On the Geography of Trade: Distance is Alive and Well

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Distance is Alive and Well

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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 on bilateral trade has increased over time. This puzzle 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 argues that this result can be compatible with declining trade costs. Actually, 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. The paper also analyzes the impact on the* DOT *of other determinants such as regional integration, changes in the geography of growth or in real exchange rates. Finally, the paper provides an empirical analysis of the evolution of the* DOT *and explains most of its negative trend.*

GÉOGRAPHIE ET COMMERCE : LA DISTANCE SE PORTE BIEN

Il a été largement proclamé qu'avec le déclin des coûts du commerce international à travers le temps, l'importance de la distance a fortement diminué. Cependant, la plupart des modèles de gravité mettent en évidence un rôle croissant de la distance à travers le temps sur les flux de commerce bilatéraux. Ce paradoxe est examiné ici. À cette fin, une nouvelle mesure de la distance commerciale (DOT) *est développée et révèle que cette distance a diminuée sur la période 1962-2000 pour le pays « moyen » dans le monde, avec un nombre de pays expérimentant une* DOT *décroissante deux fois plus important que le nombre de pays avec une* DOT *croissante. Ce résultat confirme l'importance croissante de la distance à travers le temps. Dans ce papier nous montrons comment ce résultat peut être compatible*

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avec des coûts du commerce déclinants. En effet, nous argumentons que la décision de la répartition des flux commerciaux sur différentes distances ne dépend pas du niveau des coûts du commerce mais plutôt de l'importance relative de ses composantes. Nous analysons également l'impact d'autres déterminants de la DOT *tels que l'intégration régionale, les changements dans la géographie de la croissance ou des taux de change réels. Enfin, nous proposons une analyse empirique de l'évolution de la* DOT *et expliquons la quasi-totalité de sa tendance négative.*

JEL classification: F1, N70, O57.

"The report of my death has been greatly exaggerated."
Mark Twain after reading his own obituary, June 2, 1897.

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 has been 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 model estimations seem to contradict the conventional wisdom expressed above. They find that the negative impact of distance on bilateral trade increases over time (*e.g*. Leamer [1993], Frankel [1997], Smarzynska [2001]). In their review of the literature, Leamer and Levinsohn ([1995], p. 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 [2004] examine 1052 distance effects estimated in 78 papers and find that the negative impact of distance on trade is not shrinking, but increasing slightly over the last century. They conclude that there is a "[…] puzzling persistence of the distance effect on bilateral trade".

Some recent studies have attempted to solve the puzzle using a gravity model in a series of cross-section over 1975-2000 (Coe *et al*. [2002]) or in a panel over 1962-1996 (Brun *et al*. [2005]). For standard gravity specifications, both studies find rising distance effects. When the model is estimated non-linearly, Coe *et al*. [2002] find that the coefficient for the distance variable shows some decline in 1975-2000. With an augmented transport cost function, Brun *et al*. [2005] find a decline in the coefficient of distance in a log-linear gravity model, though the decline is largely confined to bilateral trade among rich countries; for developing countries, the coefficient of distance does not decline. 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.

Given that the coefficient of distance in a gravity model measures the marginal impact of distance on bilateral trade, 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. However, it does *not* indicate how overall trade costs have changed.

The paper proposes an alternative way to solve the puzzle: we show that an increasing distance elasticity of bilateral trade is *compatible* with falling trade costs and that countries may trade at shorter distances over time even though overall trade costs decrease. The reason is 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.[1]

The paper contributes to the literature in several ways. First, we opt for a different approach in order to elucidate the puzzle of the increased impact of distance on trade over time and develop a new measure of the distance of trade, *DOT*. The evolution of this measure shows that the importance of distance has increased over time: the distance of trade *(DOT)* appears to have declined between 1962 and 2000 for a majority of countries, with a stronger decline for developing than for *OECD* countries. To paraphrase Twain, we confirm that "*The report on the death of distance has been greatly exaggerated*."

Second, the paper provides a simple analytical solution to the puzzle. Trade costs are decomposed into those 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. This explanation is supported by econometric analysis, explaining around half of the negative trend.

