THE EFFECT OF MARITIME TRANSPORT COSTS ON THE EXTENSIVE AND INTENSIVE MARGINS OF EURO-ASIAN SECTORAL TRADE

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Abstract

This paper investigates the determinants of maritime trade. It focuses in particular on the extent to which variations in trade-related costs between Asia and Europe help to explain the surge in Euro-Asian trade in eight of the most emblematic categories of products related to Asian success: textiles, footwear, confection, machinery, electronic products, vehicles, furniture and pharmaceutical products. In marked contrast to other studies that focus only on the determinants of total maritime trade, we decompose trade into two margins, as defined in Hummels and Klenow (2005): the number of different products exchanged (extensive margin) and the average value of each product (intensive margin). We estimate a trade augmented gravity model with trade cost factors for specific trade flows and industries and for both margins of trade (Hummels and Klenow, 2005). Several types of trade costs are considered, namely maritime transport costs, time to export/import, behind-the-border trade costs and distances. The main findings indicate that lower freight costs increase aggregate trade values mainly by increasing the average value of imported varieties, but also by increasing the number of products traded. Our findings suggest that political actions aimed at spurring competition and innovation in the maritime transport industry do have an impact on the volume and composition of international trade.

Keywords

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

Introduction

This paper focuses on clarifying to what extent variations in trade-related costs between Asia and Europe 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, electronic 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. In particular, we are interested in the surge of Chinese exports to Europe.

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 restructuring in the economy, changes in specialisation, factor prices and 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 infrastructure variables and estimate the elasticity of trade with respect to transport costs to take values from 2 to 5, meaning that a reduction of one percent in transport costs increases trade by 2-5 percent. In addition, Martínez-Zarzoso and Suárez-Burguet (2005) and Martínez-Zarzoso et al. (2007) obtained 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, but may be a proxy for other types of trade costs, such as familiarity or differences in tastes, 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).

Yet 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 a combination of and the 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 contemplate 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 Harmonised Standard Classification 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)[i] and 15 trading partners representing[ii] a total of 225 maritime trade routes over a period of eight years (1999-2007), with a special focus on Asia. Freight rates are obtained from the OECD Maritime Transport Costs Database. The database gathers data on unit and ad valorem transport costs for the 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 explore how well the variability of each margin is explained by 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".

By using precise and time-varying transport cost data, we find that transport costs for maritime trade between Asia and Europe have an impact on trade mainly 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.

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/disaggregated value of trade between two countries. Some recent studies for aggregate trade include Limao and Venables (2001), Sánchez et al. (2003) and Martinez-Zarzoso and Suarez-Burguet (2005), while those focusing on disaggregated trade include Martínez-Zarzoso, García-Menendez and Suárez-Burguet (2003), Martinez-Zarzoso et al. (2005) and Martinez-Zarzoso (2009) and Martinez-Zarzoso and Wilmsmeier (2011). This approach relies on a model that assumes iceberg trade costs[iii] and symmetric firms. In this setting, aggregate 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.

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

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

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[iv] (CES)[v] .

As 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, total trade values are obtained 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

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

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 because our data contain not only quantities, but also prices and the range of products varies depending on the origin and destinations. With this aim, some of the assumptions made above are relaxed. 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:

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

At least three reasons have been suggested in the literature to explain why the range of trade products might vary with trade costs (Feenstra and Kee, 2005). First, goods produced in different locations (origin and destination) can be homogeneous. In this case, if production costs at origin and destination are very similar or 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 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 intermediate goods 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 both trade margins depend negatively on the magnitude of trade costs.

The methodology we use to decompose the 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

$$T_{ij} = \sum_{s=1}^{N_{ij}} P_{ij}^{s} Q_{ij}^{s} \qquad (4)$$

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 firstly into

extensive and intensive margin

$$T_{ij} = N_{ij}\overline{PQ}_{ij} \qquad (5)$$

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

As 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 one unique shipment per commodity travelling from country *i* to country *j*.

$$N_{ij} = N_{ij}^{k} N_{ij}^{F} \qquad (6)$$

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

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

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

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

Quantities are measured in tons for all commodities. Using a common unit allows us to aggregate different products and compare prices (proxied with import unit values) across all commodities.

