THE UNEVEN EFFECT OF TRADE COSTS ON THE TWO MARGINS OF MARITIME TRADE

Sami Bensassi

Department of Economics

Universitat Jaume 1, Campus del Rio Seco, 12071

Castellón, Spain

Bensassi@eco.uji

Phone: 0034-964-72 85 90

Fax : 0034-964-72 85 91

Inmaculada Martinez-Zarzoso

Department of Economics and Institute of International Economics,

Universitat Jaume I, Campus del Riu Sec, 12071

Castellón, Spain

and

Department of Economics and Center for Statistics,

University of Goettingen, Germany.

martinei@eco.uji.es

Phone: 0049-551-39 7350

Fax: 0049-551-39 7279

Celestino Suárez Burguet

Department of Economics and Institute of International Economics,

Universitat Jaume I, Campus del Riu Sec, 12071

Castellón, Spain.

Phone: 0034-964-387156

Fax: 0034-964-72 85 91

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Abstract

This paper analyses the relationship between maritime trade and transport costs. The research contributes to the literature by disentangling the effects of transport costs, not only on total trade but also on the range of goods traded (extensive margin) and the average values of the goods traded (intensive margin). The main aim is to test some of the predictions of the new-new trade theories that introduce firm heterogeneity in productivity, as well as fixed costs of exporting. Recent research shows that spatial frictions reduce trade mainly by reducing the variety of goods traded and that most firms ship only to geographically proximate customers, instead of shipping to many destinations in quantities that decrease in distance. We focus on eight categories of products traded all over the world and use a newly released OECD international maritime transport cost database including data on international maritime transport costs. Our analysis shows that ad-valorem freight costs reduce aggregate trade values mainly by reducing the average value of imported goods (intensive margin).

Keywords

Maritime transport costs; International trade; Asia; Sector data; Competitiveness

1. Introduction

This paper focuses on clarifying to what extent variations in trade-related costs between Europe and Asia help to explain the surge in Euro-Asian trade in eight of the most emblematic categories of products related to Asian success: textiles (knitted and not knitted), footwear confection, machinery, electronics products, vehicles, furniture and pharmaceutical products. Several categories of trade costs are considered, namely maritime transport costs, time to export/import, behind-the-border trade costs and distances.

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, changes in specialisation, in factor prices and in real income. We focus on international maritime transport

costs and on trade facilitation as key aspects of trade costs and analyse how these effects operate and how significant they are.

The relationship between international trade and trade costs has traditionally been estimated using gravity models of trade, which relate bilateral trade flows to the income and population of the trading partners and the geographical distance between them. Recent research has focused on the use of more accurate proxies for transport costs, such as freight rates, infrastructure or customs procedures. In this line, Limao and Venables (2001) analyse the dependency of trade and transport costs on geographical and infrastructural variables and estimate the elasticity of trade with respect to transport costs in the range 2-5. In addition, Martínez-Zarzoso and Suárez-Burguet (2005) and Martínez-Zarzoso et al. (2007) found similar results using disaggregated data. Recent studies have found that distance is imperfectly correlated with maritime transport costs (Wilmsmeier and Hoffmann, 2008). Clark (2007) and Martínez-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 studies have underlined the importance of obtaining better data on transport costs (Anderson and van Wincoop, 2004).

However, the evidence suggesting that transport costs are only vaguely related to distance should not be confused with the proven empirical fact that distance is correlated with trade flows. Hilberry 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 costs or trade facilitation aspects, such as historical ties, cultural proximity, business networks or the combination and interrelation between those factors.

The theoretical models used to generate the gravity equation usually assume homogeneous firms within a country and consumer preference for variety. These two assumptions imply that all products are traded to all destinations. However, empirical evidence indicates that only a small number of firms are exporters and export exclusively to a limited number of countries. This empirical fact has led to the development of the so-called new-new trade theories based on firm heterogeneity in productivity and fixed exporting costs (Melitz, 2003). These new theories predict the existence of a productivity threshold for each country that firms have to exceed in order to become exporters. As a result, two margins of trade emerge: The number of unique shipments (extensive margin) and the average value of shipments (intensive margin).

In marked contrast to other studies that focus on the determinants of maritime trade, we use sectoral trade data for eight different selected industries and decompose trade into two margins: the number of varieties exchanged inside each category defined at the HS6 level (extensive margin) and the average value of each variety (intensive margin). This disaggregation shows to what extent trade costs matter in international trade and isolates which trade components are most affected by variations in different types of trade costs.

Our analysis focuses on disaggregated trade between the European Union (EU15)[1] and 15 trading partners representing[2] a total of 225 maritime trade routes over a period of eight years (1999-2007). Freight rates are obtained from the Maritime Transport Costs Database from the OECD. The database gathers data on unit transport costs and ad valorem transport costs for exports and imports of several sectors between pairs of countries, excluding loading costs. One advantage of this source is that the data are disaggregated at product level (HS2) and precisely define origin-destination and mode of transport for shipments. Therefore, we are able to decompose bilateral trade values into margins and to explore how well the variability of each margin is explained by

[1] EU15 stands for: Austria, Belgium, Denmark, France, Finland, Germany, Greece, Ireland, Italy, Luxemburg, Netherlands, Portugal, Spain, Sweden, and United Kingdom.

[2] Brazil, China, Honk-Kong, India, Indonesia, Japan, Malaysia, Philippines, Saudi Arabia, Singapore, South Korea, Thailand, the United Arab Emirates, the United States of America, Vietnam.

freight rates. In addition, we use a number of trade and cost-related variables, namely time to export and import and inland transport costs, as proxies for other trade costs related to what the literature has labelled "trade facilitation".

The paper contributes to the existing literature in several respects. Unlike previous research, we decompose European trade flows into multiple components in an effort to study what margins of trade freight rates and trade facilitation factors act upon.

By using precise and time varying transport cost data, we find that transport costs for maritime trade between Asia and Europe mainly have an impact on trade through the intensive margin of trade, at least for the products studied.

The remainder of this paper is organised as follows. Section 2 presents the methodology used to decompose the value of trade into margins and the main hypotheses to be tested. Section 3 describes the data. Section 4 shows the main results. Finally, Section 5 concludes.

