follows. Section 2 describes the data and Section 3 presents the methodology to decompose shipments into several components. Section 4 shows the main results and Section 5 concludes.

DATA DESCRIPTION

The main data source is the BTI (International Transport Database) from UNECLAC. BTI covers annual global trade and transport statistics for the eleven LAIA (*Latin American Integration Association*) countries - Argentina, Bolivia, Brazil, Chile, Colombia, Ecuador, Mexico, Paraguay, Peru, Uruguay, and Venezuela. Information includes the value (USD), volume (tonnes) of imports and exports, transport modes, the costs of international freight and insurance, and the traded products. Data are annual, for the years 1999-2004, and grouped by the Standard International Trade Classification (SITC) codes. This structure allows for calculating international transport costs per ton paid in USD for the export of a specific product at the SITC 5-digit level between countries *i* and *j* excluding loading costs.

Income and population data are taken from the World Development Indicators Database 2008 and distance from CEPII[3].

Table 1. Split between pure freight rates and insurance costs by importer

Importer	Fleadv	Segadv	Cifob	Flekg	Segkg	Cifobkg
Argentina	0.0490459	0.0073304	0.0563763	0.3271372	0.6548943	0.9820315
Brazil	0.3278932	0.0018188	0.329712	0.4661918	0.1758087	0.6420005
Chile	0.1790524	0.0092822	0.1883346	4.010412	0.3088272	4.3192392
Colombia	0.1197173	0.001803	0.1215203	0.25325	0.0422111	0.2954611
Ecuador	1.495182	0.0333283	1.5285103	0.2729071	0.1759368	0.4488439
Peru	0.1834594	0.0117477	0.1952071	0.3292462	0.4173018	0.746548
Uruguay	0.0855957	0.0062402	0.0918359	0.5498556	0.1598914	0.709747
Venezuela	0.0007182	0.0000677	0.0007859	0.0017304	0.0032216	0.004952
Total	0.3798533	0.0089007	0.388754	0.4404921	0.1779462	0.6184383

Note: Fleadv denote ad-valorem pure freight rates (as a % of fob values), Segadv denote ad-valorem insurance, Cifob denotes the sum of Fletacv and Segadv , Flekg denotes pure freight in $ per kilogram, Segkg denote insurance in $ per kilogram and Cifobkg denotes the sum of Flekg and Segkg.

Average ad-valorem freight rates in the region under study range between 4.47 percent of CIF, imports to Argentina, to 7.37 percent of CIF imports to Peru. Table 1 shows the split between pure freight rates and insurance costs by importer.

DECOMPOSING MARITIME TRADE AND MAIN HYPOTESIS

In literature the effect transport costs on trade has been commonly analysed using a gravity model of trade, with the dependent variable being the aggregate/ disaggregate value of trade between two countries. Some recent studies for aggregated trade are Sánchez, Hoffmann, Micco, Pizzolitto, Sgut and Wilmsmeier (2003), Martinez-Zarzoso and Suarez-Burguet (2005) and Limão and Venables (2001) and for disaggregated trade Martínez-Zarzoso, García-Menendez and Suárez-Burguet (2003) and Martinez-Zarzoso et al. (2005) al. (2005) Martinez-Zarzoso (2009). This approach relies on a model that assumes iceberg trade costs[4] and symmetric firms. In this setting, aggregated trade values react to trade cost in exactly the same way as firm-level quantities and consumers buy positive quantities of all varieties.

In this context we can express the quantity of a variety from origin country i to destination country j (q_{ij}) as

$$q_{ij} = E_j \left(\frac{\left(p_i t_{ij}\right)^{-\sigma}}{\tilde{P}_j} \right) \qquad (1)$$

[3] http://www.cepii.fr/anglaisgraph/bdd/distances.htm.

[4] Iceberg trade costs mean that for each good that is exported a certain fraction melts away during the trip as if an iceberg were shipped across the ocean.

where E_j denotes country j's total expenditure on the differentiated product, $(p_i t_{ij})$ is the price of product i at destination j, p_i varies across destinations due to positive iceberg transport costs, t_{ij}. $\widetilde{P}_j = \sum_i (p_i t_{ij})^{(1-\sigma)}$ is a price index and σ is the elasticity of substitution, which is constant across varieties[5] (CES)[6].

