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ON THE GEOGRAPHY OF TRADE: DISTANCE IS ALIVE AND WELL

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Abstract

It has been widely argued that, with the decline in trade costs, the importance of distance has declined over time. On the other hand, most gravity models find that the importance of distance has increased over time. This puzzle has not been satisfactorily explained and is examined here. The paper develops a new measure of the distance of trade (*DOT*) and shows that the *DOT* falls over the period 1962-2000 for the average country in the world, with the number of countries with declining *DOT* about double those with increasing *DOT*. This implies an increased importance of distance over time. The paper shows how this can be true despite declining trade costs. The paper also analyzes the impact on the *DOT* of changes in production, customs and domestic transport costs, in real exchange rates and in competition. Finally, the paper provides an empirical analysis of the evolution of the *DOT* and explains most of its negative trend.

Keywords: Geography of Trade, Distance, Trade costs, Regionalization.

JEL classification: F1, N70, O57.

Résumé

Il est largement reconnu, vu le déclin des coûts du commerce, que l'importance de la distance géographique diminue. D'un autre côté, la plupart des modèles de gravité mettent en évidence un poids croissant dans le temps de la distance sur le commerce. Ce problème d'évolution de poids de la distance est examiné dans ce papier. Nous développons une nouvelle mesure de la "distance du commerce", et montrons que cette distance diminue sur la période 1962-2000 pour le pays "moyen" dans le monde (le nombre de pays connaissant une diminution de leur "distance du commerce" étant le double de ceux connaissant une augmentation). Ceci implique une importance croissante de la distance dans le temps. Ce papier montre comment un tel résultat peut exister malgré le déclin des coûts du commerce. Ce papier propose également une analyse de l'impact sur la distance du commerce de changements dans les coûts de production, coûts de douane et de transport intérieur, ainsi que l'impact de changement des taux de change réels et de la compétitivité. Enfin, ce papier présente une analyse empirique de l'évolution de la mesure "distance du commerce" et explique la quasi totalité de sa tendance négative.

Mots clefs: Géographie des flux commerciaux, Distance, Coûts du commerce, Régionalisation.

JEL classification: F1, N70, O57.

ON THE GEOGRAPHY OF TRADE: DISTANCE IS ALIVE AND WELL

“The report of my death has been greatly exaggerated.”

Mark Twain after reading his own obituary, June 2, 1897

1. INTRODUCTION

The integration of the world economy has increased rapidly in recent decades, with world trade growing more than twice as fast as world GDP since 1980. A plausible explanation of this globalization phenomenon that has been set forth is the unilateral trade liberalization and participation in the multilateral trading system undertaken by an increasing number of countries in recent decades. Another one is the decline in trade costs, including transport and communication costs.

A decline in trade costs suggests that trade should have expanded geographically. In other words, as trade costs fall, one would expect a larger share of a country's trade to take place further away from its borders, resulting in an increase in the distance of its trade over time. The declining importance of distance over time associated with declining trade costs seems to be a widely accepted “stylized” fact, as illustrated by the title of the book “The Death of Distance [...]” (Cairncross, 1997). On the other hand, most gravity models find that distance has an increasingly negative effect on bilateral trade over time. This puzzle has not been satisfactorily explained and is examined in detail in this paper.

The paper contributes to the literature in several ways. First, it develops a new measure of the distance of trade, *DOT*, and presents evidence showing that the importance of distance has increased over time. It shows that the *DOT* has decreased over the period 1962-2000 for the average country in the world, with the number of countries with declining *DOT* close to double those with increasing *DOT*, and a larger ratio for developing countries. Other things equal, this may have potential negative development implications for countries located far from the large centers of

economic activity who, by trading increasingly with proximate countries, may lose the benefits associated with trade-related technology and institutional spillovers.^{1 2}

Second, the paper argues that the bilateral distance measure used in gravity models is not a good proxy for trade costs and does not capture the specifics of these costs that are essential for resolving the puzzle mentioned above. The paper provides a simple analytical solution to the puzzle. It shows that the change in the *DOT* is unrelated to the change in overall trade costs but depends on the relative change in its components. Trade costs are decomposed into those costs unrelated to distance—known as dwell costs—and those related to distance. This decomposition is key to show that the *DOT* falls as long as dwell costs fall relative to distance costs, irrespective of the direction of change in total transport costs or in either of its two components.

Third, the paper examines analytically the impact on the *DOT* of changes in production, customs and domestic transport costs, in the real exchange rate, in competition and in tariffs. We show that the *DOT* falls—and the importance of distance increases—when production, customs or domestic transport costs fall, when competition increases and when the real exchange rate rises, while the impact of changes in ad valorem tariffs is ambiguous.

Fourth, we provide an empirical analysis of the *DOT* for exports, imports and total trade. Explanatory variables include a trend variable, regional integration, a variable measuring geographically uneven growth, and proxies for dwell costs and for distance costs. All variables are significant and with the expected sign, and fully explain the negative trend in the *DOT* for exports and total trade and explain 60% of the trend for imports. In a smaller sample, we add the real exchange rate, a variable measuring geographically uneven changes in bilateral real exchange rates

¹ Even without changes in the *DOT* over time, these countries are at disadvantage in terms of the benefits from technology spillovers. Keller (2002) shows the negative impact of distance on these spillovers.

and a variable capturing the bulkiness of goods traded. These variables are also significant and with the expected sign.³

The remainder of the paper is organized as follows. Section 2 briefly examines the relationship between trade costs and distance in gravity models. Section 3 defines the *DOT* and provides information on the average *DOT* over the period 1962-2000 for the world, its main regions and representative countries. Section 4 offers evidence on the evolution of the *DOT* in 1962-2000 for different countries, regions and the world as a whole for exports, imports and total trade. Section 5 (6) presents hypotheses on the evolution of the *DOT* over time associated with changes in the relative cost (benefit) of trade at various distances. Estimation of the impact of several determinants of the evolution of the *DOT* is provided in Section 7. Section 8 concludes. Appendix 1 describes the data and several variables of interest and Appendix 2 provides information on transport costs.

2. BILATERAL DISTANCE AND TRANSPORT COSTS

The gravity model, which is used to study bilateral trade patterns and has become the most successful empirical model in international trade, typically uses bilateral distance as a proxy for transport costs. Though one would expect the (absolute value of the negative) elasticity of bilateral trade with respect to distance to fall with increased globalization, when the gravity model is estimated separately for different years, the elasticity actually increases over time in most studies. For instance, Frankel (1997) finds an elasticity of -0.48 in 1965 and of -0.77 in 1992. Similarly, Smarzynska (2001), in a gravity model that includes the relative distance to the center of world

²The importance of geography for transport costs and other determinants of economic development is examined in Gallup and Sachs (1999). One implication of our findings is that the *evolution* of transport costs may also have development implications.

trade, finds for intra-OECD trade an elasticity that increases in absolute value from -0.68 in 1970 to -0.97 in 1990. And Leamer (1993) finds that distance coefficients do not fall between 1970 and 1985.

Reviewing that literature, Leamer and Levinsohn (1995, pp.1387-88) note that “[...] the effect of distance on trade patterns is not diminishing over time. Contrary to popular impression, the world is not getting dramatically smaller”. Disdier and Head (2003) perform a meta-analysis of 51 gravity models and conclude that the impact of distance on trade is increasing over time in a way that is statistically significant.⁴

There are several problems with trying to infer the evolution of trade costs from the evolution of the distance coefficient in gravity models. First, Deardorff (1998) showed that models that assume CES preferences, no intermediate goods, production in a single location and iceberg trade costs generate gravity-like trade patterns. We argue that an increasing distance elasticity of bilateral trade is incompatible with iceberg trade costs. In fact, we show that the decision about what proportion to trade at different distances does not depend on the level of trade costs but on the relative importance of its components (Section 5.1). Second, that decision depends also on other trade-related and non-trade costs (Section 5.2). Third, the decision to trade at a specific distance

³ The analysis also has implications for the ‘border effect’ and the ‘home consumption bias.’ These issues are examined in Carrère and Schiff (2003).

⁴ Freund and Hummels (2003) find that FDI growth has contributed to increasing proximate trade but has had little impact on the elasticity of trade with respect to distance. The coefficient of distance presents no clear trend when estimated with the standard log-linear specification of the gravity model in cross-section over several years by Coe et al. (2002) or in a panel over 35 years by Brun et al. (2002). When the model is estimated non-linearly, Coe et al. (2002) find that the coefficient for the distance variable shows a decline in 1975-2000. With an augmented transport cost function, Brun et al. (2002) find a decline in the coefficient of distance, though the decline is largely confined to bilateral trade among rich countries; for developing countries, the coefficient of distance does not decline over time.

depends on its costs (and benefits--see Section 6) relative to the costs (and benefits) of trading at other distances. The coefficient of distance measures the marginal impact of distance on bilateral trade. Thus, an increase in the absolute value of the coefficient of distance over time means that a marginal increase in the distance of trade has become more costly. It does not indicate how overall trade costs have changed. We show in Section 5 that countries may trade at shorter distances over time even though overall trade costs decrease.

Given that changes in the bilateral distance coefficient in gravity models need not reflect changes in overall trade costs and that iceberg trade costs are inconsistent with the evidence, we opt for a different approach in order to elucidate the puzzle of the increased impact of distance on trade over time.⁵ The paper explores the pattern and evolution of trade from an economic geography perspective by examining the level and evolution of the distance of countries' trade over time.⁶ This issue has not been systematically analyzed in the literature. We find that the distance of trade (*DOT*) declined between 1962 and 2000 for a majority of countries, with a stronger decline for developing than for OECD countries. To paraphrase Twain: *"The report on the death of distance has been greatly exaggerated."*

3. AVERAGE DISTANCE OF TRADE (*DOT*)

For each country, region, and for the world, we calculate the *DOT* and its evolution over time for exports, imports and total trade (exports plus imports). Denote the value of the non-fuel trade flow between countries i and j at time t by Z_{ijt} , with $Z = M$ (imports), X (exports), T (total trade $M+X$).