2. Decomposing Maritime Trade. Main Hypothesis

In recent literature the effect of transport costs on trade has been commonly analysed using the gravity model of trade, with the dependent variable being the aggregate/ disaggregates value of trade between two countries. Some recent studies for aggregated trade are Limao and Venables (2001), Sánchez et al. (2003) and Martinez-Zarzoso and Suarez-Burguet (2005) and for disaggregated trade Martínez-Zarzoso, García-Menendez and Suárez-Burguet (2003), Martinez-Zarzoso et al. (2005) and Martinez-Zarzoso (2009) and Martinez-Zarzoso and Wilmsmeier (2010). This approach relies on a model that assumes iceberg trade costs[3] and symmetric firms. In this setting, aggregated trade values react to trade costs in exactly the same way as disaggregated trade (firm-level) quantities and consumers buy positive quantities of all varieties.

[3] 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.

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

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

(1)

where Ej denotes country j's total expenditure on the differentiated product, $(p_i t_{ij})$ is the price of product i at destination j, pi 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[4] (CES)[5] .

Since the quantity traded of each variety is in most cases not observable, adding two assumptions: namely all varieties in the origin are symmetric and the destinations will consume all the varieties in equal quantity. This allows obtaining total trade values as the product of three variables: the quantity per variety traded(q_{ij}), the price of the variety (p_i) and the number of varieties(n_i). The outcome is

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

(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

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

constant or if transport costs are not iceberg costs (Hummels and Skiba, 2004). Consequently for a given year t, we can assume:

$$T_{ij} = n_{ij} p_{ij} q_{ij} \tag{3}$$

At least three reasons have been suggested in the literature to explain why the range of trade products might vary with trade cost (Feenstra and Kee, 2005). 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 going 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. With the methodology described below we aim to shed some light on the validity of each of these explanations that justify why not all the varieties are shipped to each destination and why the trade margins depend negatively on the magnitude of trade costs.

The methodology we use to decompose aggregate value of trade into its various components is based on Hummels and Skiba (2004). Unique shipments are indexed by s and the total value of shipments from country i to country j is given by

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

where N_{ij} is the number of unique shipments (extensive margin of trade) and 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 $\overline{PQ}_{ij} = \frac{(\sum_{s=1}^{N_{ij}} P_{ij}^{s} Q_{ij}^{s})}{N_{ij}}$

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_{ijk}, 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:

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

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

$$T_{ij} = N_{ij}^{k} N_{ij}^{F} \overline{P_{ij}}\ \overline{Q_{ij}} \qquad (8)$$

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 is given by equation (5) that decomposes total trade value into the number of products traded and the average value per product. The second, given by equation (8), decomposes each of these two components further into another two. The extensive margin is decomposed into the number of distinct SITC goods shipped and the number of average shipments between a country of origin and a destination country. The intensive margin is decomposed into the average price and the average quantity. Taking logs of the first and second level decompositions and adding the time dimension, t we obtain:

$$\ln T_{ijt} = \ln N_{ijt} + \ln \overline{PQ}_{ijt} \qquad (9)$$

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

Next we analyse how each of the components of equation (10) co-vary with distance and with other trade-related costs (maritime transport costs, time to export/import, cost to export/import).

The estimating equation takes the following form:

$$\begin{aligned} \ln X_{ijkt} = {} & \alpha_i + \beta_j + \alpha_1 \ln GDP_{it} + \alpha_2 \ln GDP_{jt} + \alpha_3 \ln GDPh_{it} + \alpha_4 \ln GDPh_{jt} + \alpha_5 \ln D_{ij} + \alpha_6 TC_{ijkt} + \\ & \alpha_7 timex_{jt} + \alpha_8 timem_{jt} + \alpha_9 cosx_{it} + \alpha_{10} cosm_{jt} + \gamma_k + \lambda_t + \varepsilon_{ijkt} \end{aligned} \qquad (11)$$

where 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 $\ln(X_{ijkt})$ 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). GDP_{it} and GDP_{jt} denote Gross Domestic Product of the importer and the exporter country in year t, respectively and $GDPh_{it}$ and $GDPh_{jt}$ denote the respective Gross Domestic Product per capita. D_{ij} is the geographical distance between the trading-countries' capitals and TC_{ijkt} denote freight rates of transporting product k from j to i in period t. $timem_{ij,jt}$ and $timex_{ij,jt}$ are respectively for the time to import and the time to export in one country. $cosm_{ij,jt}$ and $cosx_{ij,jt}$ are for behind-the-border cost to import and the time to export in one country.

Since equation 11 is linear in the parameters, 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). Then we test the following alternative specification which control for time sector and time country specific effects:

$$\ln X_{ijkt} = \alpha_{ij} + \beta_1 \ln TC_{ijkt} + \lambda_{it} + \theta_{jt} + \delta_{kt} + \varepsilon_{ijkt} \qquad (12)$$

where λ_{it}, θ_{jt} are year-country fixed effects, δ_{kt} is time sector fixed effect and ε_{ijkt} is an error term. This specification is introduced in order to control for multilateral resistance effects. This specification is introduced in order to control for multilateral resistance effects. Anderson and van Wincoop (2003) describe these effects as the impact of changes in prices caused by variations of trade cost between a given country i and all its trading partners on trade with country j. It is not only the variation of the bilateral trade cost that counts for determining trade flows between two countries (i and j) but the variation of this costs in comparison with other existing trade costs linking these two countries to their other trading partners. In order to control for these effects and obtain the direct effect of trade cost reductions, some authors (Feenstra and Kee, 2004; Baldwin and Taglioni, 2006) advise to introduce year-country fixed effects in order to capture the indirect impact of trade cost reductions. In addition some characteristics related to the sectors we selected may impact bilateral trade flows between countries, namely comparative advantage in a broad sense.

Time effects allow taking factors that are common to all sectors and countries into account, e. g. technological shocks or the business cycle.