We now have two decomposition levels. The first is given by equation (5), which decomposes total trade value into the number of products traded and the average value per product. The second, given by equation (8), further decomposes each of these two components 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 average price and average quantity. Taking logs of the first and second level decompositions in order to have a linear model, and adding the time dimension for empirical purposes, t, we obtain:

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

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

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:

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

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 the log of exports of product k from country i to country *j* in period *t* or each of its components: 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 the Gross Domestic Product of the importer and 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 the freight rates of transporting product *k* from country *i* to country *j*[vi] in period *t*. $timem_{jt}$ and $timex_{jt}$ are respectively the time to import from and the time to export to a given destination *j*. $cosm_{jt}$ and $cosx_{jt}$ are behind-the-border costs[vii] to import from and export to a given country *j*.

As equation 11 is linear in the parameters, the coefficient of total imports will be equal to the sum of the coefficients of the two margins. A further decomposition can be performed, using each of the components in equation (10) as a dependent variable in equation (11). We then test the following alternative specification, which controls for time-sectoral and time-and-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-sectoral fixed effects and ε_{ijkt} is an error term. 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 in trade costs between a given country i and all its trading partners. However, not only the variation of bilateral trade costs matters when determining trade flows between two countries (i and j), but also the variation of these costs in comparison to 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) recommend introducing 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 over time, namely comparative advantage in a broad sense. Time effects that are sector-specific control for unobserved heterogeneity that is sector-specific but varies over time and is common to all countries, e. g. technological shocks.

Data Description and Variables

Maritime Transport Costs

The main data source for maritime transport costs is the OECD Maritime Transport Cost (MTC) database. The MTC covers annual transport statistics (ad-valorem transport costs, unit transport costs in dollars, total transport costs in dollars) for a vast number of trade routes according to the type of good (2-digit HS) and the type of vessel (container ship, tanker, dry or dirty bulk vessel) used to ship the goods.

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

[Figure 1]

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 developed countries before a period of stabilisation in the nineties, recording a slight increase during the last decade. As regards developing countries, ad-valorem freight rates remained around 9% until 1995, fell 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 & 3]

Large differences can be noticed at first glance between the two partners of the EU15 and between import and export ad-valorem

transport costs. Ad-valorem transport costs are higher for Chinese imports of textiles in comparison with the costs faced 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 significant (4.08% and 2.6% respectively in 2007). The same can be said of sectors 84, 85, and 87. Ad-valorem transport costs are remarkably 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 costs for these sectors and for trade between EU15 and the USA are quite similar (1.3% and 1.8% respectively in 2007). Marked differences between the costs to import from and 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 significant for vehicles (87) in the direction China-EU15 (from 17.15% in 1999 to 8.97% in 2007, which implies a decrease of 52%). We have carried out the same exercise for the other EU15 partners in our sample. In general, developing Asian countries show the same trends as China as regards the evolution of their ad-valorem maritime transport costs with the EU15 (with a decrease of 40% in freight rates for vehicles). A sharp decrease in ad-valorem transport costs in vehicles, which also occurred in the case of developed Asian countries (32%), is the most noticeable trend.

Gravity Variables

Trade data were obtained from Eurostat. We use a detailed Eurostat database, which covers both extra- and intra-EU trade. The products are classified according to the Harmonised Standard Classification (HS) codes at the HS 6-digit level. Products within eight broad categories (at two-digit level) 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 of trade, as well as the average prices of products traded between the European Union (EU15) and 15 partners have been 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-digit HS category from each exporter to each importer on a yearly basis. On average, our sample contains 77 varieties of goods exchanged within each category.

Income and population data are taken from the World Development Indicators Database 2008 and distances from capital cities are taken from CEPII[viii]. Trade facilitation variables, namely time needed to export/import and inland transport costs paid to export/import come from the World Bank Doing Business Dataset.

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.

[Table 1 & 2]

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 to 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 of the EU15 as an 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, while columns 2 and 3 display the dependent variables, namely 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]

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 displaying 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 costs using more direct proxies. Hence distance may reveal other characteristics of bilateral relations between countries that influence trade, such as trust or information. As regards the two margins of trade, the decomposition of the influence of the trade cost variables on each margin of trade shows that while distance effects work exclusively through the intensive margin (columns 2 and 3, Table 3), ad-valorem freight rates, time to import and inland transport costs have an impact on both margins of trade, indicating that they affect the fixed and variable costs of exporting.