⁵ Another issue is that bilateral distance may be inadequate because bilateral trade may also depend on another concept of distance that Anderson and van Wincoop (2003) refer to as "multilateral resistance" which is used to capture countries' remoteness. The latter is usually incorporated in recent gravity models (e.g., Brun et al., forthcoming).

Denote the share of the non-fuel trade flows between countries i and j in the total non-fuel trade of country i at time t by s_{ijt}^Z , with:

$$s_{ijt}^Z \equiv \frac{Z_{ijt}}{\sum_{j=1}^n Z_{ijt}}, \quad j = 1, \dots, n \quad (n \text{ is the number of trading partners of country } i), \quad Z = M, X, T.$$

Denote the distance between countries i and j by d_{ij} . Then, the distance DOT_{it}^Z of country i 's trade at time t is:

$$DOT_{it}^Z \equiv \sum_{j=1}^n d_{ij} s_{ijt}^Z, \quad Z = X, M, T, \quad (1)$$

and, with N countries in the world, the world's DOT at time t is:

$$DOT_{wt}^Z \equiv \sum_{i=1}^N DOT_{it}^Z s_{iwt}^Z, \quad Z = X, M, T, \quad (2)$$

where s_{iwt}^Z represents the share of country i in world trade at time t . For the DOT of a specific region R , the summation in equation (2) is over the countries of region R , weighted by the share of country i in the total trade of region R .

We compute the distance of exports, imports and total trade for 150 countries over 39 years (1962-2000) from the COMTRADE bilateral (non-fuel) trade data and the spherical distance between the main economic cities of any pair of countries.⁷ The total number of observations on the DOT is 5,777. Data sources are provided in Appendix 1.

⁶The term 'economic geography' was first coined by Keasley in 1901.

⁷ In an analysis at a highly disaggregated level, Berthelon and Freund (2004) find no impact of compositional changes in trade on the distance elasticity of trade over time. This increases our confidence in the adequacy of using aggregate data.

The average *DOT* (*ADOT*) for 1962-2000 for various countries and regions is presented in the first two columns of Table 1.⁸ What are the main results? First, the *ADOT* is about 50% larger for non-OECD countries (about 6,540 kms) than for OECD countries (about 4,390 kms), putting the non-OECD countries at a significant disadvantage.⁹ Second, within the OECD, the EU-15 and Canada have the smallest *ADOT* (about 2,800 kms), followed by the US (6,800 kms), Japan (8,500 kms), Australia (11,850 kms) and New Zealand (12,300 kms).

Third, when ranked by continent/region, the *ADOT* is smallest for the EU-15 (2,800 kms), larger for MENA¹⁰ (4,590 kms), over double the EU-15 *ADOT* in North America (5,890 kms), followed by Sub-Saharan Africa (7,790 kms), Asia (8,085 kms), and South America (8,180 kms). Fourth, no country's *ADOT* is below 5,000 kms in either South America or Sub-Saharan Africa. Our findings confirm that South America, Sub-Saharan Africa and developing Asia are the most disadvantaged developing regions, while Central America, the Caribbean and MENA are better off, in terms of the distance that their products travel to sell in foreign markets or to be consumed at home.

4. EVOLUTION OF THE DISTANCE OF TRADE (*DOT*), 1962-2000

The evolution of the *DOT* can be examined for individual countries, regions and the world as a whole. We calculate the trend of the *DOT* over time as the estimated value of ***b*** in the OLS regression (with the White correction for heteroskedasticity):

$$\ln DOT_{it}^Z = \mathbf{a} + \mathbf{b}t + \mathbf{m}_{it}, \quad t = 1, \dots, 39; \quad Z = X, M, T. \quad (3)$$

⁸ Carrère and Schiff (2003, Table A.1) provide details about each country's sample with and without mirror data.

⁹ The OECD is defined here as the OECD in 2000, with 23 member countries (and 22 observations because Belgium and Luxembourg are considered as one country in COMTRADE).

¹⁰ MENA stands for the Middle East and North Africa.

The estimated trend \hat{b} is shown in Table A.1 for a number of countries, regions and trade blocs. We use \hat{b} to compute the “change” ΔDOT_i^Z , defined as the percentage change in the fitted value of the distance \hat{DOT}_{it}^Z between 1962 and 2000 in country i , i.e.:

$$\Delta DOT_i^Z = 100 * \left(\frac{\hat{DOT}_{i2000}^Z - \hat{DOT}_{i1962}^Z}{\hat{DOT}_{i1962}^Z} \right), \quad Z = X, M, T. \quad (4)$$

The evolution of the log of the distance of imports and exports over 1962-2000 and the corresponding ΔDOT for Asia, Latin America and the Caribbean (LAC), the US, and Canada, are depicted in Figures 1-4. Figure 1 shows a strong negative trend of the DOT for Asia, with ΔDOT equal to -24.2% for exports and -33.9% for imports. Similar results are obtained for LAC (Figure 2), with ΔDOT equal to -23.2% for exports and -10.1% for imports. The opposite holds for the US (Figure 3), with positive ΔDOT equal to 7.8% for exports and 30.0% for imports. Finally, Figure 4 shows opposite trends for Canada’s imports and exports, with ΔDOT equal to -41.8% for exports and 35.9% for imports. A detailed analysis of the change in ΔDOT is provided below.

4.1. Evolution of the DOT : World and Individual Countries

The change ΔDOT_i^Z is reported in Table 1 (columns 3 and 4) for the World and various regions, countries and trade blocs. We consider the change to be empirically significant if and only if $|\Delta DOT_i^Z| > 5.5\%$.¹¹ A country is defined as having a positive (negative) change in its DOT if both exports and imports have a significantly positive (negative) change in their DOT or if one has a significantly positive (negative) change and the other is not significant. And a country has

¹¹ The cutoff value of 5.5% is arbitrary. The qualitative results remain unchanged when we use cutoff values of 10% or 15%.

opposite changes for imports and exports when they are both empirically significant but have opposite signs.

According to Table 1, the World presents no empirically significant change in the *DOT* for imports or exports in 1962-2000, with $\Delta DOT_w^X = -2.5\%$ and $\Delta DOT_w^M = 2.9\%$ ¹². We also estimate the trend of the *DOT* for the average country in the world. This is done by running regression (3) on the entire sample, and is also reported in Table 1¹³. We find significantly larger (and negative) changes in the *DOT* for the average country (-12.0% for imports, and -5.3% for exports) than for the World as a whole. In fact, at the country level, Table 1 (last column) shows a predominance of negative trends in the *DOT*. The difference between the results of the two regressions indicates that countries with negative trends tend to be relatively small in terms of their share in world trade.

For the entire sample of 150 countries, we find that i) 77 countries (51.3%) have a significant negative change in the *DOT*; ii) 39 countries (26%) have a significant positive change in the *DOT*; iii) 30 countries (20%) present opposite changes in the *DOT*; and iv) 4 countries (2.7%) have non-significant changes.¹⁴ Thus, about twice as many countries show an empirically

¹² Why is there a difference in the change in the *DOT* for exports and imports for the World as a whole? The first reason is that some countries are missing in our sample because of definitional changes during the period (e.g. the 15 ex-USSR countries). Second, the difference between cif and fob values in the weights of DOT_w^M (distance weighted by the cif value of imports) and DOT_w^X (distance weighted by the fob value of exports) combined with higher cif/fob ratios at greater distances results in $DOT_w^M > DOT_w^X$ and thus in the likelihood that $\Delta DOT_w^M \neq \Delta DOT_w^X$.

¹³The results reported in Table 1 are obtained with OLS. They are not qualitatively different when we use a “within” estimator by introducing country fixed effects in equation (3).

¹⁴The full list of countries in each category is provided in Table A.2.

significantly negative change as opposed to a positive change in the *DOT* over time (77 to 39 countries or a ratio of 1.97).¹⁵

The ratio of countries with negative to positive changes in the *DOT* is 1.67 for the OECD and 2.03 for the non-OECD. Thus, the decline in the *DOT* is relatively more frequent for non-OECD countries, and the average annual trend in the *DOT* for imports, exports and total trade is more negative for non-OECD countries than for the OECD (Tables 1 and A.1).

4.2. Evolution of *DOT*: Regions and Sub-Regions

Except for the US, with a positive change of 8% for exports and 30% for imports (Fig. 3), and Canada, with opposite changes of -42% for exports and 36% for imports (Fig. 4), other OECD countries show strong negative trends: the EU-15 (-12% for exports and -13% for imports), Australia (-23% and -20%), Japan (-17% and -25%) and New Zealand (-40% and -23%).

Non-OECD countries trade significantly closer to home over time, with a decrease in the *DOT* of 14% for imports and 7.4% for exports. However, there is much variation within that group, with negative changes in the *DOT* in the two largest developing regions, LAC (-23% for exports and -10% for imports; see Fig. 2) and non-OECD Asia (-9.8% and -26%), and positive changes in the smaller regions of Sub-Saharan Africa (2.9% and 12%) and MENA (57.3% and 20.5%).^{16 17}

The main results obtained thus far are:

¹⁵The number of countries with negative changes remains much larger than that with positive changes when we consider a cutoff point of 10% rather than 5.5% (70 to 41 or a ratio of 1.72). The results are similar for total trade (as compared to those for imports and exports). With a 5.5% cutoff point, we find that 80 (43) countries have a significant negative (positive) change in the *DOT*, with a ratio of 1.86.