Finally, the paper attempts to explain the *entire* negative trend of the *DOT* and then proposes some additional determinants by examining the impact of additional determinants, including regional integration, and changes in the geography of growth. The set of variables introduced fully explain the negative trend in the *DOT* for exports and total trade, and 60% of the trend for imports. On a reduced sample, the introduction of the changes in the geography of real exchange rates allows to explain the remaining negative trend for imports.

The remainder of the paper is organized as follows. Section 2 defines the *DOT* measure and provides information on the average *DOT* over the period 1962-2000. Section 3 offers evidence on the evolution of the *DOT* in 1962-2000 for the world, its main regions and representative countries, and for exports, imports and total trade. Section 4 presents theoretical analysis of the evolution of the *DOT* over time associated with changes in the relative components of trade costs, regional integration, the geography of growth and real exchange rates. We also analytically examine the impact on the *DOT* of changes in production, customs and domestic transport costs, as well as in competition and tariffs. An empirical validation of some of the theoretical analysis is provided in Section 5. Section 6

1. The idea of the asymmetric evolution of different trade cost components is mentioned in Brun *et al*. ([2005], appendix A.4) but the gravity model does not allow a test of this hypothesis.

concludes. Appendix 1 describes the data and several variables of interest and Appendix 2 provides information on transport costs.

DEFINITION OF THE DISTANCE OF TRADE *(DOT)*

Measure of the Distance of Trade

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

Denote the share of the trade flows between countries *i* and *j* in the total trade of country *i* at time *t* by s^Z_{ijt}, with:[1]

$$s^Z_{ijt} \equiv \frac{Z_{ijt}}{\sum_{j \neq i}^{N} Z_{ijt}}, \ j \neq i; j = 1, \ldots, N \text{ (N countries in the world)}, \ Z = M, X, T.$$

Hence, if country *i* does not trade with country *j* at time *t*, the share of trade flows with this partner j, s^Z_{ijt}, is zero.

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

$$DOT^Z_{it} \equiv \sum_{j \neq i}^{N} d_{ij} s^Z_{ijt}, \ j \neq i; j = 1, \ldots, N, \ Z = X, M, T, \quad (1)$$

and the world's *DOT* at time *t* is:

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

where s^Z_{iwt} 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)[2] from the COMTRADE bilateral (non-fuel) trade data and the spherical distance between the main economic cities of any pair of countries.[3] The total number of observations on the *DOT* is 5,777. Data sources and computation are provided in Appendix 1.

1. "Trade flows" always refer to "non-fuel trade flows".

2. In reality, we cannot state $s_{ijt} \neq 0$ for all the countries *i* whatever *j* and *t*. Hence, the number of trading partners changes from country to country and over time. However, the measure of Distance of Trade (DOT_{ijt}) is comparable across countries and time as it does not depend on the number of trading partners. Actually, we are interested in the share of trade of each country *i* at various distance, whatever the number of partners concerned for a given distance.

3. 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.

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Average Distance of Trade

The average DOT($\overline{DOT}$) for 1962-2000 for various countries and regions is presented in the first two columns of Table 1.[1] What are the main results? First, the $\overline{DOT}$ is about 50% larger for non-OECD countries (about 6,540 kms) than for OECD countries (about 4,390 kms).[2] Second, within the OECD, the EU-15 and Canada have the smallest $\overline{DOT}$ (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 $\overline{DOT}$ is smallest for the EU-15 (2,800 kms), larger for the Middle East and North Africa (4,590 kms), over double the EU-15 $\overline{DOT}$ 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 $\overline{DOT}$ is below 5,000 kms in either South America or Sub-Saharan Africa.