Since the quantity traded of each variety is in most cases not observable, adding two assumptions: a) all varieties in the origin are symmetric and b) the destinations will consume all the varieties in equal quantity, allows multiplying the quantity per variety (q_{ij}) by prices (p_i) and by the number of varieties (n_i) to obtain total trade values. The outcome is

$$T_{ij} = n_i p_i q_{ij} = E_j n_i \left(\frac{p_i (p_i t_{ij})^{-\sigma}}{\widetilde{P}_j} \right) \quad (2)$$

In equation (2) the quantity per variety is the only component of T_{ij} that has bilateral variation. Following Hillberry and Hummels (2008), we are able to examine each of the components of total trade values in a more flexible way since our data are not only quantities, but also prices and the range of products vary across origin and destinations. Therefore we need to relax some of the assumptions made above. Prices may vary across destinations, if the elasticity of substitution is not constant or if transport costs are not iceberg costs (Hummels and Skiba, 2004). Consequently for a given year t, we can assume:

$$T_{ij} = n_{ij} p_{ij} q_{ij} \quad (3)$$

At least three reasons have been suggested in the literature to explain why the range of trade products might vary with trade cost. First, goods produced in different locations (origin and destination) can be homogeneous. In this case, if production costs in origin and destination are very similar or the trade costs are sufficiently large, these goods will not be traded. Additionally, the higher transport costs are, the more likely products are to be non-traded goods. Second, if goods are differentiated by country of origin, each country producing a different variety has to incur in a fixed cost to sell the product in each destination country. Therefore, not all the varieties will be shipped to each destination and the number of varieties traded will depend negatively on the magnitude of trade costs. Finally, not all varieties are consumer goods. Intermediate inputs that are used in the production of final goods would only be exported to destination j if country j produces the final good. Due to "just in time" production processes intermediates are more likely to be traded over short distances.

The methodology we use to decompose aggregate value of trade into its various components is based on Hillberry and Hummels (2008). Unique shipments are indexed by s and the total value of shipments from country i to country j is given by

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[5] Varieties refer to different products that are substitutes in consumption.
[6] The constant elasticity of substitution (CES) assumption is made in order to obtain a simple model that is easily derived and with testable implications.

$$T_{ij} = \sum_{s=1}^{N_{ij}} P_{ij}^{s} Q_{ij}^{s} \tag{4}$$

where N_{ij} is the number of unique shipments (extensive margin of trade) and $\overline{PQ}_{ij}$ is the average value per shipment (the intensive margin). Hence, total trade value is decomposed first into extensive and intensive margin

$$T_{ij} = N_{ij}\,\overline{PQ}_{ij} \tag{5}$$

where $\overline{PQ}_{ij} = \dfrac{\left(\sum_{s=1}^{N_{ij}} P_{ij}^{s} Q_{ij}^{s}\right)}{N_{ij}}$

Since there can be multiple unique shipments within an origin-destination country pair, the number of shipments can be further decomposed into the number of distinct SITC products shipped, N_{ij}^{k}, and the number of average shipments between a country of origin and a destination country, N_{ij}^{F}. $N_{ij}^{F}>1$ means that we observe more than 1 unique shipment per commodity travelling from country i to country j.

$$N_{ij} = N_{ij}^{k} N_{ij}^{F} \tag{6}$$

The average value per shipment can also be further decomposed into average price and average quantity per shipment:

$$\overline{PQ}_{ij} = \frac{\left(\sum_{s=1}^{N_{ij}} P_{ij}^{s} Q_{ij}^{s}\right)}{\sum_{s=1}^{N_{ij}} Q_{ij}} \frac{\left(\sum_{s=1}^{N_{ij}} Q_{ij}\right)}{N_{ij}} = \overline{P}_{ij}\overline{Q}_{ij} \tag{7}$$

By substituting equations (6) and (7) into (5) we can decompose total trade between two countries into four different components:

$$T_{ij} = N_{ij}^{k} N_{ij}^{F} \overline{P}_{ij}\overline{Q}_{ij} \tag{8}$$

The quantity measure is tons for all commodities. Using a common unit allows us to aggregate over different products and compare prices (import unit values) across all commodities.

We now have two decomposition levels, the first given by equation (5) decomposes total trade value into range of products traded and average value per product and the second, given by equation (8), decomposes these two components further into another two each: the number of distinct SITC goods shipped, the number of average shipments between a country of origin and a destination country, average price and average quantity. Taking logs for the first and second level decompositions and adding the time dimension, t we obtain:

$$\ln T_{ijt} = \ln N_{ijt} + \ln \overline{PQ}_{ijt} \tag{9}$$

$$\ln T_{ijt} = \ln N^{k}_{ijt} + \ln N^{F}_{ijt} + \ln \overline{P}_{ijt} + \ln \overline{Q}_{ijt} \quad (10)$$

Next we analysed how each of the components of equation (10) co-vary with distance and with other trade-related costs. Before specifying the empirical model, we state a number of hypotheses that are based on recent theories of international trade under imperfect competition and heterogeneous firms. Melitz (2003) introduced firm heterogeneity in a general equilibrium model of international trade. Chaney (2008) extended Melitz's model to multiple countries with asymmetric trade barriers and derives three predictions for aggregated trade:
For aggregated bilateral trade flows his model predicts that the elasticity of exports with respect to trade barriers is larger than in the absence of firm heterogeneity and larger than the elasticity for each individual firm. A reduction of variable cost has two effects:

- it increases the size of exports of each exporter and;
- it allows new firms to enter the market.

Therefore, the extensive margin amplifies the impact of variable costs.