¹⁶These *DOTs* are based on weighted averages for each region. Changes in *DOTs* based on unweighted country averages are more negative. For instance, the change in the *DOT* for most countries in Sub-Saharan Africa is negative.

¹⁷The trend in the *DOT* in trade blocs is provided in Table A.1 and that across sub-periods is examined in detail in Carrère and Schiff (2003).

- i) though there was little change in the *DOT* for the World as a whole in 1962-2000, the *DOT* fell for the average country;
- ii) the number of countries for which the *DOT* fell in 1962-2000 is close to double the number of countries for which the *DOT* increased; and
- iii) the *DOT* fell more strongly in non-OECD countries than in the OECD.

In the next two sections, we examine a series of hypotheses about the factors affecting the evolution of the *DOT* over time. Section 5 deals with hypotheses related to costs and Section 6 deals with those related to benefits.¹⁸

5. IMPACT OF TRADE AND OTHER COSTS ON THE DISTANCE OF TRADE (*DOT*)

The fact that, despite the decline in transport and communication costs, the *DOT* fell for the average country and fell in many more countries than it rose over time, is puzzling. This section sets out a number of hypotheses about factors that are likely to affect a country's or region's *DOT* and its evolution. For those countries where the *DOT* declined over time, either the cost fell and/or the benefit increased for trade at short relative to long distances. This section deals with costs and Section 6 deals with benefits.

5.1. Transport costs

The analysis focuses first on transport costs. Divide transport costs (*TC*) into two components, those unrelated to the distance traveled and which are referred to as "dwell" costs (*L*), and those related to the distance traveled, i.e., distance costs (*DC*). Dwell costs include port storage costs, the cost—including time—of loading and unloading ships, the time cost of queuing outside

¹⁸ In addition to the evolution of countries' *DOT* (averaged over trading partners), our data also enables us to examine the evolution of the entire *distribution* of trade according to distance. For instance, the distance at which, say, 30% of trade is reached falls after countries join a trade bloc. Further details are available from the authors.

the port waiting to be serviced, and all other port costs. Total transport costs TC equal the sum of these two components, i.e.:

$$TC = L + DC. \quad (5)$$

Distance costs DC equal

$$DC = C_m m, \quad (6)$$

where m denotes distance and “average cost per mile” C_m includes fuel costs and all other costs of operating ships, including overhead and costs of manning and leasing ships.¹⁹ Combining (5) and (6), we have:

$$TC = L + C_m m. \quad (7)$$

Transport costs TC for a trip of a given distance m can fall either because of lower dwell costs L or because of lower costs per mile C_m . These have opposite effects on the DOT . Lower distance costs C_m raise the incentive to trade with more distant locations because their transport costs TC fall relative to those for closer locations. This raises the DOT . On the other hand, lower dwell costs L raise the incentive to trade with closer locations because transport costs fall for small distances relative to those for large ones. This reduces the DOT .²⁰

The log derivative of transport costs TC , for a trip of *given* distance m , is

$$d(\log TC) = \frac{L}{L + C_m m} d(\log L) + \frac{C_m m}{L + C_m m} d(\log C_m). \quad (8)$$

Thus, the elasticity of TC with respect to cost per mile C_m (dwell cost L) increases (falls) with m . The derivative of $d(\log TC)$ with respect to m is:

$$\partial(d \log TC) / \partial m = \frac{L * C'}{(L + C_m m)^2} (d \log C_m - d \log L), \quad (9)$$

¹⁹ Note that C_m need not be constant.

²⁰ The analysis assumes competitive port charges that reflect actual costs. Section 5.2 allows for non-competitive price-cost margins in production and distribution.

where $C' \equiv \partial DC / \partial m$, the marginal distance cost. Equation (9) implies:

$$\partial(d \log TC) / \partial m \stackrel{?}{>} 0 \stackrel{?}{=} d(\log C_m) \stackrel{?}{>} d(\log L). \quad (10)$$

Thus, if dwell costs L fall proportionately more (or rise proportionately less) than distance costs C_m , i.e., if $d(\log L) < d(\log C_m)$, then $\partial(d \log TC) / \partial m > 0$, i.e., the reduction in transport costs TC falls (or the increase in transport costs rises) as distance m increases. Thus, as long as dwell costs L fall relative to distance costs C_m , it becomes relatively more attractive to trade at closer distances and the DOT falls. This holds irrespective of whether total transport costs, dwell costs or distance costs rise or fall.

What do the data tell about the evolution of dwell costs relative to distance costs? There is little information on that, though some changes in technology point to a decline in relative dwell costs. For instance, containerization started in 1966 on North Atlantic routes, then spread to North America-Asia and Europe-Asia routes by the early 1970s. The share of world tonnage shipped by container increased from 2% to 55% in 1970-1996 and it increased faster and earlier in the US, from 40% in 1970 to 55% by 1979 (Hummels, 1999). Containerization lowered port labor costs and time in port, and though it probably also lowered distance costs, the cost reduction was most likely larger for the dwell (port) component. Containerization also reduced another component of dwell costs, namely the cost of the inland movement of goods by facilitating their transfer between different shipping modes. In that case, $d(\log L) < d(\log C_m) < 0$, implying $\partial(d \log TC) / \partial m > 0$ (equation (10)) and a reduction in the DOT . Further details on the evolution of transport costs are provided in Appendix 2.

Fluctuations in the price of oil would also be expected to affect the DOT . Prices jumped at the time of the oil embargo in 1973 and again in 1980, resulting in higher distance costs and an expected fall in the DOT . Real oil prices have declined since the early 1980s (until 2000 when our sample period ends), with an expected increase in the DOT .

Another issue is the effect of exchange rate policy on the *DOT*. Many dwell costs are in local currency (e.g., port labor costs) while distance costs are typically quoted in US dollars. Thus, one can rewrite equation (7) to include the exchange rate as:

$$TC = L/\mathbf{p} + C_m m, \quad (7')$$

where \mathbf{p} is the exchange rate (defined as units of local currency per US dollar). Assume that an exporting country suffers from inflation, with dwell costs rising together with local prices. If the exchange rate depreciates at the same rate as prices increase (whether because of policy or market forces), then L/\mathbf{p} remains unchanged. However, if the exchange rate depreciation lags behind the rate of inflation, dwell costs L/\mathbf{p} rise relative to distance costs and the *DOT* rises. On the other hand, a sudden devaluation has the opposite effect.

5.2. Additional Trade and Non-Trade Cost Determinants of Changes in *DOT*

Section 5.1 examined the consequences for the *DOT* of changes in the dwell and distance components of international transport costs. Other trade-related costs as well as non-trade costs affect the *DOT* and are examined here. The cost to consumers in country j of a product imported from country i , P_{ji} , is:

$$P_{ji} = (C_i + MU_i + DT_i + CC_i + L_i + D_{ij} + L_j)\mathbf{t}_j + CC_j + DT_j + MU_j, \quad (11)$$

where C_i is the production cost in i , MU_i is the markup (or price-cost margin) in the exporting industry in i , DT_i is the domestic transport cost from the plant to the port in i , CC_i (CC_j) are customs costs in i (j), L_i (L_j) are dwell costs in i (j), D_{ij} is the distance cost of shipping the good from i to j , \mathbf{t}_j is the ad-valorem tariff factor (1 + the ad-valorem tariff) in j , DT_j is the domestic transport costs from the port to the consumption center in j , and MU_j is the markup in the distribution industry in j .

Anderson and van Wincoop (2004) estimate the costs of shipping a good from a foreign producer to a domestic final user. These costs include transport, border-related and distribution

costs, or $(P_{ji} - C_i)$ in equation (11). The authors argue that these costs amount to 170% of production costs (with $(P_{ji} - C_i)/C_i = 1.7$) in rich countries and amount to significantly more in developing countries.

Collecting in equation (11) the non-distance costs, NDC , on the one hand, and the distance costs, DC , on the other hand, we have:

$$P_{ji} = [(C_i + MU_i + DT_i + CC_i + L_i + L_j)t_j + CC_j + DT_j + MU_j] + D_{ij}t_j, \quad (12)$$

with

$$NDC = (C_i + MU_i + DT_i + CC_i + L_i + L_j)t_j + CC_j + DT_j + MU_j, \quad (13)$$

and

$$DC = D_{ij}t_j. \quad (14)$$

A reduction in any of the cost components of NDC has the same impact on the DOT as the reduction in dwell costs L examined in Section 5.1 and leads to a decline in the DOT . For instance, the cost of some tradables, such as high-tech equipment, has fallen dramatically over time. This has the greatest proportional impact on price at the factory if workers can buy the product at cost. The proportional price reduction is somewhat smaller in the local store because of additional fixed costs, is smaller still in more distant locations where the price includes domestic transport costs, smaller still in neighboring countries, and smallest in the most distant countries. This implies a fall in the DOT .

What about the effect of the ad-valorem tariff factor t_j ? A given reduction in t_j has a larger proportional effect on DC than on NDC . The effect is equi-proportional for DC (equation (14)) but is less than equi-proportional for NDC because some of its terms are not affected by a reduction in t_j (equation (13)). This raises the DOT . On the other hand, the reduction in t_j raises the degree of international market contestability and leads to a reduction in markups.

This has the opposite effect of lowering the *DOT*. Which effect dominates is ambiguous a priori.²¹

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6. BENEFIT DETERMINANTS OF THE *DOT*²³

We examine two phenomena, namely, regional integration and the uneven economic growth across countries or regions.²⁴

6.1. Regional Integration

Regional integration agreements (RIAs) or trade blocs are typically formed between neighboring countries. Given that the *DOT* for intra-bloc trade is typically smaller than for extra-bloc trade and that RIAs tend to raise intra-bloc trade by making it privately more beneficial, RIAs tend to reduce the *DOT* of its member countries.