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

Country/Region	Average Level in the Distance of		Change in the Distance of		
	Exports $\overline{DOT}_i^{X a)}$ (in kms)	Imports $\overline{DOT}_i^{M a)}$ (in kms)	Exports $\Delta\overline{DOT}_i^{X a)}$ (in %)	Imports $\Delta\overline{DOT}_i^{M a)}$ (in %)	Categories[b)]
1. *World*	**4789.6**	**4937.6**	**– 2.5**	**2.9**	No Change
Average country[c)]	5466.6	5653.2	– 5.3	– 12.0	**Negative Change**
World w/o USA	4464.8	4521.4	– 2.4	– 7.0	**Negative Change**
World w/o EU-15	6445.0	6637.3	– 5.2	0.2	**Negative Change**
OECD countries	4300.0	4472.7	– 7.0	8.7	Opposite Changes
non-OECD countries	6825.0	6253.5	– 7.4	– 14.0	**Negative Change**
2. *EU-15 members*	**2699.8**	**2962.5**	**– 12.3**	**– 13.1**	**Negative Change**
France	2548.6	2726.7	8.1	– 5.9	Opposite Changes
Italy	2957.0	3082.3	1.7	– 31.0	**Negative Change**
Spain	3147.0	3666.2	– 32.2	– 21.1	**Negative Change**
United Kingdom	3987.9	3976.6	– 41.9	– 36.7	**Negative Change**
3. *Americas*	**6008.5**	**6311.8**	**– 5.5**	**26.7**	Positive Change
Americas w/o USA	4948.0	4906.6	– 27.4	– 0.3	**Negative Change**
Americas w/o CAN and USA	7188.7	6631.5	– 23.2	– 10.1	**Negative Change**
South America	8582.1	7778.3	– 5.1	2.0	No Change
NAFTA	5664.6	6108.5	– 3.5	38.4	Positive Change
Canada	2809.6	2796.8	– 41.8	35.9	Opposite Changes
Mexico	4410.4	5102.4	– 33.3	– 8.0	**Negative Change**
USA	6697.1	7158.5	7.8	30.0	Positive Change

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

2. 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 the COMTRADE database).

Table 1. *Average Level and Change in the Distance of Exports* DOT_i^X *and Imports* DOT_i^M*, 1962-2000 (continued) –*

Country/Region	Average Level in the Distance of		Change in the Distance of		
	Exports $\overline{DOT}_i^{Xa)}$ (in kms)	Imports $\overline{DOT}_i^{Ma)}$ (in kms)	Exports $\Delta\overline{DOT}_i^{Xa)}$ (in %)	Imports $\Delta\overline{DOT}_i^{Ma)}$ (in %)	Categories[b)]
MERCOSUR	8679.5	8568.4	– 8.4	– 2.5	**Negative Change**
Argentina	9127.9	9213.7	– 17.8	– 9.3	**Negative Change**
Brazil	8476.3	8304.5	5.2	7.3	Positive Change
Uruguay	8409.9	7244.8	– 38.0	– 22.2	**Negative Change**
CARICOM	4511.5	5182.3	– 1.3	3.0	No Change
ANDEAN Pact	6930.2	6469.1	– 18.3	– 8.4	**Negative Change**
Colombia	6071.1	6401.6	– 16.2	– 1.8	**Negative Change**
CACM	5029.1	4838.9	– 24.2	– 11.6	**Negative Change**
4. *Asia*	**8243.1**	**7924.5**	**– 24.2**	**– 33.9**	**Negative Change**
Australia	10718.1	12993.0	– 22.7	– 20.2	**Negative Change**
New Zealand	12602.1	12031.4	– 40.0	– 23.3	**Negative Change**
China	5168.9	6330.2	– 2.5	– 38.4	**Negative Change**
Hong Kong, China	9036.7	5097.1	– 35.6	– 42.1	**Negative Change**
Japan	8416.0	8668.4	– 16.9	– 24.6	**Negative Change**
Asia non OECD	7349.6	6706.3	– 9.8	– 26.0	**Negative Change**
ASEAN	7447.0	7421.0	0.6	– 11.4	**Negative Change**
Korea, Rep.	7192.9	6294.5	4.94	3.96	No Change
Taiwan	7732.9	6806.7	– 1.99	– 6.45	**Negative Change**
Thailand	6645.1	7329.5	39.1	– 22.3	Opposite Changes
Philippines	8665.6	7967.7	– 9.5	– 33.3	**Negative Change**
India	6861.6	7633.2	– 6.2	– 25.5	**Negative Change**
5. *Sub-Saharan Africa*	**7684.0**	**7893.5**	**2.9**	**12.3**	Positive Change
SACU	9751.8	10107.1	– 13.9	– 0.2	**Negative Change**
EAC	6815.3	7403.5	– 37.6	– 12.6	**Negative Change**
Kenya	6071.6	7547.0	– 32.3	– 5.9	**Negative Change**
Zimbabwe[d)]	6308.4	6867.4	11.1	– 17.9	Opposite Changes
UEMOA	5096.4	5577.5	13.9	23.2	Positive Change
Nigeria	5570.9	6784.0	– 3.0	3.9	No Change
Senegal	4775.9	5417.4	44.2	26.4	Positive Change
Cote d'Ivoire	5349.7	5869.5	– 9.2	21.3	Opposite Changes
Cameroon	5314.6	6053.6	– 10.7	12.7	Opposite Changes
Ghana	6759.6	6739.6	– 17.1	1.01	**Negative Change**
6. *MENA*	**4071.8**	**5106.5**	**57.3**	**20.5**	Positive Change