In more homogeneous sectors aggregated exports are very sensitive to changes in transportation costs, because many firms enter and exit when variable costs change.
The elasticity of exports with respect to variable costs does not depend on the elasticity of substitution between goods. Whereas the elasticity of exports with respect to fixed costs is negatively related to the elasticity of substitution. This in contrast models with representative firms, according to which the elasticity of exports with respect to transport costs equals the elasticity of substitution minus one.

Further, with respect to the two margins of trade, Chaney (2008) shows that in the presence of firm heterogeneity, the extensive margin and the intensive margin are affected in different directions by the elasticity of substitution. The impact of trade barriers is strong in the intensive margin for high elasticities of substitution, whereas the impact is mild on the extensive margin. The author proves that the dampening effect of the extensive margin dominates the magnifying effect of the intensive margin.

We are interested to know if these predictions hold for maritime trade flows within Latin America. In order to test some of the abovementioned predictions, the estimating equation takes the following form:

$$\ln M_{ijkt} = \alpha_i + \beta_j + \alpha_1 \ln GDP_{it} + \alpha_2 \ln GPD_{jt} + \alpha_3 \ln POP_{it} + \alpha_4 \ln POP_{jt} + \alpha_5 \ln D_{ij} + \gamma_k + \lambda_t + \varepsilon_{ijkt} \quad (11)$$

were γ_k and λ_t are industry and year fixed effects and α_i and β_j are importer and exporter fixed effects. ε_{ijkt} is an error term and ln(M_{ijkt}) is in turn the log of the average value per shipment (intensive margin), and the log of the range of shipments (extensive margin), as described in equation (9). Since OLS is linear, the coefficient on total imports will be equal to the sum of the coefficients on the two margins. A further decomposition can be done, using each of the components in equation (10) as dependent variable in equation (11). Some summary statistics of our data are presented in Table 1.

MAIN RESULTS

First we present some general results for the decomposition of trade flows (Table 2). Argentina imports goods from other Latin American country of the greatest overall value, followed by Brazil; whereas Colombia receives the greatest number of shipments from the region. Products imported to Mexico from other LAC countries have the highest average value in comparison to the other importing countries.

Table 2. The extensive and the intensive margins of Latin American maritime trade flows

Var. Means	Value	Nij	Average Value
Argentina	9 705 055	106.701	117 584.3
Brazil	6 152 345	104.636	102 297.9
Chile	2 186 648	35.161	86 494.24
Colombia	3 625 897	255.318	41 095.26
Ecuador	3 685 330	126.920	35 877.6
Mexico	5 241 092	18.884	278 440.5
Peru	2 447 187	35.246	102 030.2
Uruguay	206 142.1	13.263	29 462.56
Venezuela	3 993 809	146.725	51 066.9

Table 3 presents the results of testing model (1) using distance as a proxy for transport costs. The dependent variable in the first column - Table 3 is the total imported value to a country in year t. In the subsequent columns each of the components of equation (10) is used as dependent variables. The coefficients of the gravity equation have the expected sign. GDP has a significant positive effect on both, the exported volume of goods and the range of shipments. Distance has a negative estimate for all components, except the average freight price. This shows a positive distance coefficient. Increases in the shipping distance correspond to increases in average price per ton. A similar result was obtained by Hillberry and Hummels (2008).

The decomposition of the influence of distance on trade shows a greater effect on the extensive margin (column 2 - Table 3), for all sampled products. About 71 percent of the distance effect on trade works through the extensive margin (i.e. 0.399/(0.399+0.163)); 29 percent of the increase in aggregate trade flows comes from larger average shipments. Previous research finds similar results, with the extensive margin being more important than the intensive margin (Hillberry and Hummels, 2008; Mayer and Ottaviano, 2008). Our results are closer to Mayer and Ottaviano (2008), who analyze French and Belgian individual export flows and show that 75 percent of the distance effect on trade comes from the extensive margin.

Turning to the second level decomposition of equation (11), on the one hand we see that the decline in number of shipments over space come entirely from the second component (N_{ijf}), proximate geographic countries see a larger number of unique shipments per commodity, whereas the number of commodities shipped between countries (N_{ijk} in column 4 - Table 3) does not seem to vary with distance. On the other hand, the components of average value per shipment (columns 6 and 7 - Table 3) change with distance in opposite direction. Increases in shipment distance correspond to increases in average prices per ton and decreases in average quantities shipped. The more plausible explanation is related to trade composition: goods with low value to weight are imported from closer locations than goods with high value to weight ratios.