²¹ The US applies its ad-valorem tariff on the fob value of the product. The fob value does not include transport costs D_{ij} (or dwell costs L_j in j). In that case, equation (14) becomes $DC = D_{ij}$, and a reduction in the US ad-valorem tariff factor t_{US} lowers *NDC* but not *DC*. This reduces the *DOT* for US imports. On the other hand, US tariffs have been low for a while, with a decline from 3.8% to 1.8% in 1989-2001 (World Bank, 2003), so that this effect on the US *DOT* is likely to have been small.

²² The impact of trade facilitation and lower communication costs is examined in Carrère and Schiff (2003, Section 4.3).

²³ The classification of the determinants of changes in the *DOT* in terms of costs and benefits is somewhat arbitrary. Nevertheless, the factors examined in this section differ from those in Section 5 as they do not deal with changes in trade costs.

²⁴ Other aspects are examined in Carrère and Schiff (2003), including counter-season trade, international production fragmentation, and the increasing value of time in trade because of the increasing importance of the ability to respond to fluctuations in demand and supply. Lack of data prevented empirical estimation of these effects on the *DOT*.

Since Viner's (1950) classic work, the static economic effects of RIAs have been examined in terms of the concepts of trade creation and trade diversion. Whether trade creation or trade diversion dominates also affects the impact of RIAs on the *DOT*.²⁵ Trade creation increases trade among members of the RIA (without affecting trade with excluded countries) and, given their relative proximity, reduces the *DOT*. The negative effect of a RIA on the *DOT* is stronger with trade diversion because it also reduces trade with more distant excluded countries. Thus, for a given increase in trade among member countries, the greater the degree of trade diversion, the larger the reduction in the *DOT*. Estimation of the impact of RIAs on the *DOT* is presented in Section 7. Detailed estimation results on the individual impact of eight RIAs is provided in Carrère and Schiff (2003).

6.2. Economic Growth

Another issue that can affect the *DOT* over time is economic growth. Countries belonging to a region that experiences a high rate of economic growth will find it beneficial to trade relatively more with countries of the region. This will tend to lower these countries' *DOT*. This is the case, for instance, for the East Asia-Pacific (EAP) region. There is a negative correlation between EAP's growth rate relative to that of the world and its *DOT* (see Carrère and Schiff, 2003, Section 5.2). This is confirmed by Frankel and Wei (1996) who, with the help of a gravity model, find that the increase in trade within East Asia "... can be entirely explained by the rapid growth of the countries."

We also find a negative correlation between a region's differential growth rate with the world and the trend in that region's *DOT*. For instance, NAFTA's growth rate was lower than the world's average before 1990 and higher in 1990-2000, and its *DOT* increased in 1962-1989 and fell

²⁵ In addition to the welfare implications of trade creation and diversion, RIAs may improve member countries' terms of trade for goods traded both among RIA partners and with outside countries (Chang and Winters, 2002) and even for goods not traded among RIA partners (Schiff and Chang, 2003).

in 1990-2000. The MERCOSUR region grew slightly faster than the world in 1962-1979, much slower than the world in 1980-1989, and faster than the world in 1990-2000, with the *DOT* trend equal to -.05 in the first period, .20 in the second one, and -.76 in the third one. The impact of uneven economic growth on countries' *DOT* is estimated in Section 7.

7. ESTIMATION OF THE DETERMINANTS OF THE *DOT*

In this section, we estimate for the full sample the impact on the *DOT* of dwell costs, distance costs, regional integration and economic growth, and for a reduced sample the additional effect of real exchange rates and products' bulkiness.²⁶ The mean value of these variables and of the *DOT*, as well as their minimum, maximum and standard deviation, are presented in Table 2. The correlation between the variables is mostly negative and very low, with the largest (in absolute value) equal to -.30. Estimation in this section is carried out using a panel model with country fixed effects (i.e., the "Within" estimator).²⁷ The expected sign of the effect on the *DOT* for all the variables is provided in the last column of Table 4.

7.2.1. Trend

The regression of *DOT* on a time trend variable t for 1964-2000 for the entire sample of 150 countries is shown in Table 3 (first column of exports, imports and total trade). The estimated annual trend \hat{b} is -.10% for exports, -.21% for imports and -.14% for total trade, significant at the 5% level for imports and total trade and at the 10% level for exports.

²⁶ We did not examine the impact of trade policy for the full sample because tariff data for a large number of countries only start in the mid-1980s and have a lot of missing values. Note that Section 5.2 showed that changes in ad-valorem tariffs have an ambiguous impact on the *DOT*.

²⁷ We tested for unit roots for panel data. The test (Im, Pesaran and Shin, forthcoming) significantly rejects the null hypothesis of unit roots.

7.2.2. Dwell and Distance Costs

Detailed data on the evolution of dwell and distance costs are not available for most countries. We use the evolution of the real price of oil as a proxy for the evolution of distance costs, and changes in the country-specific infrastructure index based on Canning (1995) and Limao and Venables (2001) as a proxy for changes in dwell and domestic transport costs. An increase in the price of oil raises the relative cost of the more distant trade, while an increase in the infrastructure index lowers the relative cost of the more proximate trade, with both expected to lead to a reduction in the *DOT*.

The regression of the *DOT* on the real price of oil, the infrastructure index and a time trend is also shown in Table 3 (second column for exports, imports and total trade). The coefficients of the price of oil is negative, significant at the 5% level for imports and total trade and not significant for exports. The coefficient of infrastructure is also negative, significant at the 5% level for imports and total trade and at the 10% level for exports. Thus, the empirical results support our hypothesis. Note that these variables explain close to 50% of the trend for imports, exports and total trade (the trend coefficients fall by close to 50%). This suggests that dwell costs have fallen relative to distance costs.²⁸ The paper now examines the impact of additional variables on the *DOT*.²⁹

7.2.3. Regional Integration

We have two dummy variables for RIAs, one for all RIAs except the EU, and one for the EU. The reason for a separate dummy variable for the EU is that the latter is a much deeper RIA

²⁸ The issue of time costs associated with timely delivery is examined in Carrère and Schiff (2003, Section 5.4; see also references therein) but is not addressed here due to lack of data. This issue is examined in a theoretical model by Evans and Harrigan (2003) who use it to derive specialization patterns.

²⁹ Brun et al. (forthcoming) estimate a gravity model for bilateral imports which includes the price of oil and an infrastructure index. They do not examine the interaction effects between these variables and the distance elasticity, and do not provide a theoretical framework to explain how the distance elasticity relates to the ratio of dwell to distance costs.

and we want to test whether it has had a stronger impact on the *DOT*. The results are provided in Table 3 (third column of exports, imports and total trade). The RIA dummy is negative, significant at the 10% level for exports and total trade and not significant for imports. The EU dummy is negative, significant at the 5% level for imports and total trade and at the 10% level for exports. Note that, as expected, the impact of the EU on the *DOT* is several times larger than that of the other RIAs.

Moreover, the trend variable no longer has any explanatory power for the *DOT* of exports and total trade, and the trend coefficient for the *DOT* of imports has been reduced by 60% in absolute value (-.08% versus -.21%) and its significance has been reduced from 5% to 10%. Thus, our explanatory variables fully explain the trend in the *DOT* for exports and total trade and explain 60% of the trend in the *DOT* for imports.

Carrère and Schiff (2003) examined regional integration and the *DOT* in more detail and found that all have a negative impact on the *DOT* of their member countries. Nevertheless, the ratio of positive to negative trends of the *DOT* was found to be close to twice as large for RIA than for non-RIA countries. One hypothesis is that there are some positive externalities associated with increasing trade with neighboring countries, such as increased security and other political and institutional benefits (Schiff and Winters, 2003), and that such externalities provide an incentive for countries with the more positive *DOT* trends to use regional agreements to capture them.

7.2.4. Geography of Economic Growth

We test the impact of uneven economic growth on the *DOT* by constructing an index that indicates for each country whether high growth occurred mainly in proximate or in distant countries. For each country i , the index of relative growth REG_{it} is:

$$REG_{it} = \frac{\sum_{j \neq i}^N d_{ij} (y_{jt} - y_{j,t-1})}{\sum_{j \neq i}^N (y_{jt} - y_{j,t-1})}, \quad j \neq i; j = 1, \dots, N, \quad (16)$$

where d_{ij} is the distance between countries i and j , $y_{jt} - y_{j,t-1}$ is the real change in GDP and is a proxy for the change in import demand by country j ,³⁰ and N is the number of countries in the world. For any country i , REG increases (falls) as changes in GDP are larger (smaller) in distant rather than in proximate countries. We use the REG variable lagged one year in the regression on the assumption that trade reacts to changes in demand with a lag.

One would expect that if the absolute change in GDP is larger in more distant countries and REG increases, the DOT for exports and total trade also increases. The results are shown in Table 3 (last column of exports, imports and total trade). As expected, the coefficient of REG is positive, significant at the 10% level for exports and total trade, and not significant for imports. The elasticity is larger for exports than for total trade because the elasticity for imports is small and not significant. The latter is to be expected since the measure REG relates directly to the demand for a country's exports. The high growth in distant countries need not raise a country's imports. We obtain similar but statistically less significant results with the current rather than the lagged REG variable.

7.2.5. Real Exchange Rate and Bulkiness

We examine here the impact of the real exchange rate (RER) and bulkiness on the DOT , in addition to the variables examined above. The results are not directly comparable with those above because the sample used here is less than two thirds of the size of the full sample (2,713 observations rather than 4,119).

Data on exchange rates are from the IFS data base (IMF) and the nominal exchange rate is defined as the number of units of domestic currency per US dollar. An increase in the RER means a depreciation of the domestic currency and a decrease in non-distance costs (many of which are in domestic currency) relative to distance costs. This lowers the relative cost of trade at closer

³⁰ In other words, the implicit assumption is that the marginal propensity to import is constant and the same for all countries. Note that all countries in the sample are included, whether country i trades with them or not.

distances and lowers the *DOT*. This is shown in Table 4 (columns 2 and 3 for exports, imports and total trade). The coefficient of the *RER* variable is negative, significant at the 5% level for exports and total trade and either significant at the 10% level or not significant for imports.