GDP, as a proxy for the size of the economy of the partners of the EU15, has a positive impact on trade and its margins. When the EU15 is the exporter, GDP and GDP per capita display the expected positive sign. However, this is not the case for EU15 imports (Table 4). GDP per capita is negative, indicating perhaps that the type of products imported are labour-intensive. This could be due to the composition of our sample being largely dominated by 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 cost variables for EU15 imports (Table 4) are remarkably different to those obtained for EU15 exports (Table 3). The main differences concern distance, which shows a positive and significant coefficient in Table 4, indicating that the EU imports more from more distant destinations. This positive

distance effect cannot be due to factors that are time invariant, as they are controlled for by adding country dummies. However, this could be showing the increasingly important role played by China as one of the main EU trading partners. Important differences are also found for ad-valorem freight rates, which record a higher impact on EU imports (almost double) than on EU exports. Indeed a 10 percent decrease in ad-valorem transport costs is associated to an increase in EU imports of 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 costs display 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 in internal transport costs could considerably impact their exports to the EU and other destinations.

[Table 4]

Next, we focus exclusively on the effect of reductions in freight rates on EU trade. Tables 5 and 6 present the results for the specification given by equation (12). It has the advantage of extending the analysis to more years and of isolating the impact of maritime transport costs more effectively 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 a dependent variable. The coefficients have the expected signs in most specifications and ad-valorem transport costs display a negative coefficient for all components and for EU15 exports (Table 5) and imports (Table 6).

As previously, ad-valorem transport costs have a greater effect on the intensive margin of trade (column 3 - Tables 5 & 6) than on the extensive margin (column 2 - Tables 5 & 6) for all sampled products. Approximately 83% of the impact of ad valorem transport costs 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 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 costs will increase imports by approximately 12 percent, a more than proportional increase. Our results for EU exports are strikingly similar to those obtained for intra-Latin American trade by Martínez-Zarzoso and Wilmsmeier (2010), who also obtained an elasticity of (-0.5) for maritime transports costs with respect to the extensive margin and an elasticity of (-0.19) with respect to the intensive margin.

When decomposing the effect of the intensive margin into the impact on the average quantity of each shipment and their average

price, the foremost is a decrease in the average price for EU15 imports (78% i.e. 0.838/(0.838+0.327)) and also for EU15 exports (62% i.e. 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 positive and significant for EU15 exports (Table 5), indicating that an increase in transport costs leads to an increase in the average quantity of goods shipped, accompanied by a decrease in prices.

Summarising, our results indicate that reductions in freight rates increase not only the average quantities of EU exports (intensive margin), but also the number of products exported, whereas for EU imports only the average quantities imported are affected by reductions in freight rates. One possible explanation for this is that the products imported by the EU from the 15 trading partners included in our dataset are less differentiated in comparison to the products exported from the EU, which would mean the number of varieties that can be produced is limited.

[Table 5 & 6]

We also investigate whether our results are common for all the sectors under study. In order to do so, we have grouped the sectors into four categories of products. The first group includes the textile and footwear sectors (sectors 62, 63, 64), the second includes machinery, construction, vehicles and electronics (sectors 84, 85, 87) and the two last groups correspond to the two remaining sectors, namely 30 (pharmaceutical products) and 94 (furniture)[ix].

The corresponding estimation results for the first group are shown in Tables 7 and 8. The estimated coefficients for transport costs are not statistically significant and have the expected signs for EU15 imports. These results are not surprising, as ad-valorem transport costs have barely decreased for textile goods over the period under study (see Figure 2 above). This may also be due to other events, such as the end of the Multifibre agreement in 2005, which influenced exports of textiles to the EU15. It is worth noting that the effect of this agreement, which is sector-specific, was controlled for in our results shown in Tables 5 and 6 through the addition of sector-specific time dummies.

[Table 7 & 8]

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 in ad-valorem transport costs is observed for vehicles in the direction Asia-Europe.

[Table 9 & 10]

Finally, so as 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 in 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. In particular, for Asian exports to the EU, the intensive margin of trade is much more sensitive to variations in transport costs than for Asian imports from the EU, indicating that Asia will benefit more than the EU from reductions in transport costs.

[Table 11 & 12]

We have applied several strategies in order to check the robustness of our results. In order to control for the possible endogeneity of the trade cost 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[x].