Table 3. Explaining the extensive and the intensive margins with distance

	M1	M2	M3	M4	M5	M6	M7
Margins	**Total**	**Extensive**	**Intensive**	**Extensive components**		**Intensive components**	
	Value	**Nij**	**Av(P*Q)**	**Nijf**	**Nijk**	**avPrice**	**AvQ**
LD	-0.562**	-0.399***	-0.163***	-0.410***	0.011	0.175***	-0.338***
	-4.128	-16.746	-4.978	-26.845	0.451	8.54	-7.937
IGDPLN	2.294***	0.532***	1.762***	0.594***	-0.063	0.637***	1.125***
	34.059	10.457	27.081	24.923	-1.498	14.075	13.539
EGDPLN	0.485***	0.348***	0.137*	0.388***	-0.04	0.033	0.105
	5.582	6.915	2.442	9.184	-0.972	1.086	1.552
IPOPULN	1.336***	0.792***	0.545***	0.787***	0.004	-0.066***	0.611***
	14.167	26.717	15.334	42.343	0.199	-3.504	14.94
EPOPULN	0.424**	0.015	0.408***	-0.028	0.043	0.052**	0.357***
	4.68	0.448	15.117	-1.962	1.78	2.945	11.709
Y2000	0.297*	0.268***	0.029	0.256***	0.012	-0.132***	0.160***
	2.346	14.801	1.393	28.763	0.809	-8.864	6.486
Y2001	0.302*	0.151***	0.151***	0.142***	0.009	-0.110***	0.261***
	3.008	9.612	5.594	20.105	0.672	-6.186	7.557
Y2002	0.173	0.135***	0.038	0.128***	0.006	-0.167***	0.205***
	0.995	7.217	1.465	17.636	0.386	-8.458	6.095
Y2003	0.134	0.306***	-0.172***	0.312***	-0.006	-0.233***	0.061
	0.665	12.958	-5.737	34.024	-0.336	-10.109	1.794
Y2004	0.302	0.375***	-0.073*	0.383***	-0.008	-0.136***	0.063
	1.526	13.668	-2.264	40.718	-0.36	-6.011	1.606
CONSTANT	-38.44***	-17.70***	-20.74***	-15.04***	-2.659**	1.971**	-22.71***
	-23.661	-18.29	-22.415	-31.095	-3.301	3.01	-18.474
R^2	0.33	0.485	0.518	0.476	0.401	0.571	0.563
N	860986	860986	860986	860986	860986	860986	860986
LL	-1721049	-1283085	-1376281	-1061089	-973961	-892378	-1474909
RMSE	1.786261	1.074062	1.196847	0.829949	0.750071	0.682261	1.34211
AIC	3442116	2566204	2752595	2122212	1947957	1784791	2949851
BIC	3442221	2566402	2752794	2122411	1948155	1784989	2950050

Notes: t-statistics are given below each estimate. The dependent variables are listed in the second row. Value denotes imports in current $ of good k from the exporting country i to the importing country j in natural logarithms, N_{ij}; N_{ijf} and N_{ijk} denote respectively the number of shipments, the number of distinct SITC goods shipped and the number of average shipments between a country of origin and a destination country, AV(P*Q), avPrice, avQ denote respectively average value of imports, average price of imports and average quantity imported. All dependent and independent variables, excluding time dummies, are also in natural logarithms. LD denotes the log of distance, EGDPLN and IGDPLN denote Gross Domestic Product of the exporter and the importer country respectively and EPOPULN and IPOPULN denote the respective populations. All the estimations use country and product fixed effects and White's heteroscedasticity-consistent standard errors. Panel data are for the year 1999-2004.

Table 4 shows the decomposition of the influence of ad-valorem transport costs on maritime trade. The effect is lower on the extensive margin (column 2), for all products and for our sample. Around 29 percent of the trade cost effect on trade works through the extensive margin, whereas 71 percent of the variation in aggregate trade flows works through the intensive margin (column 3). Hence, shipping costs seems to affect the intensive margin to a greater extent, which is in accordance with the theoretical prediction that changes in variable costs mainly affect the intensive margin of trade (Chaney, 2008). It is widely recognized that shipping costs decrease with higher values traded and hence can be considered as variable costs of trade.