As mentioned above, the bulkiness of many manufacturing products has fallen over time. This would be expected to raise the *DOT*. Over time, the ratio of manufacturing exports (imports) to agricultural and mineral commodity exports (imports) X_{mc} (M_{mc}) has increased, reducing the bulkiness of trade. We use these ratios as proxies for bulkiness. The results are shown in Table 4. As expected, the impact of X_{mc} on the *DOT* of exports and total trade is positive, as is the impact of M_{mc} on imports and total trade (all significant at the 5% level).³¹

7.2.6. Geography of Real Exchange Rates

Trade also depends on bilateral real exchange rates RER_{ij} between countries i and j . If a country j devalues its currency relative to that of home country i , the appreciation of RER_{ij} is likely to result in a decrease (increase) in exports from i to j (imports from j to i). The impact on DOT_i will depend on the distance between countries i and j and on the shares traded. To capture that effect, we define an index that captures the change in the RER_{ij} of country i relative to all its trading partners j , weighted by the bilateral distance d_{ij} and trade share s_{ij} :

$$RELNER_{it} = \frac{\sum_{j \neq i}^N d_{ij} s_{ijt} \left(\frac{RER_{ijt} - RER_{i,j,t-1}}{RER_{i,j,t-1}} \right)}{\sum_{j \neq i}^N \left(\frac{RER_{ijt} - RER_{i,j,t-1}}{RER_{i,j,t-1}} \right)} \quad j \neq i; j = 1, \dots, N, \quad (17)$$

Table 2 presents a few statistics on $RELNER_{it}$, with the index normalized between values of zero and one. For any country i , $RELNER_{it}$ increases when the increase (depreciation) in RER_{ijt}

³¹ Note that X_{mc} and M_{mc} increase over time and have positive coefficients. This explains why their inclusion leads to some increase in the negative trend coefficient.

is larger for distant rather than for proximate countries. Thus, one would expect that when $RELNER_{it}$ increases, the DOT of exports (imports) increases (decreases). The impact on the DOT of total trade is then ambiguous. Results are reported in Table 4. As expected, an increase in $RELNER_{it}$ leads to a significant increase (decrease) in the DOT of exports (imports), with a weak impact on the DOT of total trade. The same qualitative results are obtained when the shares s_{ijt} are deleted from $RELNER_{it}$ in equation (17).

8. CONCLUSION

It has been widely argued that the importance of distance has declined with the reduction in transport and communication costs and the integration of the global economy. On the other hand, gravity models find an increasingly important impact of distance on trade. This paper examines this puzzle and makes several contributions. First, it develops a new measure of the distance of trade (DOT) and presents findings on its evolution for individual countries, regions and for the world. We find that the DOT falls over time for the average country in the world, and that the number of countries with declining DOT is close to double those with increasing DOT . In other words, distance has become increasingly important over time for a majority of countries. This may be costly for those countries located far from the main centers of economic activity.

Second, the paper examines analytically a number of hypotheses in order to explain the evolution of the DOT . One of the conclusions is that the evolution of the DOT is unrelated to that of the overall level of trade costs but depends on the relative evolution of its components. Specifically, the DOT falls over time as long as dwell costs fall relative to distance costs, irrespective of the direction of change in total transport costs or in either of its two components. Third, the paper shows that reductions in production, domestic transport and customs costs, and increases in competition and the real exchange rate, result in a decline in the DOT , that reductions

in the bulkiness or weight of traded goods results in an increase in the *DOT*, and that the impact of a change in ad-valorem tariffs is ambiguous.

Fourth, the paper provides an empirical analysis of the *DOT* for exports, imports and total trade. Explanatory variables (and their sign) include a trend variable (negative), regional integration (negative), a variable *REG* measuring geographically uneven growth (positive), an infrastructure index whose value increases as dwell and domestic transport costs fall (negative) and the price of oil as a proxy for distance costs (negative). Thus, all variables have the expected sign, most are significant, and their inclusion fully explains the negative trend in the *DOT* for exports and for total trade and explains 60% of the trend for imports. In a smaller sample, we add the real exchange rate (negative impact on the *DOT*), a geographic variable *RELRER* measuring changes in bilateral real exchange rates (positive for exports and negative for imports) and a variable capturing the decline in the bulkiness of goods traded (positive). These variables also have the expected sign and are significant.

One of the more surprising findings is that, despite the negative impact of regional integration on the *DOT*, the share of countries with a positive trend in the *DOT* is larger for countries that are members of trade blocs than for countries that are not. This issue deserves further analysis.

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Average Distance of Trade and Change, 1962-2000

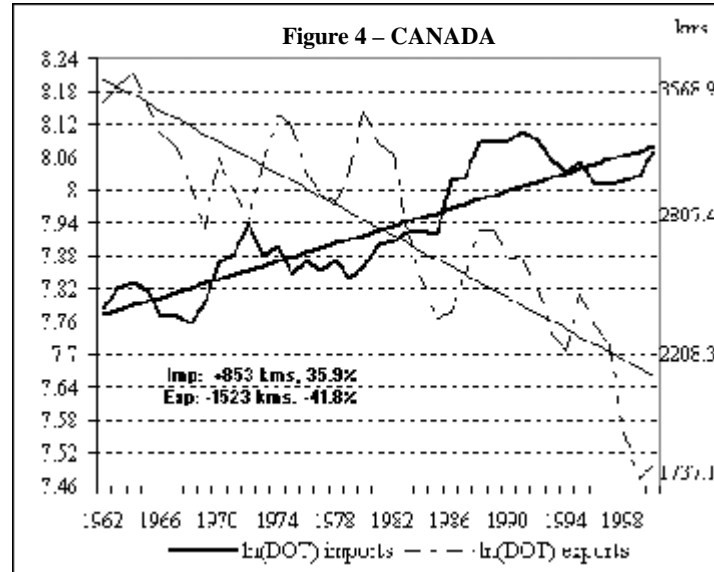
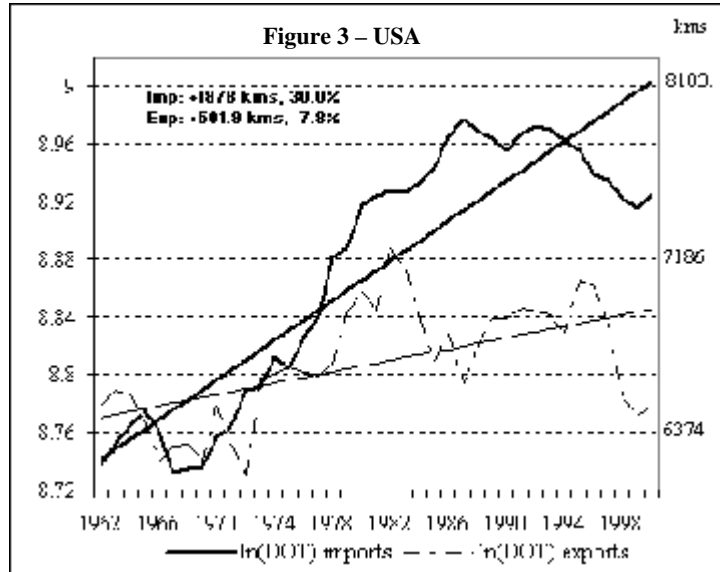
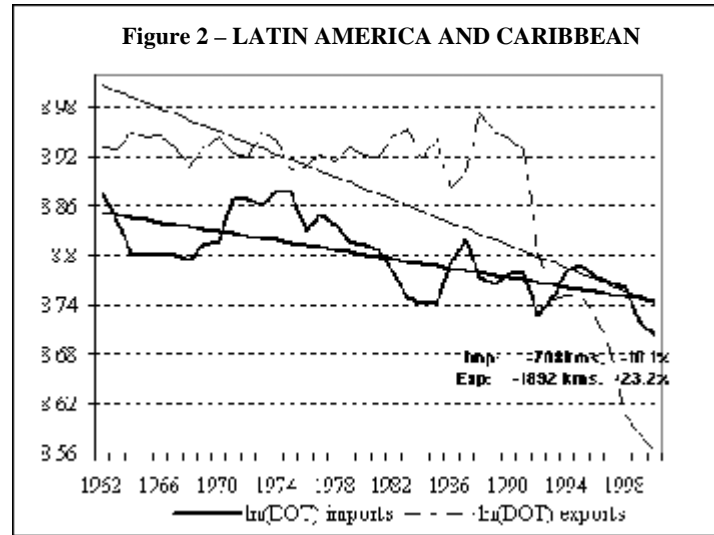
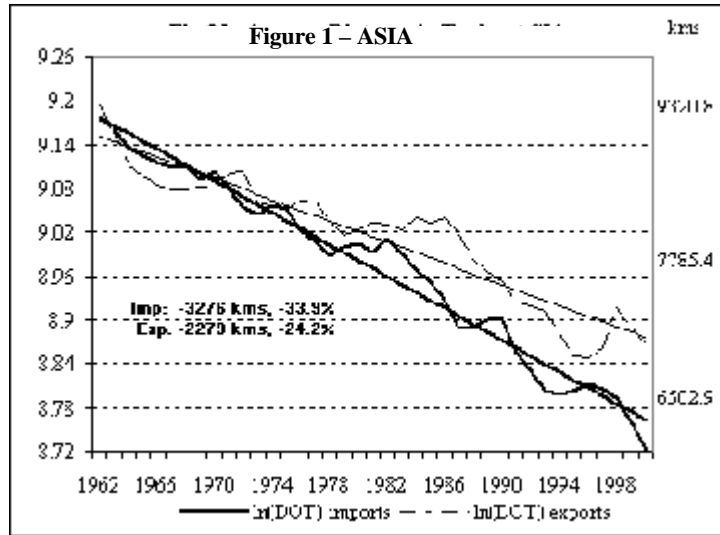