a) $\Delta DOT_i^Z = 100\left(\frac{\ddot{DOT}_{i2000}^Z - \ddot{DOT}_{i1962}^Z}{\hat{DOT}_{i1962}^Z}\right)$ and $\overline{DOT}_i^Z = \frac{1}{39}\sum_{t=1962}^{2000} DOT_i^Z$, Z = X, M;

b) Categories:

No Change: $|\Delta DOT_i^X| < 5.5\%$ 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 $\Delta DOT_i^M < -5.5\%$]

Positive 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 $\Delta DOT_i^M > 5.5\%$]

Opposite Changes: [$\Delta DOT_i^X < -5.5\%$ and $\Delta DOT_i^M > 5.5\%$] or [$\Delta DOT_i^X > 5.5\%$ and $\Delta DOT_i^M < -5.5\%$]

c) unweighted country average;

d) calculated on 1965-2000.

EVOLUTION OF THE DISTANCE OF TRADE, 1962-2000

Trend of the Distance of Trade

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 β in the OLS regression (with the White correction for heteroskedasticity):

$$\ln DOT_{it}^{Z} = \alpha + \beta t + \mu_{it},\ t = 1, \ldots, 39\ ;\ Z = X, M, T. \qquad (3)$$

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

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

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.

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 $|\Delta DOT_i^Z| > 5.5\%$.[1] 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 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

1. The cutoff value of 5.5% is arbitrary. Qualitative results remain unchanged with cutoff values of 10% or even 15%.

Average Distance of Trade

Figure 1. *Asia*

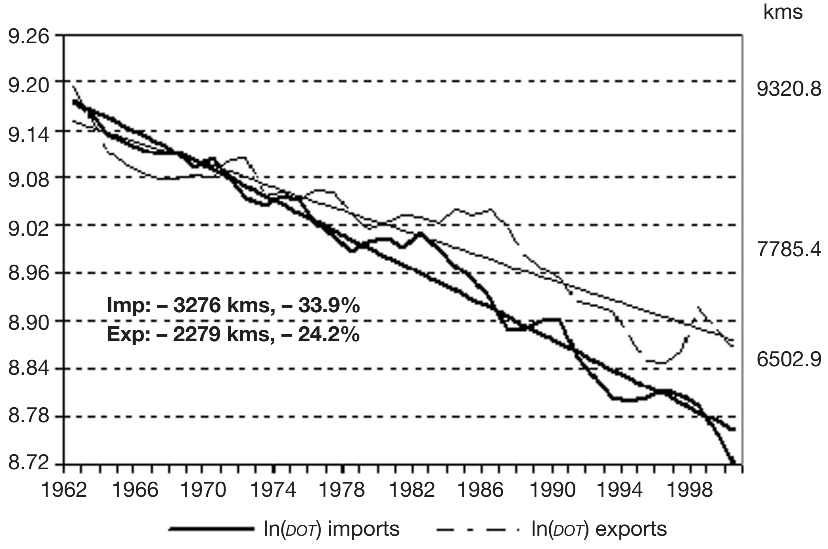
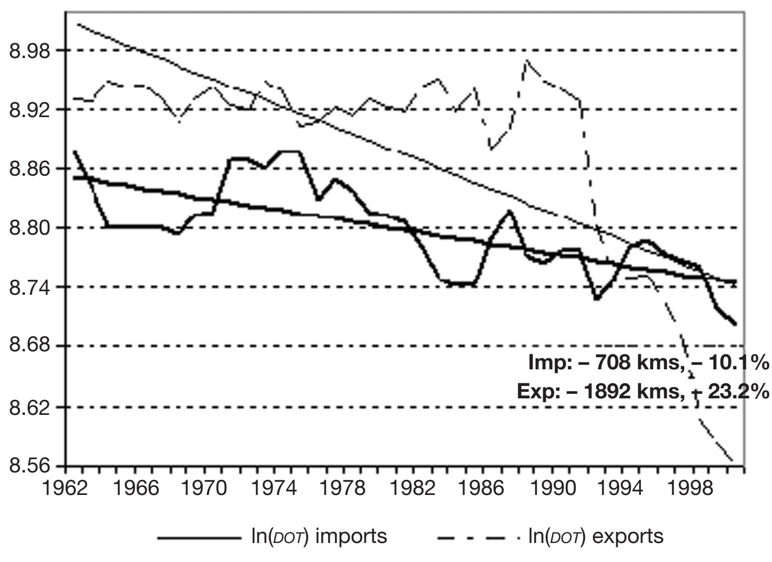