Table 4. Explaining the extensive and the intensive margins with freight rates

	M1	M2	M3	M4	M5	M6	M7
Margins	**Total**	**Extensive**	**Intensive**	**Extensive components**		**Intensive components**	
	Value	**Nij**	**Av(P*Q)**	**Nijk**	**Nijf**	**avPrice**	**AvQ**
LCIFOB	-0.240*	-0.050***	-0.190***	-0.049***	-0.001	-0.166***	-0.024
	-3.041	-4.37	-14.06	-5.858	-0.116	-14.23	-1.685
LD	-0.538**	-0.414***	-0.123***	0.02	-0.434***	0.236***	-0.359***
	-3.906	-16.143	-3.808	0.865	-27.589	10.772	-8.063
IGDPLN	2.187***	0.510***	1.677***	-0.092*	0.602***	0.582***	1.095***
	28.376	10.283	25.222	-2.165	25.448	12.84	13.49
EGDPLN	0.382**	0.346***	0.037	-0.053	0.399***	-0.017	0.053
	3.661	6.35	0.613	-1.246	9.904	-0.554	0.721
IPOPULN	1.239***	0.746***	0.493***	-0.015	0.761***	-0.081***	0.575***
	12.88	25.105	13.639	-0.71	38.694	-4.458	13.677
EPOPULN	0.435**	0.037	0.398***	0.042	-0.005	0.031	0.366***
	4.172	1.093	15.36	1.697	-0.341	1.907	12.529
Y2000	0.277	0.213***	0.065**	0.035	0.178***	-0.087***	0.151***
	1.801	9.848	2.619	1.748	21.213	-5.074	4.756
Y2001	0.378*	0.292***	0.086**	0.01	0.282***	-0.060***	0.146***
	3.064	15.064	2.711	0.552	36.057	-3.566	3.757
Y2002	0.304	0.252***	0.052	0.008	0.244***	-0.126***	0.178***
	1.688	10.415	1.544	0.395	26.241	-6.458	4.143
Y2003	0.316	0.451***	-0.135***	0.004	0.447***	-0.193***	0.058
	2.055	14.505	-4.009	0.156	38.985	-9.369	1.398
Y2004	0.468*	0.545***	-0.077*	0.005	0.539***	-0.110***	0.034
	2.76	15.361	-2.155	0.181	45.431	-5.513	0.76
CONS	-35.954***	-17.013***	-18.942***	-1.959*	-15.054***	2.623***	-21.565***
	-47.244	-17.393	-20.001	-2.391	-31.89	4.144	-17.343
R^2	0.386	0.512	0.557	0.399	0.532	0.614	0.585
N	665 383	665 383	665 383	665 383	665 383	665 383	665 383
LL	-1 294 469	-967 913	-1 041 602	-752 022	-775 480	-670 847	-1 135 914
RMSE	1.693311	1.036559	1.157952	0.749345	0.776235	0.663284	1.334282
AIC	2 588 955	1 935 860	2 083 238	1 504 077	1 550 994	1 341 729	2 271 861
BIC	2 589 046	1 936 054	2 083 432	1 504 271	1 551 188	1 341 923	2 272 055

Notes: t-statistics are given below each estimate. The dependent variables are listed in the second row. Value denotes imports in current $ of good k from the exporting country i to the importing country j in natural logarithms, N_{ij}; N_{ijf} and N_{ijk} denote respectively the number of shipments, the number of distinct SITC goods shipped and the number of average shipments between a country of origin and a destination country, AV(P*Q), avPrice, avQ denote respectively average value of imports, average price of imports and average quantity imported. All dependent and independent variables, excluding time dummies, are also in natural logarithms. LCIFOB denotes ad-valorem shipping costs, including freight and insurance, LD denotes the log of distance, EGDPLN and IGDPLN denote Gross Domestic Product of the exporter and the importer country respectively and EPOPULN and IPOPULN denote the respective populations. All the estimations use country and product fixed effects and White's heteroscedasticity-consistent standard errors. Panel data are for the year 1999-2004.

DISCUSSION

To our knowledge, this is the first paper that evaluates the effect of maritime transport costs on the two margins of trade. Previous research finds similar results for the effect on total import values. Our results are closer to those found in a recent study done by Korinek (2009). The results in this study, for a broad sample of countries, indicate that a 10 percent increase in shipping costs is associated with a 3 percent drop in trade. In our sample a 10 percent increase in shipping costs is associated with a 2.4 percent drop in trade.

Table 5. Explaining the extensive and the intensive margins with freight rates and insurance

	M1	M2	M3	M4	M5	M6	M7
Margins	**Total**	**Extensive**	**Intensive**	**Extensive components**		**Intensive components**	
	Total Value	**Nij**	**Av(P*Q)**	**Nijk**	**Nijf**	**avPrice**	**AvQ**
LCTON	-0.318*	-0.158***	-0.160***	-0.079***	-0.079***	0.107***	-0.267***
	-3.207	-8.743	-8.174	-6.112	-7.841	15.018	-13.547
LINSTON	0.027	0.030**	-0.003	0.003	0.027***	0.108***	-0.111***
	0.576	3.147	-0.253	0.433	4.518	14.438	-8.093
LD	-0.397*	-0.422***	0.025	0.033	-0.455***	0.135***	-0.110**
	-2.453	-15.186	0.875	1.242	-22.823	5.793	-2.659
Y2000	0.213	0.163***	0.05	-0.003	0.166***	-0.042*	0.092**
	1.114	6.354	1.834	-0.14	10.898	-2.361	3.007
Y2001	0.288*	0.283***	0.004	-0.023	0.307***	-0.022	0.027
	2.431	10.618	0.131	-1.017	20.393	-1.163	0.745
Y2002	0.197	0.240***	-0.043	-0.03	0.270***	-0.055**	0.012
	0.984	8.114	-1.201	-1.243	17.257	-2.738	0.303
Y2003	0.347	0.417***	-0.069	-0.042	0.459***	-0.059**	-0.011
	1.92	12.817	-1.962	-1.703	23.086	-2.923	-0.282
Y2004	0.519	0.537***	-0.017	-0.055*	0.592***	0.005	-0.022
	2.135	14.694	-0.485	-2.01	28.416	0.249	-0.583
CONS	-14.74***	-12.08***	-2.66**	-1.67*	-10.40***	7.29***	-9.95***
	-15.895	-12.274	-3.192	-2.448	-18.516	16.912	-9.64
R^2	0.404	0.524	0.556	0.418	0.531	0.656	0.636
N	436639	436639	436639	436639	436639	436639	436639