Table 1: Average Level and Change in the Distance of Exports DOT_i^X and Imports DOT_i^M , 1962-2000

Country/Region	\overline{DOT}_i^X ^{b)} (in kms)	\overline{DOT}_i^M ^{b)} (in kms)	ΔDOT_i^X ^{a)} (in %)	ΔDOT_i^M ^{a)} (in %)	Categories	
1. World	4789.6	4937.6	-2.5	2.9	0	
average country ⁹⁾	5466.6	5653.2	-5.3	-12.0	-	
World w/o USA	4464.8	4521.4	-2.4	-7.0	-	
World w/o EU-15	6445.0	6637.3	-5.2	0.2	-	0 No Change
OECD countries	4300.0	4472.7	-7.0	8.7	<	$ \Delta DOT_i^X < 5.5\%$ and $ \Delta DOT_i^M < 5.5\%$
non-OECD countries	6825.0	6253.5	-7.4	-14.0	-	
2.1 EU- 15 members	2699.8	2962.5	-12.3	-13.1	-	
France	2548.6	2726.7	8.1	-5.9	<	- Negative Change
Italy	2957.0	3082.3	1.7	-31.0	-	$\Delta DOT_i^X < -5.5\%$ and $\Delta DOT_i^M < -5.5\%$
Spain	3147.0	3666.2	-32.2	-21.1	-	or
United Kingdom	3987.9	3976.6	-41.9	-36.7	-	$\Delta DOT_i^X < -5.5\%$ and $ \Delta DOT_i^M < 5.5\%$
3. Americas	6008.5	6311.8	-5.5	26.7	+	
Americas w/o USA	4948.0	4906.6	-27.4	-0.3	-	or
Americas w/o CAN and USA	7188.7	6631.5	-23.2	-10.1	-	$ \Delta DOT_i^X < 5.5\%$ and $\Delta DOT_i^M < -5.5\%$
South America	8582.1	7778.3	-5.1	2.0	0	
NAFTA	5664.6	6108.5	-3.5	38.4	+	+ Positive Change
Canada	2809.6	2796.8	-41.8	35.9	<	$\Delta DOT_i^X > 5.5\%$ and $\Delta DOT_i^M > 5.5\%$
Mexico	4410.4	5102.4	-33.3	-8.0	-	or
USA	6697.1	7158.5	7.8	30.0	+	$\Delta DOT_i^X > 5.5\%$ and $ \Delta DOT_i^M < 5.5\%$
MERCOSUR	8679.5	8568.4	-8.4	-2.5	-	or
Argentina	9127.9	9213.7	-17.8	-9.3	-	$ \Delta DOT_i^X < 5.5\%$ and $\Delta DOT_i^M > 5.5\%$
Brazil	8476.3	8304.5	5.2	7.3	+	
Uruguay	8409.9	7244.8	-38.0	-22.2	-	
CARICOM	4511.5	5182.3	-1.3	3.0	0	< Opposite Changes
ANDEAN Pact	6930.2	6469.1	-18.3	-8.4	-	$\Delta DOT_i^X < -5.5\%$ and $\Delta DOT_i^M > 5.5\%$
Colombia	6071.1	6401.6	-16.2	-1.8	-	or
CACM	5029.1	4838.9	-24.2	-11.6	-	$\Delta DOT_i^X > 5.5\%$ and $\Delta DOT_i^M < -5.5\%$
4. Asia	8243.1	7924.5	-24.2	-33.9	-	
Australia	10718.1	12993.0	-22.7	-20.2	-	
New Zealand	12602.1	12031.4	-40.0	-23.3	-	
China	5168.9	6330.2	-2.5	-38.4	-	
Hong Kong, China	9036.7	5097.1	-35.6	-42.1	-	
Japan	8416.0	8668.4	-16.9	-24.6	-	
Asia non OECD	7349.6	6706.3	-9.8	-26.0	-	
ASEAN	7447.0	7421.0	0.6	-11.4	-	
Korea, Rep.	7192.9	6294.5	4.94	3.96	0	
Taiwan	7732.9	6806.7	-1.99	-6.45	-	
Thailand	6645.1	7329.5	39.1	-22.3	<	
Philippines	8665.6	7967.7	-9.5	-33.3	-	
India	6861.6	7633.2	-6.2	-25.5	-	
5. Sub-Saharan Africa	7684.0	7893.5	2.9	12.3	+	
SACU	9751.8	10107.1	-13.9	-0.2	-	
EAC	6815.3	7403.5	-37.6	-12.6	-	
Kenya	6071.6	7547.0	-32.3	-5.9	-	
Zimbabwe ^{d)}	6308.4	6867.4	-6.1	-17.9	-	
UEMOA	5096.4	5577.5	13.9	23.2	+	
Nigeria	5570.9	6784.0	-3.0	3.9	0	
Senegal	4775.9	5417.4	44.2	26.4	+	
Cote d'Ivoire	5349.7	5869.5	-2.4	21.3	+	
Cameroon	5314.6	6053.6	-10.7	12.7	<	
Ghana	6759.6	6739.6	-17.1	10.5	<	
6. MENA	4071.8	5106.5	57.3	20.5	+	

$$a) \Delta DOT_i^Z = 100 \left(\frac{\hat{DOT}_{i2000}^Z - \hat{DOT}_{i1962}^Z}{\hat{DOT}_{i1962}^Z} \right)$$

Z = X, M;

$$b) \overline{DOT}_i^Z = \frac{1}{39} \sum_{t=1962}^{2000} DOT_i^Z ;$$

c) unweighted country average;

d) calculated on 1965-2000.

Table 2. Large Sample (4119 observations)

Variable	Mean	Min	Max	Std. Dev.
DOT^X_{it}	5468.712	185.000	16496.460	2589.298
DOT^M_{it}	5616.527	234.022	22336.160	2113.719
DOT^T_{it}	5632.127	231.671	15134.090	2178.610
REG_{it-1}	8764.310	3014.544	18747.080	2034.281
Po_{it}	93.172	12.264	213.176	59.505
Infra_{it}	0.727	0.002	6.504	1.053

Reduced Sample (2713 observations)

Variable	Mean	Min	Max	Std. Dev.
DOT^X_{it}	5238.635	808.635	16496.460	2604.390
DOT^M_{it}	5512.639	1571.053	22336.160	2273.597
DOT^T_{it}	5460.420	1670.454	15134.090	2313.019
REG_{it-1}	8579.234	3014.544	16950.240	2140.141
Po_{it}	97.061	12.264	213.176	57.783
Infra_{it}	0.887	0.002	5.713	1.097
RER_{it}	100	0.099	281.19	23.57
RELRER_{it}	0.409	0	1	0.068
Xm_{cit}	2.751	0.000	86.403	5.716
Mm_{cit}	4.000	0.304	29.075	2.098

Note: t = trend variable ; P^{oil} = real price of oil (1995=100) ; Infra = infrastructure index (see Appendix 1); REG = index of relative growth (see equation 16); $RER_{it} = NER_{it} * (CPI_{US,t} / CPI_{i,t})$ with NER_{it} = nominal exchange rate (units of local currency per US dollar), (source: IMF); for each country, the RER is specified such as its mean over the period is 100; Xmc = ratio of manufacturing exports to agricultural and mineral commodity exports and Mmc = ratio of manufacturing imports to agricultural and mineral commodity imports (source: WB); RELRER = index of distance-weighted changes in bilateral RER_{ijt} (see equation 17).

** and * indicate significance at 5% and 10%, respectively.

Table 3. Determinants of the Distance of Trade (Within Estimator)

1964-2000					ln DOT _{it}							
	Exports				Imports				Total trade			
t	-0.0010*	-0.0006*	-0.0001	0.0001	-0.0021**	-0.0012**	-0.0008*	-0.0008*	-0.0014**	-0.0007*	-0.0001	-0.000
ln P ^{oil} _t		-0.005	-0.005	-0.004		-0.015**	-0.015**	-0.015**		-0.016**	-0.015**	-0.015**
ln Infra _{it}		-0.023*	-0.023*	-0.023*		-0.020**	-0.020**	-0.020**		-0.024**	-0.024**	-0.024**
RIA _{it}			-0.038*	-0.037*			-0.007	-0.007			-0.021*	-0.021*
EU _{it}			-0.083*	-0.083*			-0.092**	-0.092**			-0.093**	-0.093**
ln REG _{it-1}				0.052*				0.016				0.021*
Constant	8.46**	8.40**	8.40**	7.94**	8.59**	8.49**	8.49**	8.46**	8.57**	8.46**	8.47**	8.27**
obs	4119	4119	4119	4119	4119	4119	4119	4119	4119	4119	4119	4119
AdjR ²	0.18	0.19	0.29	0.29	0.19	0.20	0.29	0.29	0.18	0.24	0.25	0.30

Note: t = trend variable ; P^{oil} = real price of oil ; Infra = infrastructure index (see Appendix 1); RIA = dummy variable = 1 starting in year when RIA was created or revived; EU = dummy variable = 1 for countries belonging to EU-15; REG = index of relative growth (see equation 16).