Conclusions

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 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, inland transport costs and maritime transport costs on each margin.

The decomposition of the influence of the trade cost variables on each margin of trade shows that while distance effects work 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 record very high elasticity with respect to EU imports, which is almost 10 times the elasticity found for EU exports. It is worth noting that EU imports in the sectors considered are dominated by countries in Asia where reductions in internal transport costs could considerably impact their exports to the 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 partly 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 transport costs impact trade. These results deviate significantly from the results obtained when transport costs are approximated using the geographical distance between countries.

Our findings suggest that political actions aimed at spurring competition in the maritime transport industry and supporting

innovations in the shipping industry do have an impact on the volume and the composition of international trade. In particular, increasing ship size and limiting the consumption of fuels by ships could reduce freight rates and improve the competitiveness of Asian firms in the EU market and stimulate the creation of new products. These results call for further research on the effects of transport market structures on trade patterns and transport costs.

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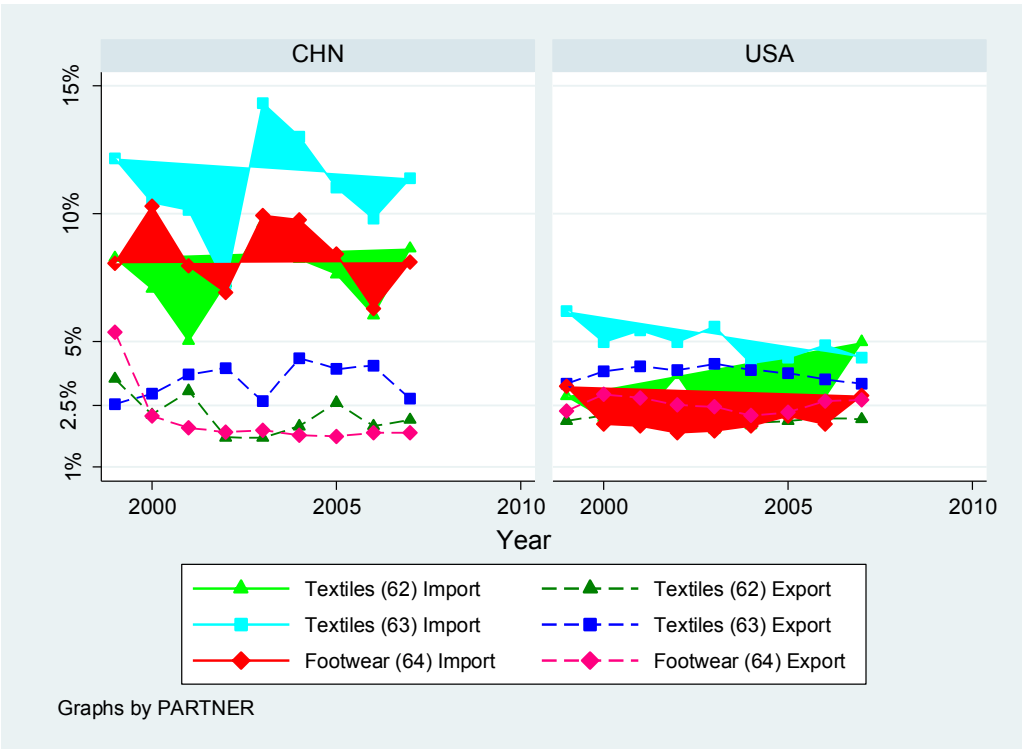
FIGURES