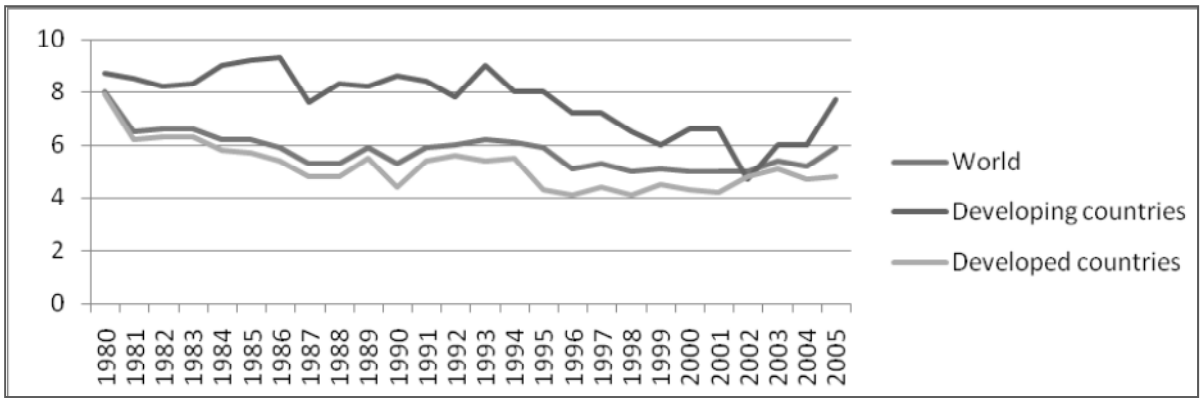
3. Data Description and Variables

3.1 Maritime Transport Costs

The main data source on maritime transport costs is the Maritime Transport Cost (MTC) database from the OECD. The MTC covers annual transport statistics (ad-valorem transport cost, unit transport cost in dollar, total transport costs in dollar) for a vast number of trade routes according to the type of good (2-digits HS) and the type of boat (container ships, tanker, dry and dirty bulks vessels) used to ship the goods.

It is a widely accepted statement that trade openness has increased the last three decades. The corner stone of this statement is the well-documented fall of tariffs barriers (Hummels 2001). Is the same trend noticeable for transport cost? Figures 1 from Korinek (2009) shows the evolution of international maritime transport costs since 1980. The general trend appears to be a slight decrease of the ad valorem equivalent of international maritime transport costs over the period 1980-2005.

Figure 1: Dynamics of maritime transport (ad-valorem equivalent) costs from 1980 to 2005

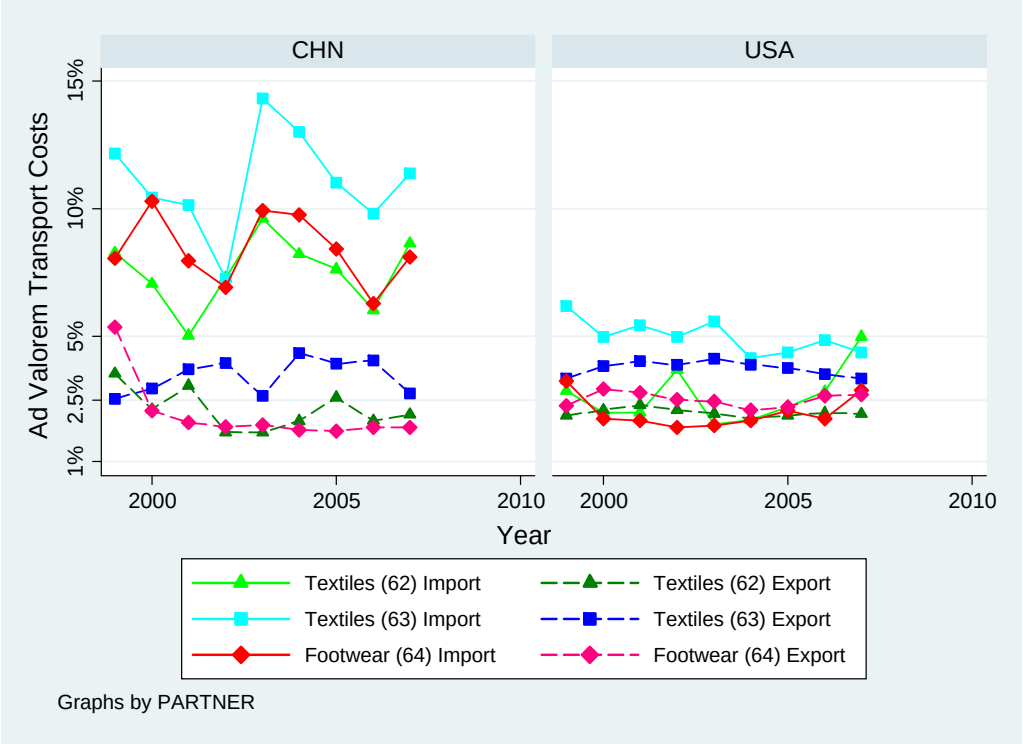


Source: Korinek (2009)

Some differences appear between developing and developed countries. Ad-valorem transport costs are higher for developing countries in every single year with the only exception of 2002. Transport