** and * indicate significance at 5% and 10% respectively.

Table 4. Impact of Real Exchange Rate and Bulkiness on the Distance of Trade (Within Estimator)

1964-2000										Expected Sign
	ln DOT _{it}									
	Exports			Imports			Total trade			
t	0.0007	-0.0002	-0.0012*	-0.0001	-0.0001	-0.0009*	0.0003	-0.0000	-0.0007*	
ln Poil _t	0.001	0.003	0.001	-0.007**	-0.008**	-0.010**	-0.004*	-0.006**	-0.008**	-
ln Infrait	-0.002	0.000	0.001	-0.014**	-0.014**	-0.013**	-0.012**	-0.013**	-0.012**	-
RIA _{it}	-0.106**	-0.106**	-0.101**	-0.031**	-0.031**	-0.034**	-0.059**	-0.058**	-0.059**	-
EU _{it}	-0.067**	-0.047**	-0.042**	-0.112**	-0.111**	-0.115**	-0.101**	-0.093**	-0.094**	-
ln REG _{it-1}	0.018	0.015	0.015	-0.007	-0.007	-0.010	0.002	0.0009	-0.0004	+
ln RER _{it}		-0.069**	-0.076**		-0.002	-0.013*		-0.025**	-0.034**	-
REL _{RER} _{it}		0.025*	0.033*		-0.037*	-0.036*		-0.006	-0.004*	+, -, ?
X _{mc} _{it}			0.006**						0.0014**	+
M _{mc} _{it}						0.010**			0.0062**	+
Constant	8.34**	8.14**	8.10**	8.57**	8.58**	8.53**	8.48**	8.41**	8.38**	
obs	2713	2713	2713	2713	2713	2713	2713	2713	2713	
AdjR ²	0.22	0.28	0.28	0.29	0.29	0.29	0.28	0.30	0.32	

Note: t = trend variable ; P^{oil} = real price of oil (1995=100) ; Infra = infrastructure index (see Appendix 1); REG = index of relative growth (see equation 16); RER_{it}=NER_{it}*(CPI_{US,t}/CPI_{it}) with NER_{it}= nominal exchange rate (units of local currency per US dollar), (source: IMF); for each country, the RER is specified such as its mean over the period is 100; X_{mc} = ratio of manufacturing exports to agricultural and mineral commodity exports and M_{mc} = ratio of manufacturing imports to agricultural and mineral commodity imports (source: WB); REL_{RER} = index of distance-weighted changes in bilateral RER_{ijt} (see equation 17).

** and * indicate significance at 5% and 10% respectively.

Appendix 1. Data, Sample and Computations

This study is based on non-fuel trade data from 1962 to 2000 of 150 countries³² from the COMTRADE (UN). The list of the available countries is in Table A.1. These countries account for more than 90% of world trade. The distance of trade (DOT) is computed for each country and year using these trade data and the spherical distance between the main economic cities of any pair of countries. The source for the location of capitals is the CIA World Factbook. The calculations of the spherical distances are our own.

To overcome missing data problems, when a country's import data are not available, mirror estimates (export data reported by the partner countries) are used (and similarly for missing export data). This approach has the advantage of covering almost all the missing data³³. Once the DOT per country and year is computed using the database with mirror estimates, we have 5,777 observations (98.5% of the potential number of data points),³⁴ rather than 4,641 for imports and 4,670 for exports in the data base without mirror estimates. Information on the number of data per country and year are available from the authors.

The infrastructure index includes the density of roads, paved roads, railways, and telephone lines for each country and year (see Limao and Venable 2001; Brun et al. forthcoming)³⁵. This

³² Actually the sample covers more than 150 countries as data concerning Belgium -Luxembourg and SACU (Southern African Customs Union) is not presented for each individual country.

³³ Mirror statistics also have some shortcomings, especially for trade between developing countries where they do not always match the original data.

³⁴ The potential number of data points is 5850 (=150*39).

³⁵ Each country's infrastructure is measured by an index constructed from four variables from the Canning (1996) dataset: km of road, km of paved road, km of rail (each per sq. km of country area), and telephone main lines per person. We took the mean over the four variables (each being normalized to have a mean equal to one), ignoring missing observations. This is equivalent to assuming that roads, paved roads, railways and telephone lines are perfect substitutes as inputs to a transport services production function. Taking the

index (in annual percentage change) captures both the impact of the evolution of domestic transport costs and of the evolution of dwell costs. The correlation between this infrastructure index and a port efficiency index, for a sample of 44 developing and OECD countries for which data on port efficiency in 1998 are available, is 0.70.³⁶ Similarly, the correlation between this infrastructure index and a custom clearance index is -0.59 .³⁷

mean over the non-missing variables implicitly assumes that the missing observations take on average the same value as the non-missing variables (See Limao and Venables 2001, Appendix 1). As the final year of the Canning (1996) dataset is 1995, we used the predicted value of the infrastructure index for 1996 to 2000 according to a quadratic trend estimated by country on the 1962-1995 available data.

³⁶ The port efficiency index goes from 1 (inefficient port) to 7 (most efficient port) and is based on surveys of representative firms in each country. Source: The Global Competitiveness Report, various years (1996-2000); also available in Appendix B in Clark, Dollar and Micco (2001) for 1998.

³⁷ The customs clearance index corresponds to the time (median number of days) needed to clear customs, based on surveys performed (by the World Bank) with respect to importers in each country. Source: Appendix B in Clark, Dollar and Micco (2001) for 1998.

Table A.1: Trend (in percentage) in the Distance ^{a)} of:

Country/Region	Exports		Imports		Total Trade	
	Coeff	p-value	Coeff	p-value	Coeff	p-value
1. World	-0.07	0.08	0.08	0.12	0.01	0.85
World Average by country	-0.14	0.06	-0.34	0.00	-0.33	0.00
World w/o USA	-0.07	0.16	-0.19	0.00	-0.13	0.02
World w/o EU-15	-0.14	0.01	0.01	0.84	-0.06	0.09
1.1 OECD countries (2000)	-0.19	0.00	0.22	0.00	0.02	0.73
1.2 non-OECD countries (2000)	-0.20	0.00	-0.40	0.00	-0.30	0.00
2. Europe	-0.32	0.00	-0.32	0.02	-0.33	0.01
2.1 EU- 15 members	-0.35	0.00	-0.37	0.01	-0.36	0.01
- EU- 12 members	-0.41	0.00	-0.42	0.01	-0.42	0.00
- EU- 9 members	-0.37	0.00	-0.40	0.03	-0.39	0.01
- EU- 6 members	0.09	0.35	-0.10	0.50	-0.01	0.91
France	0.20	0.00	-0.16	0.30	0.02	0.88
Germany	-0.06	0.52	-0.08	0.41	-0.07	0.40
Italy	0.04	0.66	-0.98	0.00	-0.46	0.00
Spain	-1.02	0.00	-0.62	0.00	-0.82	0.00
United Kingdom	-1.43	0.00	-1.20	0.00	-1.30	0.00
2.2 Others c)	-0.03	0.51	0.23	0.00	0.12	0.01
3. Americas	-0.15	0.05	0.62	0.00	0.28	0.00
Americas w/o CAN and USA	-0.69	0.00	-0.28	0.00	-0.46	0.00
3.1 NAFTA	-0.09	0.23	0.86	0.00	0.44	0.00
Canada	-1.42	0.00	0.83	0.00	-0.30	0.00
Mexico	-1.06	0.00	-0.22	0.00	-0.58	0.00
United States	0.20	0.00	0.69	0.00	0.49	0.00
3.2 MERCOSUR	-0.23	0.00	-0.07	0.15	-0.14	0.00
Argentina	-0.52	0.00	-0.26	0.00	-0.37	0.00
Brazil	0.13	0.10	0.18	0.00	0.17	0.01
Paraguay	-0.75	0.00	0.17	0.28	0.01	0.88
Uruguay	-1.26	0.00	-0.66	0.00	-0.97	0.00
3.3 CARICOM	-0.03	0.64	0.08	0.64	0.06	0.54
3.4 ANDEAN Pact	-0.53	0.00	-0.23	0.00	-0.34	0.00
Bolivia	-1.26	0.00	-0.56	0.00	-0.84	0.00
Colombia	-0.47	0.01	-0.05	0.31	-0.18	0.03
Ecuador	-0.29	0.02	-0.46	0.00	-0.36	0.00
Peru	0.19	0.03	-0.28	0.00	-0.07	0.08
Venezuela. RB	-0.08	0.78	-0.26	0.00	-0.32	0.00
3.4 CACM	-0.73	0.00	-0.32	0.00	-0.52	0.00
4. Asia	-0.73	0.00	-1.09	0.00	-0.90	0.00
Asia w/o China	-0.71	0.00	-1.03	0.00	-0.85	0.00
4.1 East Asia and Pacific (EAP)	-0.81	0.00	-1.15	0.00	-0.97	0.00
- EAP w/o China	-0.80	0.00	-1.09	0.00	-0.93	0.00
Australia	-0.68	0.00	-0.59	0.00	-0.56	0.00
China	-0.08	0.60	-1.28	0.00	-0.65	0.00
Hong Kong. China	-1.16	0.00	-1.44	0.00	-1.79	0.00
Japan	-0.49	0.00	-0.74	0.00	-0.61	0.00
Korea. Rep.	0.13	0.52	0.10	0.50	0.10	0.25
New Zealand	-1.35	0.00	-0.70	0.00	-1.04	0.00