Notes: t-statistics are given below each estimate. The dependent variables are listed in the second row. Value denotes imports in current $ of good k from the exporting country i to the importing country j in natural logarithms, N_{ij}; N_{ijf} and N_{ijk} denote respectively the number of shipments, the number of distinct SITC goods shipped and the number of average shipments between a country of origin and a destination country, AV(P*Q), avPrice, avQ denote respectively average value of imports, average price of imports and average quantity imported. All dependent and independent variables, excluding time dummies, are also in natural logarithms. All explanatory variables, excluding time dummies, are also in natural logarithms. LCTON denotes the log of shipping cost per tonne including insurance, LINSTON is the log of the insurance per tonne and LD denotes the log of distance. All the estimations use country and product fixed effects and White's heteroscedasticity-consistent standard errors. Panel data are for the year 1999-2004.

Turning to the second level decomposition of equation (11), on the one hand we see that the decline in number of unique shipments due to higher shipping costs come entirely from the first component (N_{ijk}). Model 4 (Table 3) shows that the number of commodities shipped between countries decreases when shipping costs are higher, whereas the number of unique shipments per commodity (N_{ijf}) plays no role (Column 5). On the other hand, results in Models 6 and 7 show that the components of average value per shipment change with shipping costs in the same direction. Increases in shipment costs are associated to decreases in average quantities shipped and in average prices per ton. 87 percent of the variation in average imported value works trough changes in average prices per ton, whereas only 13 percent works trough changes in average quantities shipped.

With respect to the previous results found in Table 3 for spatial frictions, the main pattern remains unchanged, the only difference is that adding shipping costs slightly reduces the estimated coefficient for distance and that the percentage of variation in distance explained through the extensive margin of maritime trade increases from 71 percent to 77 percent.

Table 6. Results by product category

	M1	M2	M3	M4	M5	M6	M7
Margins	**Total**	**Extensive**	**Intensive**	**Extensive components**		**Intensive components**	
MANUFACTURES							
	VALUE	**Av(P*Q)**	**Nij**	**Nijk**	**Nijf**	**avPrice**	**AvQ**
LCIFOB	-0.231*	-0.186***	-0.045***	-0.042***	-0.003	-0.164***	-0.022
	-2.892	-13.42	-3.799	-5.02	-0.299	-13.592	-1.503
LD	-0.595**	-0.163***	-0.432***	-0.012	-0.420***	0.235***	-0.399***
	-3.843	-5.114	-16.252	-0.523	-25.139	10.388	-8.801
R^2	0.391	0.553	0.494	0.401	0.53	0.607	0.565
N	621 981	621 981	621 981	621 981	621 981	621 981	621 981
AGRICULTURAL PRODUCTS							
	VALUE	**Av(P*Q)**	**Nij**	**Nijk**	**Nijf**	**avPrice**	**AvQ**
LCIFOB	-0.328*	-0.185*	-0.144**	-0.134***	-0.009	-0.146***	-0.038
	-3.322	-2.089	-3.62	-3.974	-0.562	-6.55	-0.384
LD	0.322	0.187	0.135	0.459***	-0.324***	0.088	0.099
	1.207	1.132	1.75	4.54	-5.729	1.93	0.509
R^2	0.403	0.335	0.484	0.383	0.444	0.461	0.333
N	29 646	29 646	29 646	29 646	29 646	29 646	29 646
RAW MATERIALS							
	VALUE	**Av(P*Q)**	**Nij**	**Nijk**	**Nijf**	**avPrice**	**AvQ**
LCIFOB	-0.444***	-0.293**	-0.152**	-0.096	-0.056	-0.283***	-0.01
	-6.143	-3.767	-3.517	-1.475	-1.219	-5.507	-0.141
LD	0.229	0.202	0.028	0.495***	-0.467***	0.148**	0.054
	0.54	1.796	0.36	4.736	-6.313	3.788	0.455
R^2	0.349	0.42	0.432	0.364	0.531	0.537	0.453
N	9348	9348	9348	9348	9348	9348	9348

Notes: t-statistics are given below each estimate. The dependent variables are listed in the second row. Value denotes imports in current $ of good k from the exporting country i to the importing country j in natural logarithms, N_{ij}; N_{ijf} and N_{ijk} denote respectively the number of shipments, the number of distinct SITC goods shipped and the number of average shipments between a country of origin and a destination country, AV(P*Q), avPrice, avQ denote respectively average value of imports, average price of imports and average quantity imported. All dependent and independent variables, excluding time dummies, are also in natural logarithms. LCIFOB denotes ad-valorem shipping costs, including freight and insurance and LD denotes the log of distance. All the estimations use country and product fixed effects and White's heteroscedasticity-consistent standard errors. Panel data are for the year 1999-2004.