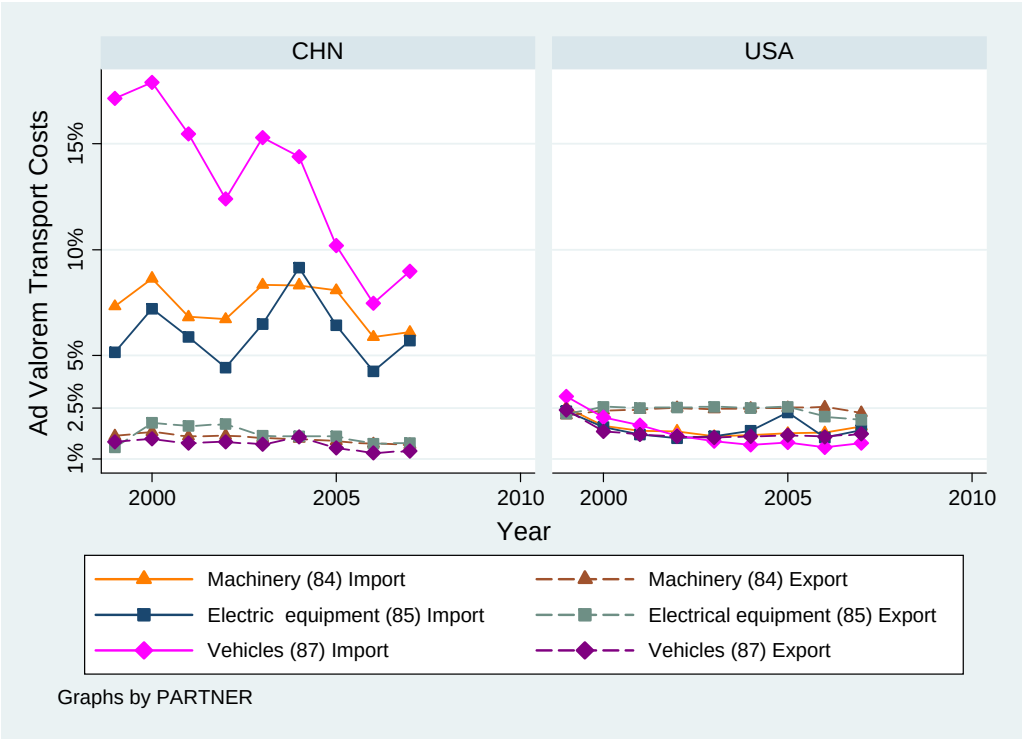
costs decreased rapidly in the eighties for the developed countries before a period of stabilization in the nineties and a show slight increase during the last decade. As regards developing countries, ad-valorem freight rates remained around 9 % until 1995, felt steadily between 1995 and 2001 and increased sharply after 2001. Figures 2 and 3 detail the evolution of ad-valorem transport cost between the EU15 and China, and between the EU15 and the USA, in the textile sector and the footwear industry (62, 63, 64) and in the machinery, electrical equipment and vehicles sectors (84, 85, 87), respectively.

Figure 2: Ad-valorem transport costs in the textile and footwear sectors between the EU15 and the USA and the EU15 and China



Source: OECD maritime transport costs database

Figure 3: Ad-valorem transport costs in the sector 84, 85 and 87 between the EU15 and the USA and the EU15 and China



Source: OECD maritime transport costs database

Large differences can be noticed at first sight between the two partners of the EU15 and between import and export ad-valorem transport costs. Ad-valorem transport costs are more important for Chinese imports of textiles in comparison with the costs bear by EU15 exporters (9.3% and 2.05% respectively in 2007). In the case of the EU15-USA trade in textiles, the difference between export and import ad-valorem transport costs is less important (4.08% and 2.6% respectively in 2007). The same remarks can be done for the sectors 84, 85, and 87. Ad-valorem transport costs are higher for Chinese exports to the EU15 than for EU15 exports to China (6.9% and 0.7% respectively in 2007). Otherwise, ad-valorem transport cost between EU15 and the USA are particularly similar (1.3% and 1.8% respectively in 2007). Strong differences between the costs to import from and to export to China reveal perhaps the large trade imbalance that exists between Europe and China (Behrens and Picard, 2011). Evidence showing decreases in transport costs calculated at the equivalent ad-valorem tariff are only apparent for vehicles (87) in the direction China-EU15 (from 17.15% in 1999 to 8.97% in 2007, which means a decrease of 52%). We have done the same exercise for the other EU15 partners in our sample. In general, developing Asian countries show the same trends as China

in the evolution of their ad-valorem maritime transport costs with the EU15. A strong decrease in ad-valorem transport costs in vehicles is the most noticeable event (-40%). This decrease has also occurred for the developed Asian countries (-32%).

3.2 Gravity Variables

Trade data come from Eurostat. We use the external trade detailed database which covers both extra- and intra-EU trade. The products are classified according to the Harmonized Standard Classification (HS) codes at the HS 6-digit level. Eight categories of manufactured products are taken into consideration (categories 30, 62, 63, 64, 84, 85, 87, 90 as described in Table A.1 in the Appendix). The extensive and intensive margins, average prices and average quantities of products traded between the European Union (EU15) and the 15 partners we have calculated over the period 1999-2007 using export values and export quantities. We count the number of products (6-digits HS) exported within each 2-digits HS category from each exporter to each importer yearly. On average for the whole sample contains about 77 varieties of goods that are exchanged.

Income and population data are taken from the World Development Indicators Database 2008 and distance is taken from CEPII[6]. Trade facilitation variables, namely time needed to export/import and inland transport cost paid to export/import are from the Doing Business Dataset from the World Bank.

A description of the main variables, sources and units in which the variables are measured is presented in Table 1 and summary statistics of the main variables are presented in Table 2.

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

Table 1: Variables and data sources

Variables	Source	Unit
Dependent variables:		
Total trade value ijkt	Eurostat	Current $
Number of varieties traded: Extensive Margin ijkt	Authors' calculation from Eurostat	Number of HS6 categories in an HS2 class of goods
Average value of traded varieties: Intensive Margin ijkt	Authors' calculation from Eurostat	Current $
Average quantity traded ijkt	Authors' calculation from Eurostat	Current $
Average price of traded varieties ijkt	Authors' calculation from Eurostat	Current $
Independent variables:		
Ad-valorem transport cost (TC_adijkt)	OECD Maritime Transport Cost database	Percentage of the good value[7]
Total transport cost (TC_tijkt)	OECD Maritime Transport Cost database	Current $
Unit value transport cost (TC_uijkt)	OECD Maritime Transport Cost database	Current $

[7] The three variables from the Maritime Transport Cost database of the OECD have been computed from different sources using the difference between Free on Board (FOB) and CIF (Cost insurance, freight) prices of goods for trade to the USA, New Zealand and Australia, container freight data from Containerization International, Drewry Consulting and from privates shippers, bulk shipping freight rates from the Baltic Dry Index and the International Grain Council (IGC). The paper of Korinek (2008) explains the methodology followed to harmonize this data.