Country/Region	Exports		Imports		Total Trade	
	Coeff	p-value	Coeff	p-value	Coeff	p-value
Taiwan	-0.05	0.84	-0.18	0.10	-0.13	0.38
- Others EAP	-0.09	0.23	-0.39	0.00	-0.24	0.00
ASEAN	0.02	0.84	-0.32	0.00	-0.17	0.01
Othersb)	-0.76	0.00	-1.21	0.00	-0.96	0.00
4.2 South Asia	0.10	0.93	-0.82	0.00	-0.39	0.00
- India	-0.26	0.20	-0.77	0.00	-0.52	0.00
- Others	0.55	0.00	-0.84	0.00	-0.18	0.02
Afghanistan	0.01	0.99	-0.71	0.00	-0.40	0.05
Bangladesh	0.61	0.04	-1.94	0.00	-0.58	0.01
Nepal	2.43	0.00	0.47	0.00	1.17	0.07
Pakistan	0.18	0.20	-0.80	0.00	-0.43	0.00
Sri Lanka	0.86	0.00	-0.32	0.00	0.28	0.00
5. Sub-Saharan Africa	0.08	0.14	0.17	0.00	0.15	0.00
5.1 East and Southern Africa (ESA)	-0.06	0.43	-0.01	0.80	-0.03	0.60
- SACU	-0.39	0.00	0.00	0.88	-0.17	0.00
- ESA w/o SACU	-0.06	0.33	-0.20	0.03	-0.16	0.04
SADC (w/o SACU)	0.22	0.00	-0.29	0.01	-0.09	0.33
EAC	-1.24	0.00	-0.35	0.00	-0.67	0.24
5.2 West Africa	0.62	0.00	0.17	0.00	0.53	0.00
- Nigeria	-0.14	0.05	0.10	0.09	0.31	0.00
- West Africa w/o Nigeria	0.19	0.00	0.88	0.00	0.28	0.00
UEMOA	0.34	0.00	0.55	0.00	0.47	0.00
CEMAC	0.35	0.00	0.30	0.00	0.33	0.00
6. Middle East and North Africa	1.19	0.00	0.49	0.00	0.63	0.10
6.1 Middle East	1.03	0.00	0.34	0.00	0.44	0.00
- GCC	1.72	0.00	0.28	0.00	0.25	0.00
- Israel	1.02	0.00	-0.11	0.14	0.43	0.00
- Others d)	0.07	0.57	0.17	0.01	0.15	0.01
6.2 North Africa	0.20	0.03	0.36	0.00	0.36	0.00
- Egypt. Arab Rep.	-0.47	0.00	0.30	0.03	0.31	0.01
- Others e)	0.77	0.00	0.32	0.00	0.43	0.00

a) $100 * \hat{b}$. with \hat{b} from $\ln(DOT_t^z) = a + bt + m_t$. $t=1..39$. $Z = X, M, T$ (equation 3);

b) Fiji. Kiribati. Macao China. New Caledonia. Papua New Guinea. French Polynesia. Samoa. Solomon Islands. Tonga. Vanuatu;

c) Cyprus. Faeroe Islands. Greenland. Hungary. Iceland. Norway. Poland. Switzerland. Turkey;

d) Iran Islamic Rep.. Iraq. Jordan. Lebanon. Syrian Arab Rep.. Yemen Rep.;

e) Algeria. Djibouti. Libya. Malta. Morocco. Tunisia.

Table A.2: Countries per Category (number in RIA/number of countries)/= (96/150)

	No Change 0 (2/4)	Opposite Changes >< (18/30)	Positive Change + (29/39)	Negative Change - (47/77)	
OECD (20/22)	Switzerland*	Austria* Canada* France* Netherlands* Sweden*	Denmark* Finland* Iceland* Ireland* Norway United States*	Australia* Belgium-lux* Germany* Greece* Italy* Japan	New Zealand* Portugal* Spain* United Kingdom*
	Central African Rep.* Nigeria South Korea	Algeria Belize* Brunei* Cameroon* Cote d'Ivoire* Cyprus* Faeroe Islands Gambia Greenland Honduras* Israel* Kiribati Lao PDR* Libya Macao Mali* Sri Lanka St. Lucia* Suriname Syria Thailand* Tonga Yemen Zaire* Zimbabwe*	Antigua and Barbuda* Bahamas* Bahrain* Benin* Brazil* Burkina Faso* Cape Verde Chad* Chile Comoros Congo* Djibouti Dominica* Gabon* Jordan* Kuwait* Lebanon* Liberia Malta Mauritania Montserrat* Morocco* Nepal Oman* Qatar* Rwanda Saudi Arabia* Senegal* Seychelles* Singapore* St. Vincent and the Grenadines* Togo* Unit. Arab Emirates*	Afghanistan Angola* Argentina* Bangladesh Barbados* Bermuda Bolivia* Burundi China Colombia* Costa Rica* Cuba Dominican Rep. Ecuador* Egypt* El Salvador* Fiji French Polynesia Ghana Grenada* Guatemala* Guyana Haiti Hong Kong Hungary* India Indonesia* Iran Iraq Jamaica* Kenya* Madagascar* Malawi* Malaysia*	Mauritius* Mexico* Mozambique* Myanmar* Netherlands Antilles New Caledonia Nicaragua* Niger* Pakistan Panama Papua New Guinea Paraguay* Peru* Philippines* Poland* St Pierre and Miquelon Samoa Sierra Leone Solomon Islands Somalia South Africa* Sudan Taiwan Tanzania* Trinidad and Tobago* Tunisia* Turkey* Uganda* Uruguay* Vanuatu Venezuela. RB* Vietnam* Zambia*
non OECD (76/128)					

* Countries in a regional integration agreement.

No Change= $(|\Delta DOT_i^X| < 5.5\% \text{ and } |\Delta DOT_i^M| < 5.5\%)$

Opposite Changes= $(|\Delta DOT_i^X| < -5.5\% \text{ and } |\Delta DOT_i^M| > 5.5\%) \text{ or } (|\Delta DOT_i^X| > 5.5\% \text{ and } |\Delta DOT_i^M| < -5.5\%)$

Positive Change= $(|\Delta DOT_i^X| > 5.5\% \text{ and } |\Delta DOT_i^M| > 5.5\%) \text{ or } (|\Delta DOT_i^X| > 5.5\% \text{ and } |\Delta DOT_i^M| < 5.5\%) \text{ or } (|\Delta DOT_i^X| < 5.5\% \text{ and } |\Delta DOT_i^M| > 5.5\%)$

Negative Change= ($|\Delta DOT_i^X| < -5.5\%$ and $|\Delta DOT_i^M| < -5.5\%$) or ($|\Delta DOT_i^X| < -5.5\%$ and $|\Delta DOT_i^M| < 5.5\%$) or ($|\Delta DOT_i^X| < 5.5\%$ and $|\Delta DOT_i^M| < -5.5\%$)

Appendix 2. Transport Costs

Information on general or liner cargo does not distinguish between dwell and distance costs, though that for charter shipping does. Hummels (1999) argues that for charter shipping bulk commodities (on a worldwide basis) as well as for general or liner cargo (for ships loading and unloading in Germany and the Netherlands), including containerized vessels, the cost per value shipped has risen since 1952. However, Lundgren (1996) concludes that the constant dollar price of shipping bulk commodities fell substantially between 1950 and 1993, though not the *ad-valorem* barrier of shipping bulk commodities (Hummels, 1999). Since the figures for charter shipping do not include port costs, the increase in charter shipping distance costs should have a negative impact on the *DOT*. On the other hand, the evidence on US air cargo rates indicates very large distance cost reductions between 1955 and 1977, which may explain the increase in the US *DOT* over time.

The bulkiness (and/or weight) of many tradable products has fallen over time, resulting in a fall in C_m and an increase in the *DOT* for any given mode of transport.³⁸ With the fall in air transport costs as well as in many products' bulkiness, there has also been a gradual shift from ocean to air transport over time, with a further increase in the *DOT*. In a model of choice between ocean and air transport, Carrère and Schiff (2003) show that a fall in bulkiness leads to a rise in air relative to ocean travel.³⁹

International trade between neighboring countries is typically made over land. Glaeser and Kohlhase (2003) find that that US overland transport costs have declined, with the cost of moving a ton a mile by rail falling by 2.5% a year since 1890, and trucking costs falling by 2% a year since the Motor Carrier Act of 1980. They attribute this to improved transport technologies and to the

³⁸ The share of light manufactures in the exports of developing countries to developed ones increased over time, from 5% in 1955 to 58% in 1992 (Hillman, forthcoming), reducing the average bulkiness of trade.

³⁹ They also examine the impact of changes in interest rates, speed of travel, shipping fees and value of goods shipped on the choice of air versus ocean travel.

fact that the value of goods lies increasingly in quality rather than quantity. They also find a positive relation between products' value per ton and the distance hauled. Indirect evidence also suggests that overland transport costs in the US declined relative to ocean transport costs (Hummels 1999). The fall in US overland shipping costs provides an incentive to increase overland trade, resulting in an increase in the *DOT* over land but in a reduction in the overall *DOT* (due to the increased share of overland trade).

The above suggests that total ocean shipping costs may have risen over time while those for air and land transport have declined.⁴⁰ Table A.3 shows the evolution of the share of US imports and exports by ocean, air and land. First, we note a decline in the share of ocean trade and an increase in the share of trade by air and land. The share of trade by land declines before 1980 and increases thereafter, the latter coinciding with the Motor Carrier Act of 1980 and with the period when CUSFTA and NAFTA were signed. The opposite occurs with ocean trade, with the share of imports declining after 1980 while the share of exports declines after 1975.

Table A.3. US Trade by Transport Mode (% of value)

year	Imports			Exports		
	Ocean	Air	Land	Ocean	Air	Land
1965	69.9	6.2	23.9	61.6	8.3	30.1
1970	62.0	8.6	29.4	57.0	13.8	29.2
1975	65.5	9.2	25.3	58.9	14.1	27.0
1980	68.6	11.6	19.8	54.8	20.9	24.3
1985	60.4	14.9	24.8	43.0	24.5	32.4
1990	57.2	18.4	24.4	38.4	28.1	33.5
1994	51.2	21.6	27.3	34.7	29.3	36.0

Sources: Hummels (1999, Table 3).

⁴⁰ Note that as far as the choice between shipping modes is concerned, the evolution of total transport costs matters rather than that of dwell versus distance costs.