Figure 2. *Latin America and Caribean*



and Change, 1962-2000

Figure 3. *USA*

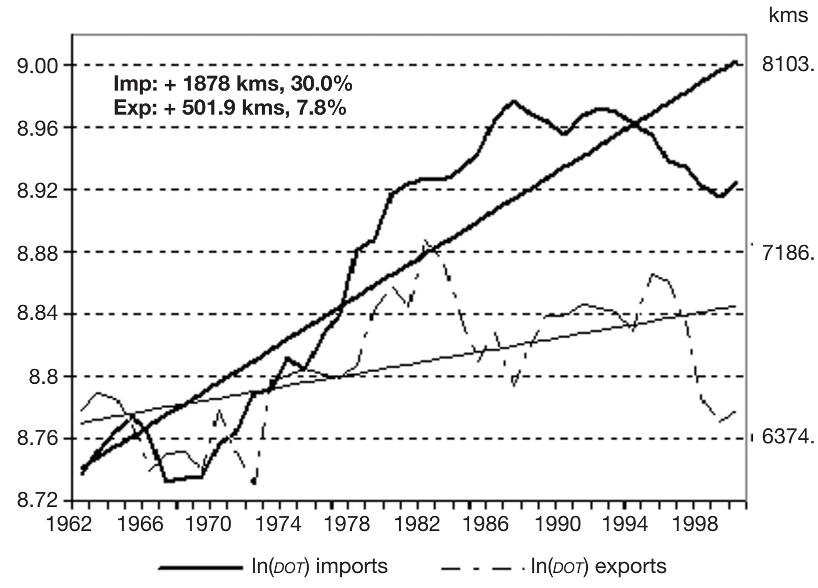
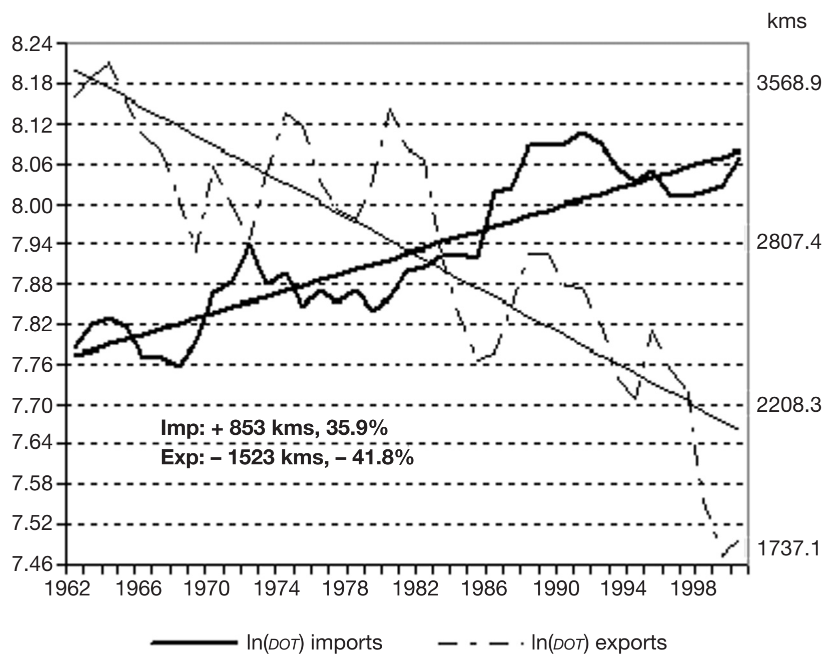


Figure 4. *Canada*



$\Delta DOT_w^M = 2.9\%$[1]. We also estimate the trend of the *DOT* for the average country in the world. This is done by running regression (3) on all (individual) country observations in the sample, and is also reported in Table 1[2]. 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.[3] Thus, about twice as many countries show an empirically significant negative change as opposed to a positive change in the *DOT* over time (77 to 39 countries or a ratio of 1.97).[4]

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).