Shipping costs can also be decomposed into insurance and pure freight and we use this decomposition to test some of the predictions outlined before with respect to fix and variable trade costs. The results are presented in Table 5. In this case we use transport cost per tonne and insurance paid per tonne shipped. In this specification the effects of transport costs on the two margins of trade is more evenly distributed (50 percent of the variation of total imports is explained through the extensive margin and 50 percent through the intensive margin) and the effect of distance works completely through the extensive margin and does not affect the intensive margin. With respect to insurance, the effect on each margin goes in opposite direction: a higher insurance per tonne increases the number of unique shipments and slightly reduces the average value of the shipments.

Turning to the second level decomposition of equation (11), on the one hand we see that the increase in number of shipments due to a higher insurance cost come entirely from the second component (N_{ijf}), higher insurance costs is associated to a larger number of unique shipments per commodity, whereas the number of commodities shipped between countries does not seem to vary with insurance cost. On the other hand, the components of average value per shipment change with shipping costs in opposite directions and they almost compensate each other. Increases in insurance cost are associated to decreases in average quantities shipped and to increases in average prices per ton. 50 percent of the absolute variation in average imported value works trough each channel. The explanation could be related, once again, to trade composition: goods with low value to weight pay a lower insurance than goods with high value to weight ratios.

Finally, Table 6 presents separated results for three product categories: agriculture, raw materials and manufactures. Results for manufactures are very similar to those found for all products (Table and 4), interestingly differences are found for agriculture and raw materials. First, when the sample is restricted to agriculture and raw materials the total value of imports does not depend on distance, whereas shipping cost presents a higher estimated coefficient that for raw materials is almost double than the one found for manufactures.

Turning to the second level decomposition of equation (11), on the one hand we see that the decline in number of shipments over space come entirely from the second component (N_{ijf}) only for manufactures. Proximate geographic countries see a larger number of unique shipments per commodity, whereas for agricultural products and raw materials the number of commodities shipped between countries does seem to increase with distance. On the other hand, the components of average value per shipment change with distance in opposite direction only for manufactures. Increases in shipment distance correspond to increases in average prices per ton and decreases in average quantities shipped. However, for raw materials and agriculture only the average price increases with distance, whereas the average quantity does not co-vary with spatial frictions.

With respect to shipping costs, we also observe a different pattern for agriculture and raw materials as compared with manufactures. The effect of a reduction in shipping costs on trade comes through both margins for the former, whereas for the latter it mainly works through the intensive margin.

These findings suggest that the differences in the various shipping markets, bulk and container market are also reflected in trade margins. This also hints towards the influence of different pricing strategies in the bulk and container shipping market. Future research will have to further investigate the influence of transport market structures on international transport costs and trade. This also underlines the findings from Wilmsmeier and Hoffmann

(2008), who find a significant influence of the market and service structure for the case of the Caribbean.

As a robustness check, and in line with some previous findings (Martínez-Zarzoso and Nowak-Lehman, 2007), we consider a non-linear relationship between distance and the trade margins. The results are presented in Appendix 2. While for total value exported the coefficient of squared distance is not statistically significant from zero, we find an inverted U-shaped relationship between distance and the number of shipments, between distance and the average value shipped and between distance and the average quantity shipped. Therefore, the number of goods shipped increase with distance for shorter distances and then decreases. The turning point corresponds to a distance of 563 kilometres (the minimum distance in our sample is 215 km and the maximum 2854 km). The average quantity shipped increase only for distances lower than 702 km, whereas the average value imported increases with distances lower than 1252 km and then decreases. Further research is needed to explain these findings, a possible explanation can be found by considering the type of products shipped.

CONCLUSIONS

This paper focuses on the analysis of the relationship between maritime trade and transport costs in Latin America. According to new theories of international trade with imperfect competition and heterogeneous firms, lower trade costs increases bilateral trade through an increase of both margins of trade. We use highly disaggregated trade data to decompose intra-LA imports into these two components to shed some light on why trade costs matter for trade. Several new findings are derived. First, about 71 percent of the distance effect on trade works through the extensive margin, indicating that the number of shipments sharply decreases with distance. Spatial frictions are less relevant for the intensive margin, with only 29 percent of the distance effect working through this margin. Second, the opposite pattern is observed for ad-valorem freight rates: only 29 percent of its effect on trade works through the extensive margin, whereas 71 percent is attributable to the intensive margin.

Finally, the main results hold for manufactures, but change for agriculture and raw materials, especially with respect to spatial frictions, that are much less relevant for these categories of goods. Especially, the later results call for further research on the effect of transport market structures on trade pattern and transport costs.