Growth Domestic Product (GDPi,j)	World Development Indicators (WB)	Current $
Growth Domestic Product per capita (GDPhi,j)	World Development Indicators (WB)	Current $
Distance (Dij)	CEPII	Km
Time to export (timexij)	Doing Business (WB)	Days
Time to import (timemij)	Doing Business (WB)	Days
Inland Cost to export (cosxij)	Doing Business (WB)	Current $
Inland Cost to import (cosmij)	Doing Business (WB)	Current $

Note: WB stands for the World Bank, OECD for Organisation for Economic Co-operation and Development, and CEPII for the Centre d'Etudes Prospectives et d'Informations Internationales.

Table 2: Summary statistics of the main variables of interest

Variables	Obs.	Mean	Std. Dev.	Min	Max
Total trade value	1702	1.65E+09	4.40E+09	126.1872	4.01E+10
Number of varieties traded	1702	77.1322	85.11258	1	338
Average value of traded varieties	1702	2.24E+07	6.34E+07	126.1872	7.04E+08
Average quantity traded	1702	12128.35	41332.47	0.5	736194.9
Average price of traded varieties	1702	5629.184	21926.37	37.25831	681461.5
Ad-valorem transport cost	1702	0.0439365	0.0464001	0.0015	0.7778
Total transport cost	1702	3.69E+07	1.26E+08	1036.01	1.85E+09
Unit value transport cost	1702	0.3854813	0.2490228	0.0529	2.7433

Note: Obs. stands for number of observations.

4. Maritime Transport Costs and the Two Margins of Trade

The gravity model of trade presented above is estimated for bilateral trade and also for both trade margins for exports and imports of EU15 with 15 destinations over the period 1999 to 2007. This section presents the main results. First we present the results for the specification including the classic gravity equation variables based on Equation (11). We decompose our results according the position the EU15 as exporter (Table 3) or importer (Table 4).

Equation (11) is estimated using a least squares dummy variable estimator (LSDV) that introduces different sets of dummy variables to control for unobservable heterogeneity as described in section 2 above. The first column of Table 3 shows the results when the dependent variable is sectoral trade value, in columns 2 and 3 the dependent variables are the extensive and the intensive margins, respectively. Finally, the last two columns show the results for a further decomposition of the intensive margin into average quantity (column 4) and average price (column 5). The same structure is used for Tables 4-11.

Table 3: Main results for EU exports

	Total trade value $_{ijkt}$	Extensive Margin $_{ijkt}$	Intensive Margin $_{ijkt}$	Average quantity $_{ijkt}$	Average price $_{ijkt}$
$lGDP_i$	0.616***	0.055***	0.561***	0.528***	0.033**
	(19.388)	(7.311)	(17.821)	(14.728)	(2.059)
$lGDPh_i$	0.355***	0.060***	0.295***	0.275***	0.02
	(6.102)	(4.412)	(5.193)	(4.234)	(0.604)
lD_{ij}	-1.408***	0.038	-1.446***	-1.718***	0.272**
	(-7.393)	(0.945)	(-7.808)	(-7.703)	(2.37)
lTC_ad_{ijkt}	-0.337***	-0.062***	-0.275***	0.308***	-0.583***
	(-4.475)	(-3.223)	(-3.82)	(2.68)	(-8.38)
$ltimem_{ijt}$	-0.190*	0.097***	-0.287***	-0.125	-0.162***
	(-1.92)	(4.092)	(-2.914)	(-1.154)	(-2.782)
$lcosm_{ijt}$	-0.285***	-0.044*	-0.241**	-0.360***	0.119*
	(-2.901)	(-1.766)	(-2.536)	(-3.121)	(1.894)
R-squared	0.929	0.973	0.902	0.87	0.872
N	328	328	328	328	328
ll	-337.4789	101.3537	-324.4473	-379.1412	-175.9363
aic	734.9578	-142.7073	708.8946	818.2825	411.8725
bic	848.7482	-28.91693	822.685	932.0729	525.6629

Note: Importer, year and sectoral fixed effects control for unobserved sources of variability linked to countries, sectors and time variant characteristics. ***, **, *, indicate significance at 1%, 5% and 10%, respectively. T-statistics robust to

heteroskedasticity and autocorrelation are in brackets. l denotes natural logarithms. The variables time to import (timem) and cost to import (cosm) are only available after 2003, therefore the estimation is restricted to the period 2004-2007.[8]

The estimates shown in Table 3 concerning the target variables (freight costs, time to import and inland transport costs to import) show a significant and negative impact on EU15 exports, with distance also showing a negative and significant coefficient with an elasticity that is higher than unity. These results strongly support the finding obtained in several studies (Wilmsmeier and Martinez-Zarzoso 2010) that distance has an impact on trade after controlling for transport cost using more direct proxies. Hence distance may reveal other characteristics of bilateral relations between countries. As regards the two margins of trade, The decomposition of the influence of the trade cost variables on each margin of trade shows that whereas the distance effects works exclusively through the intensive margin (columns 2 and 3, Table 3), ad-valorem freight rate, time to import and inland transport costs have an impact on both margins of trade indicating that they affect the fixed and the variable costs of exporting.

The impact of GDP as a proxy for the size of the economy of the partners of the EU15 on trade and its margins is positive. When the EU15 is the exporter the GDP and GDP per capita have the expected positive sign. This is not the case for EU15 imports (Table 4), the GDP per capita is negative, indicating perhaps that the type of products imported are labour intensive products. This could be due to the composition of our sample largely dominated from Asian countries due to data availability. Exports to the EU15 from these countries are dominated by low value added products mainly produced by countries with lower levels of GDP per capita.