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%).[5]

1. 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 $\Delta DOT_w^M \neq \Delta DOT_w^X$.

2. The 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).

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

4. The 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.

5. The 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].

The main results obtained thus far are:

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 theoretically and then empirically a series of hypotheses about the factors affecting the evolution of the *DOT* over time.

IMPACT OF TRADE COSTS AND OTHER FACTORS ON THE DISTANCE OF TRADE

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.

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

$$TC = L + DC. \tag{5}$$

Distance costs DC equal

$$DC = C_m m, \tag{6}$$

where m denotes distance and C_m "average cost per kilometer". C_m includes fuel costs and all other costs of operating ships, including overhead and costs of manning and leasing ships.[1] Combining (5) and (6), we have:

$$TC = L + C_m m. \tag{7}$$

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*.

1. Note that C_m need not be constant.

The log derivative of transport costs TC, *i.e.* the relative variation of TC $\left(\frac{dTC}{TC}\right)$, for a trip of given distance m, is

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

The derivative of $d(\log TC)$ with respect to m is:

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

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

$$\partial(d \log TC)/\partial m \gtreqless 0 \Leftrightarrow d(\log C_m) \gtreqless d(\log L). \tag{10}$$

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*.

Exchange Rates

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:

$$TC = L/\pi + C_m m, \tag{7'}$$

where π 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/π remains unchanged. However, if the exchange rate depreciation lags behind the rate of inflation, dwell costs L/π rise relative to distance costs and the *DOT* rises. On the other hand, a sudden devaluation has the opposite effect.

Note also that trade depends on bilateral real exchange rates and so that its impact on *DOT* 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 geography of the change in the real exchange rate (see p. 000).

Regional Integration

Regional integration agreements (RIAs) or trade blocs are typically formed between neighboring countries.[1] 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.

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*. 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*.

The Geography of 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*. 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 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.

1. On the actual 208 Preferential Trade Agreements in force in 2004 (*i.e.* notified to the GATT/WTO), 160 (77%) are implemented between countries of a same region. Source: World Trade Organization secretariat and Author's calculation.

Additional Determinants of Changes in *DOT*

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:

$$P_{ji} = (C_i + MU_i + DT_i + CC_i + L_i + D_{ij} + L_j)\tau_j + CC_j + DT_j + MU_j, \qquad (11)$$

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*, τ_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:

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

with

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

and

$$DC = D_{ij}\tau_j. \qquad (14)$$

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 4.1 and leads to a decline in the *DOT*. For instance, the cost of some tradable goods, 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 τ_j ? A given reduction in τ_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 τ_j (equation (13)). This raises the *DOT*. On the other hand, the reduction in τ_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*.[1]

1. 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 τ_{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.

Other aspects are also 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.

Note that lack of data prevented empirical estimation of the effects presented in section 4.5. on the *DOT*. However, an empirical analysis of the impact of the determinants developed in sections 4.1-4.4 is now provided.

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. 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).[1]

Table 2. *Large Sample (4,119 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}	5532,127	231,671	17134,090	2178,610
REG_{it-1}	8764,310	3014,544	18747,080	2034,281
P^{oil}_{t}	93,172	12,264	213,176	59,505
$Infra_{it}$	0,727	0,002	6,504	1,053

Reduced Sample (2,713 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	1570,454	17134,090	2313,019
REG_{it-1}	8579,234	3014,544	16950,240	2140,141
P^{oil}_{t}	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

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 15); $RER_{it} = NER^{*}_{it}\,(CPI_{US}/CPI_{it})$ 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; RELRER = index of distance-weighted changes in bilateral RER_{ijt} (see equation 16).

1. We tested for unit roots for panel data. The test (Im, Pesaran and Shin [2003]) significantly rejects the null hypothesis of unit roots.