Figure 1: Maritime transport (ad-valorem equivalent) costs from 1980 to 2005

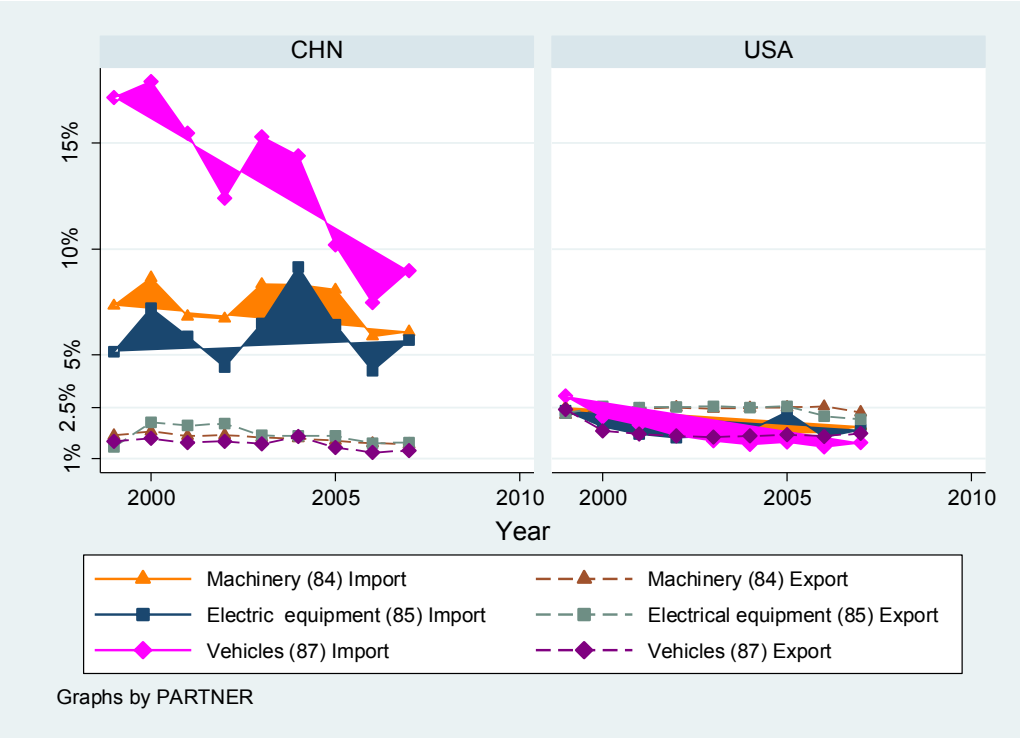
Source: Korinek (2009).

Figure 2: Ad-valorem transport costs in the textile and footwear sectors between Europe, US and China



Source: OECD Maritime Transport Costs Database.

Figure 3: Ad-valorem transport costs in sectors 84, 85 and 87 between Europe, US and China



Source: OECD Maritime Transport Costs Database.

TABLES

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
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[xi]
Total transport cost (TC_tijkt)	OECD Maritime Transport Cost database	Current $
Unit value transport cost (TC_uijkt)	OECD Maritime Transport Cost database	Current $
Growth Domestic Product (GDPi,j)	WB World Development Indicators	Current $

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

Notes: WB stands for the World Bank, OECD for the 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.

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)
$lGDPh_j$	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. As a result, the estimation is restricted to the period 2004-2007.[1]

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. Data availability of the variables time to export (timex) and cost to export (cosx) restrict the period to 2004-2007.

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, country characteristics that changed yearly (in our case GDP, GDP per capita, 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, country 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 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, country 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, country 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 9: Main results for EU exports of sectors 84, 85 and 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, country 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 and 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, country 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 11: Main results for Asian imports from the EU

	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, country 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 Asian Exports to the EU

	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, country 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.

Appendix

Table A.1. Categories 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

[i] We only considered EU-15 due to data availability concerning transportation costs.

[ii] EU15 stands for: Austria, Belgium, Denmark, France, Finland, Germany, Greece, Ireland, Italy, Luxemburg, Netherlands, Portugal, Spain, Sweden, and United Kingdom. The 15 partners selected are the following: China, Hong-Kong, India, Indonesia, Japan, Malaysia, Philippines, Singapore, South Korea, Thailand, Vietnam, Saudi Arabia, the United Arab Emirates, Brazil and the United States of America.

[iii] 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.

[iv] Varieties refer to different products that are substitutes in consumption.

[v] The constant elasticity of substitution (CES) assumption is made in order to obtain a simple model that is easily derived and with testable implications.

[vi] Distances between capital cities are considered.

[vii] Cost to import and export is defined as: "the fees levied on a 20-foot container in U.S. dollars. All the fees associated with completing the procedures to export or import the goods are taken into account, including costs for documents, administrative fees for customs clearance and inspections, customs broker fees, port-related charges and inland transport costs. The cost does not include customs tariffs and duties or costs related to sea transport and only official costs are recorded." http://www.doingbusiness.org/methodology/trading-across-borders.

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

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

[x] Results available upon request from the authors.

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