The estimates concerning trade costs variables for EU15 imports are remarkably different to those obtained for EU15 exports (Table 4). The main differences concern distance that now show a positive and significant coefficient indicating that the EU import more of the products considered

[8] AIC is the Akaike Information Criterion. This criterion indicates the quantity of information lost in a model intending to reproduce a particular distribution. A higher AIC for a given model with respect to other models indicates that more information is lost. BIC stands for Bayesian Information Criterion and is closely related to the AIC but gives a higher penalty for the number of parameters in the model. Hence, a relatively higher BIC indicates that more information is lost and that the model maybe over fitted in comparison to other models. Both are model selection criteria used to compare models with the same dependent variable. The model with lower values of AIC and BIC should be selected.

from more distant destinations. This positive distance effect cannot be due to factors that are time invariant since they are controlled for by adding country dummies. However it could be sowing the increasing important role played by China as one of the main EU trading partner. Important differences are also found for ad-valorem freight rates that show a higher impact on EU imports (almost double) than on EU exports. Indeed a 10 percent decrease in ad-valorem transport costs increases imports by 6.3 percent (3.3 percent for exports) and the effect works only through the intensive margin. The variable time needed to import is now not statistically significant for any of the dependent variables (different trade margins) and inland transport cost presents a very high elasticity with respect to EU imports which is almost ten times the elasticity found for EU exports. It is worth noting that EU imports in the sectors considered are dominated by countries in Asia in which reductions of internal transport costs could considerably impact their exports to EU and other destinations.

Table 4: Main results for EU imports

	Total trade value $_{ijkt}$	Extensive Margin $_{ijkt}$	Intensive Margin $_{ijkt}$	Average quantity $_{ijkt}$	Average price $_{ijkt}$
$lGDP_j$	1.157***	0.187***	0.971***	1.053***	-0.083**
	(15.668)	(10.178)	(14.773)	(15.929)	(-2.521)
$lGDPh_j$	-0.667***	-0.051	-0.616***	-0.767***	0.150***
	(-4.603)	(-1.317)	(-4.914)	(-5.706)	(2.663)
lD_{ij}	2.701***	0.747***	1.954***	1.490***	0.464*
	(4.929)	(5.495)	(4.177)	(3.172)	(1.86)
lTC_ad_{ijkt}	-0.632**	0.05	-0.682***	-0.159	-0.523***
	(-2.51)	(0.859)	(-3.056)	(-0.669)	(-4.239)
$ltimex_{ijt}$	-0.211	-0.034	-0.177	0.142	-0.319**
	(-0.534)	(-0.378)	(-0.511)	(0.412)	(-1.974)
$lcosx_{ijt}$	-2.585***	-0.246***	-2.339***	-2.456***	0.117
	(-7.04)	(-2.765)	(-7.081)	(-6.868)	(0.657)
R-squared	0.598	0.863	0.509	0.581	0.642
N	328	328	328	328	328
ll	-676.0369	-172.3534	-634.126	-636.1909	-358.0525
aic	1412.074	404.7069	1328.252	1332.382	776.1051
bic	1525.864	518.4973	1442.042	1446.172	889.8955

Note: Importer, year and sectoral fixed effects control for unobserved source of variability linked to countries, sector and year characteristics. ***, **, *, indicate significance at 1%, 5% and 10%, respectively. T-statistics are in brackets. l is for natural logarithms. Because of the availability of the variables time to import (timem) and cost to import (cosm), the period of time is 2004-2007.

Next, we focus exclusively on the effect of reductions of freight rates on EU trade. Tables 5 and 6 present the result for the specification given by equation (12). It has the advantage to extend the analysis to more years and to isolate the impact of maritime transport costs in a better way after controlling for unobservable sources of variability through a set of time-and-country and sector-and-time fixed effects. As before, the dependent variable in the first column is the total imported or exported value from a given country. In the rest of the columns each of the components of equation (10) is used as dependent variable. The coefficients have the expected signs in most specifications and the ad-valorem transport cost show a negative coefficient for all components and for EU15 exports (Table 5) and imports (Table 6).

As before, ad-valorem transport cost shows a greater effect on the intensive margin of trade (column 3 - Table 5 & 6) than on the extensive margin (column 2 - Table 5 & 6), for all sampled products. About 83% of the ad valorem transport cost effect on trade works through the intensive margin (i.e. 0.222/(0.222+0.045)) in the case of EU15 exports; and about 99% (i.e. 1.166/(1.166+0.004)) in the case of EU15 imports. In comparison to the results shown in Tables 3 and 4, we can conclude that the estimated elasticities are robust to changes in the model specification and that controlling for unobserved heterogeneity that is country-and-time specific does not modify the main results. Indeed the elasticity of EU imports with respect to ad-valorem transport costs is slightly higher than before indicating that a 10 percent reduction in transport cost will increase imports by about 12 percent, a more than proportional increase.

When decomposing the effect of the intensive margin into the effect on the average quantity of each shipment and their average price, the main impact pass through a decrease of the average price for EU15 imports (78% i. e. 0.838/(0.838+0.327)) and also for EU15 exports (62% ie 0.567/(0.567+0.345)). The impact of transport costs on the average quantity shipped is negative and significant (-0.327) only for EU15 imports (Table 6), but it is positive and significant for EU15 exports (Table 5) indicating that an increase in transport costs lead to an increase in the average quantity of the goods shipped that is accompanied by a decrease in prices.

Table 5: Main results for EU exports. Extended sample

	Total trade value $_{ijkt}$	Extensive Margin $_{ijkt}$	Intensive Margin $_{ijkt}$	Average quantity $_{ijkt}$	Average price $_{ijkt}$
lTC_ad$_{ijkt}$	-0.267***	-0.045***	-0.222***	0.345***	-0.567***
	(-4.743)	(-2.953)	(-4.095)	(4.38)	(-10.997)
R-squared	0.938	0.982	0.915	0.885	0.877
N	847	847	847	847	847
ll	-847.7875	428.8576	-812.6861	-944.2613	-409.9588
aic	2045.575	-507.7151	1975.372	2238.523	1169.918
bic	2875.373	322.0825	2805.17	3068.32	1999.715

Note: Importer-and-year and sector-and-year fixed effects are added to control for unobserved sources of variability linked to multilateral resistance effects and sector-year characteristics. Hence, countries characteristics that changed yearly (in our case GDP, GDP per head, Distance, Time to export/import, Cost to export/import) are omitted. ***, **, *, indicate significance at 1%, 5% and 10%, respectively. T-statistics are in brackets. l denotes natural logarithms. The period is from 1999 to 2007.