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APPENDICES

Appendix 1. Summary statistics

VARIABLE		Obs	Mean	Std. Dev.	Min	Max
LTCIF	Value of bilateral imports ($)	897 652	13.735	2.230	0.000	19.328
LNIJ	Number f shipments	897 652	4.004	1.509	0.000	7.301
LNIJF	Number of distinct SITC products	897 652	4.367	1.156	0.000	6.309
LNIJK	Number of average shipments between countries i and j	897 652	-0.363	0.980	-6.309	1.453
LAVCIF	Average value of imports cif	897 652	9.731	1.737	0.000	17.488
LAVP	Average price of imports	897 652	7.957	1.076	-1.955	19.058
LAVQ	Average quantity imported	897 652	1.774	2.058	-6.908	11.541
LCIFOB	Ad-valorem transport costs	689 121	-2.911	1.062	-14.202	9.079
LD	Distance importer / exporter	896 980	7.700	0.769	5.371	8.971
LIGDP	GDP importer	897 652	8.115	0.327	6.918	8.897
LEGDP	GDP exporter	860 986	8.389	0.330	6.109	9.521
LIPOPU	Population importer	897 652	17.381	0.888	15.058	19.043
LEPOPU	Population exporter	860 986	16.861	1.664	11.184	19.043

Note: where L denote natural logs.

Appendix 2. Non linear relationship between distance and trade margins

	M1	M2	M3	M4	M5	M6	M7
Margins	**Total**	**Extensive**	**Intensive**	**Extensive components**		**Intensive components**	
	Value	**Nij**	**Nijk**	**Nijf**	**avPrice**	**AvQ**	**Av(P*Q)**
LD	4.842	**1.989*** **	0.425	**1.564*** **	0.677*	**2.176*** **	**2.853*** **
	1.349	5.957	1.261	6.793	2.022	3.862	6.56
LD2	-0.356	**-0.157*** **	-0.027	**-0.130*** **	-0.033	**-0.166*** **	**-0.199*** **
	-1.48	-7.023	-1.215	-8.751	-1.528	-4.43	-6.82
IGDPLN	2.524***	0.634***	-0.045	0.679***	0.659***	1.232***	1.891***
	12.656	11.943	-1.024	27.78	14.312	14.013	27.051
EGDPLN	0.592**	0.395***	-0.032	0.427***	0.043	0.155*	0.197***
	4.773	7.704	-0.773	10.021	1.353	2.171	3.388
IPOPULN	1.232***	0.746***	-0.004	0.749***	-0.076***	0.563***	0.487***
	9.378	27.229	-0.181	40.89	-3.468	12.898	13.381
EPOPULN	0.417***	0.012	0.042	-0.030*	0.051**	0.354***	0.405***
	5.729	0.363	1.76	-2.122	2.934	11.515	14.864
Y2000	0.317*	0.277***	0.014	0.263***	-0.130***	0.170***	0.04
	2.323	15.137	0.913	29.06	-8.77	6.802	1.915
Y2001	0.310*	0.154***	0.01	0.145***	-0.109***	0.264***	0.156***
	3.056	9.766	0.714	20.421	-6.161	7.636	5.722
Y2002	0.178	0.137***	0.007	0.130***	-0.166***	0.207***	0.041
	1.016	7.245	0.407	17.484	-8.455	6.128	1.561
Y2003	0.143	0.310***	-0.006	0.316***	-0.232***	0.066	-0.167***
	0.711	13.038	-0.297	33.59	-10.109	1.898	-5.509
Y2004	0.309	0.378***	-0.008	0.386***	-0.136***	0.066	-0.069*
	1.602	13.623	-0.336	39.302	-6.003	1.667	-2.108
CONS	-59.500**	-27.006***	-4.273**	-22.733***	0.016	-32.510***	-32.494***
	-3.933	-17.759	-2.779	-26.247	0.011	-13.195	-17.428
TURNING POINT	**-**	563.628	-	409.683	28497.620	702.199	1252.003
R^2	0.337	0.488	0.401	0.48	0.572	0.564	0.521
N	860986	860986	860986	860986	860986	860986	860986
LL	-1716142	-1280442	-973799	-1058063	-892090	-1473034	-1372883
RMSE	1.776111	1.07077	0.74993	0.827038	0.682033	1.339192	1.192133
AIC	3432305	2560919	1947633	2116163	1784216	2946104	2745801
BIC	3432421	2561129	1947843	2116373	1784426	2946314	2746011

Notes: t-statistics are given below each estimate. The dependent variables are listed in the second row. Value denotes imports in current $ of good k from the exporting country i to the importing country j in natural logarithms, N_{ij}; N_{ijf} and N_{ijk} denote respectively the number of shipments, the number of distinct SITC goods shipped and the number of average shipments between a country of origin and a destination country, AV(P*Q), avPrice, avQ denote respectively average value of imports, average price of imports and average quantity imported. All dependent and independent variables, excluding time dummies, are also in natural logarithms. LCIFOB denotes ad-valorem shipping costs, including freight and insurance, LD denotes the log of distance, LD2 denotes the log of distance squared, EGDPLN and IGDPLN denote Gross Domestic Product of the exporter and the importer country respectively and EPOPULN and IPOPULN denote the respective populations. All the estimations use country and product fixed effects and White's heteroscedasticity-consistent standard errors. Panel data are for the year 1999-2004.