Table 6: Main results for EU imports. Extended sample

	Total trade value $_{ijkt}$	Extensive Margin $_{ijkt}$	Intensive Margin $_{ijkt}$	Average quantity $_{ijkt}$	Average price $_{ijkt}$
lTC_ad$_{ijkt}$	-1.170***	-0.004	-1.166***	-0.327**	-0.838***
	(-7.143)	(-0.138)	(-7.959)	(-2.246)	(-11.383)
R-squared	0.683	0.923	0.584	0.628	0.767
N	855	855	855	855	855
ll	-1618.201	-203.1848	-1527.125	-1528.242	-715.8044
aic	3578.402	748.3696	3396.25	3398.484	1773.609
bic	4390.84	1560.808	4208.689	4210.922	2586.047

Note: Importer-and-year and sector-and-year fixed effects are added to control for unobserved sources of variability linked to multilateral resistance effects and sector-year characteristics. Hence, countries characteristics that changed yearly (in our case GDP, GDP per head, Distance, Time to export/import, Cost to export/import) are omitted. ***, **, *, indicate significance at 1%, 5% and 10%, respectively. T-statistics are in brackets. l denotes natural logarithms. The period is from 1999 to 2007.

We also investigate whether our results are common for all sectors under study. With this aim we have grouped the sectors into four categories of products. The first group includes textile and footwear sectors (sectors 62, 63, 64), the second one includes machinery, construction, vehicles and electronics (sectors 84, 85, 87) and the two last groups corresponds to the two remaining sectors 30 (pharmaceutical products) and 94 (furniture)[9]. The corresponding estimation results for the first group are shown in tables 7 and 8. The estimated coefficients for transport costs are not statistically

[9] Results for sectors 30 and 94 are not shown. They are available upon request from the authors.

significant and have the expected signs for EU15 imports. These results are not surprising, ad-valorem transport cost have barely decrease for textiles goods over the period under study (see Figure 2 above) may be due also to other events as the end of the Multifibre agreement in 2005 that have influence exports of textiles to the EU15.

Table 7: Main results for EU exports of sectors 62, 63, 64

	Total trade value $_{ijkt}$	Extensive Margin $_{ijkt}$	Intensive Margin $_{ijkt}$	Average quantity $_{ijkt}$	Average price $_{ijkt}$
lTC_ad_{ijkt}	-0.047	-0.025	-0.021	0.382**	-0.403***
	(-0.413)	(-0.982)	(-0.17)	(2.251)	(-4.418)
R-squared	0.959	0.974	0.944	0.869	0.925
N	318	318	318	318	318
ll	-196.882	202.7456	-222.3385	-336.7835	-136.7897
aic	641.764	-157.4912	692.677	921.5669	521.5795
bic	1108.258	309.0031	1159.171	1388.061	988.0738

Note: Importer-and-year and sector-and-year fixed effects are added to control for unobserved sources of variability linked to multilateral resistance effects and sector-year characteristics. Hence, countries characteristics that changed yearly (in our case GDP, GDP per head, Distance, Time to export/import, Cost to export/import) are omitted. ***, **, *, indicate significance at 1%, 5% and 10%, respectively. T-statistics are in brackets. l denotes natural logarithms. The period is from 1999 to 2007.

Table 8: Main results for EU imports of sectors sector 62, 63, 64

	Total trade value $_{ijkt}$	Extensive Margin $_{ijkt}$	Intensive Margin $_{ijkt}$	Average quantity $_{ijkt}$	Average price $_{ijkt}$
lTC_ad_{ijkt}	0.202	0.058	0.144	0.949*	-0.805***
	(0.683)	(0.662)	(0.477)	(1.967)	(-3.644)
R-squared	0.89	0.973	0.876	0.842	0.859
N	321	321	321	321	321
ll	-375.8084	173.7948	-365.5022	-430.2363	-76.91174
aic	1003.617	-95.58966	983.0044	1112.473	405.8235
bic	1478.818	379.6119	1458.206	1587.674	881.0251

Note: Importer-and-year and sector-and-year fixed effects are added to control for unobserved sources of variability linked to multilateral resistance effects and sector-year characteristics. Hence, countries characteristics that changed yearly (in our case GDP, GDP per head, Distance, Time to export/import, Cost to export/import) are omitted. ***, **, *, indicate significance at 1%, 5% and 10%, respectively. T-statistics are in brackets. l denotes natural logarithms. The period is from 1999 to 2007.

Tables 9 and 10 show the results for the second group of products: machinery, construction, vehicles and electronics. The estimated coefficients for transport costs are only significant and have the expected signs for EU15 imports (Table 10), whereas no impact is shown on the value of EU exports.

Indeed, a sharp decrease of ad-valorem transport cost has been observed for vehicles in the direction Asia-Europe.

Table 9: Main results for EU exports of sectors 84, 85, 87

	Total trade value $_{ijkt}$	Extensive Margin $_{ijkt}$	Intensive Margin $_{ijkt}$	Average quantity $_{ijkt}$	Average price $_{ijkt}$
lTC_ad_{ijkt}	0.037	-0.008	0.045	0.237*	-0.192***
	(0.19)	(-0.263)	(0.263)	(1.663)	(-2.605)
R-squared	0.887	0.992	0.886	0.934	0.86
N	321	321	321	321	321
ll	-220.2142	417.789	-193.9119	-136.2841	30.80701
aic	688.4285	-587.578	635.8237	520.5683	186.386
bic	1156.087	-119.9193	1103.482	988.227	654.0447

Note: Importer-and-year and sector-and-year fixed effects are added to control for unobserved sources of variability linked to multilateral resistance effects and sector-year characteristics. Hence, countries characteristics that changed yearly (in our case GDP, GDP per head, Distance, Time to export/import, Cost to export/import) are omitted. ***, **, *, indicate significance at 1%, 5% and 10%, respectively. T-statistics are in brackets. l denotes natural logarithms. The period is from 1999 to 2007.

Table 10: Main results for EU imports of sectors 84, 85, 87

	Total trade value $_{ijkt}$	Extensive Margin $_{ijkt}$	Intensive Margin $_{ijkt}$	Average quantity $_{ijkt}$	Average price $_{ijkt}$
lTC_ad_{ijkt}	-1.189***	-0.001	-1.188***	-0.521***	-0.667***
	(-5.527)	(-0.012)	(-6.326)	(-2.747)	(-7.19)
R-squared	0.843	0.95	0.781	0.796	0.834
N	321	321	321	321	321
ll	-441.9138	22.9519	-403.5112	-387.7609	-162.1246
aic	1135.828	206.0962	1059.022	1027.522	576.2492
bic	1611.029	681.2978	1534.224	1502.723	1051.451

Note: Importer-and-year and sector-and-year fixed effects are added to control for unobserved sources of variability linked to multilateral resistance effects and sector-year characteristics. Hence, countries characteristics that changed yearly (in our case GDP, GDP per head, Distance, Time to export/import, Cost to export/import) are omitted. ***, **, *, indicate significance at 1%, 5% and 10%, respectively. T-statistics are in brackets. l denotes natural logarithms. The period is from 1999 to 2007.

Finally, to investigate to what extent our results are driven by EU trade with Asia, tables 11 and 12 show the results obtained from estimating equation (12) only for trade flows between EU and Asian countries. The results confirm that the decrease of ad-valorem transport costs has a significant and positive effect on trade between the EU15 and the Asian countries in our sample. Once again the effects through the intensive margin and the average price dominate.

We have applied several strategies in order to check for the robustness of our results. To control for possible endogeneity of the trade costs variables, we have used lagged values and tried alternative sets of fixed effects. In all these cases, we find almost no variations in the results in comparison to those presented in this paper[10].

Table 11: Main results for EU exports to Asia

	Total trade value $_{ijkt}$	Extensive Margin $_{ijkt}$	Intensive Margin $_{ijkt}$	Average quantity $_{ijkt}$	Average price $_{ijkt}$
lTC_ad_{ijkt}	-0.289***	-0.041**	-0.248***	0.255***	-0.504***
	(-4.328)	(-2.205)	(-3.965)	(2.884)	(-8.908)
R-squared	0.934	0.98	0.905	0.871	0.874
N	671	671	671	671	671
ll	-664.2356	301.8931	-619.0826	-726.8106	-306.9977
aic	1634.471	-297.7861	1544.165	1759.621	919.9954
bic	2324.313	392.0556	2234.007	2449.463	1609.837

Note: Importer-and-year and sector-and-year fixed effects are added to control for unobserved sources of variability linked to multilateral resistance effects and sector-year characteristics. Hence, countries characteristics that changed yearly (in our case GDP, GDP per head, Distance, Time to export/import, Cost to export/import) are omitted. ***, **, *, indicate significance at 1%, 5% and 10%, respectively. T-statistics are in brackets. l denotes natural logarithms. The period is from 1999 to 2007.

Table 12: Main results for EU imports from Asia

	Total trade value $_{ijkt}$	Extensive Margin $_{ijkt}$	Intensive Margin $_{ijkt}$	Average quantity $_{ijkt}$	Average price $_{ijkt}$
lTC_ad_{ijkt}	-1.147***	-0.034	-1.112***	-0.159	-0.953***
	(-5.95)	(-0.957)	(-6.501)	(-0.955)	(-11.891)
R-squared	0.659	0.924	0.546	0.614	0.787
N	735	735	735	735	735
ll	-1397.447	-162.4165	-1316.176	-1316.763	-565.5208
aic	3106.894	636.8329	2944.353	2945.526	1443.042
bic	3824.474	1354.413	3661.932	3663.106	2160.621

Note: Importer-and-year and sector-and-year fixed effects are added to control for unobserved sources of variability linked to multilateral resistance effects and sector-year characteristics. Hence, countries characteristics that changed yearly (in our case GDP, GDP per head, Distance, Time to export/import, Cost to export/import) are omitted. ***, **, *, indicate significance at 1%, 5% and 10%, respectively. T-statistics are in brackets. l denotes natural logarithms. The period is from 1999 to 2007.

5. Conclusion

This paper focuses on the analysis of the relationship between European maritime trade and trade costs. According to new theories of international trade with imperfect competition and

[10] Results available upon request from the authors.

heterogeneous firms, lower trade costs increase bilateral trade through an increase in both margins of trade. We use highly disaggregated trade data to decompose trade into its extensive and intensive margins and to estimate the effects of different sources of trade costs, namely distance, time needed to trade and transport costs on each margin.

The decomposition of the influence of the trade cost variables on each margin of trade shows that whereas the distance effects works mainly through the intensive margin for EU exports, changes in ad-valorem freight rates, time to import and inland transport costs have an impact on both margins of trade indicating that they affect both the fixed cost and the variable cost of exporting. In particular, inland transport costs present a very high elasticity with respect to EU imports which is almost ten times the elasticity found for EU exports. It is worth noting that EU imports in the sectors considered are dominated by countries in Asia in which reductions of internal transport costs could considerably impact their exports to EU and other destinations. This indicates the importance of investing in trade facilitation initiatives in developing countries.

A decrease in freight rates has a substantial and positive impact on trade, particularly on the intensive margin of trade and in part through a decrease in the average price of traded goods and an increase in the average quantity traded. This result indicates that Europe exports more of the same goods at a more competitive price for consumers. To a lesser extent, decreases in maritime transport costs also increase trade in new varieties of goods, in particular for EU exports to Asia. This finding helps to understand how the dynamics of transports cost impact trade. It departs significantly from the results obtained when transport costs are approximated using geographical distance between countries.

Our findings suggest that political actions directed to spur competition in the maritime transport industry and to support innovations in the shipping industry do have an impact on the volume and the composition of international trade. In particular, increasing ships size and limiting the consumption of fuels by ships could reduce freight rates and improve competitiveness of European

firms in Asian markets and stimulate the creation of new products. These results call for further research on the effects of transport market structures on trade pattern and transport costs.

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Appendix

Table A.1. Categories and sectors used in the analysis

Categories	HS-2 Digit code	Description
1	62	Articles of apparel, accessories, not knit or crochet
1	63	Other made textile articles, sets, worn clothing etc
1	64	Footwear, gaiters and the like, parts thereof
2	84	Nuclear reactors, boilers, machinery, etc
2	85	Electrical, electronic equipment
2	87	Vehicles other than railway, tramway
3	30	Pharmaceutical products
4	94	Furniture, lighting, signs, prefabricated buildings