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 columns of exports, imports and total trade). The estimated annual trend β 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.

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 [1996] 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 columns for exports, imports and total trade). The coefficient for 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.[1]

Regional Integration

We have two dummy variables for Regional Integration Agreements (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 and we want to test whether it has had a stronger impact on the *DOT*. The results are provided in Table 3 (third columns 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 significantly 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 around 60% of the trend in the *DOT* for imports.

1. Brun *et al.* [2005] 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.

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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
$\ln P_t^{oil}$		– 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 15).
** and * indicate significance at 5% and 10% respectively.

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 (Detailed estimation results on the individual impact of eight RIAs are provided). Nevertheless, as shown in table A.2, 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.

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:

$$\text{REG}_{it} = \frac{\sum_{j \neq i}^{N} d_{ij}(y_{jt} - y_{j,\, t-1})}{\sum_{j \neq i}^{N} (y_{jt} - y_{j,\, t-1})}, \quad j \neq i \, ; j = 1, \ldots, \text{N}. \tag{15}$$

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*,[1] 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.

Real Exchange Rate

We examine here the impact of the real exchange rate (RER) 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).

1. 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.

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 distances and lowers the *DOT*. This is shown in Table 4 (columns 2 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.

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

1964-2000	$\ln DOT_{it}$					
	Exports		Imports		Total trade	
t	0.0007	– 0.0002	– 0.0004*	– 0.0001	0.0003	– 0.0000
$\ln P_t^{oil}$	0.001	0.003	– 0.007**	– 0.008**	– 0.004*	– 0.006**
$\ln Infra_{it}$	– 0.002	0.000	– 0.014**	– 0.014**	– 0.012**	– 0.013**
RIA_{it}	– 0.106**	– 0.106**	– 0.031**	– 0.031**	– 0.059**	– 0.058**
EU_{it}	– 0.067**	– 0.047**	– 0.112**	– 0.111**	– 0.101**	– 0.093**
$\ln REG_{it-1}$	0.018	0.015	– 0.007	– 0.007	0.002	0.0009
$\ln RER_{it}$		– 0.069**		– 0.002		– 0.025**
$RELRER_{it}$		0.025*		– 0.037*		– 0.006
Constant	8.34**	8.14**	8.57**	8.58**	8.48**	8.41**
obs	2713	2713	2713	2713	2713	2713
$AdjR^2$	0.22	0.28	0.29	0.29	0.28	0.30

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 15); $RER_{it} = NER^*_{it} (CPI_{US}/CPI_{it})$ 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; RELRER = index of distance-weighted changes in bilateral RER_{ijt} (see equation 16).
** and * indicate significance at 5% and 10% respectively.

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}:

$$RELRER_{it} = \frac{\sum_{j \neq i}^{N} d_{ij} s_{ijt} \left(\frac{RER_{ijt} - RER_{ij,\,t-1}}{RER_{ij,\,t-1}} \right)}{\sum_{j \neq i}^{N} \left(\frac{RER_{ijt} - RER_{ij,\,t-1}}{RER_{ij,\,t-1}} \right)} \quad j \neq i \,;\, j = 1, \ldots, N, \qquad (16)$$

Table 2 presents a few statistics on RELRER_{it}, with the index normalized between values of zero and one. For any country i, RELRER_{it} increases when the increase (depreciation) in RER_{ijt} is larger for distant rather than for proximate countries. Thus, one would expect that when RELRER_{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 RELRER_{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 RELRER_{it} in equation (16).

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.

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 negative evolution of the *DOT* is compatible with falling trade costs as this evolution 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* 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*), and a geographic variable RELRER measuring changes in bilateral real exchange rates (positive for exports and negative for imports). These variables also have the expected sign, are significant, and explain the remaining negative trend for imports.

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APPENDIX 1

Data, Sample and Computations

This study is based on non-fuel trade data from 1962 to 2000 of 150 countries[1] 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 data.[2] 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),[3] 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 Venables [2001]; Brun *et al.* [2005])[4]. This 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.[5] Similarly, the correlation between this infrastructure index and a custom clearance index is – 0.59.[6]

1. 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.

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

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

4. 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, 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.

5. 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 [2002] for 1998.

6. 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 [2002] for 1998.

Table 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

Table 1. *(continued) – Trend (in percentage) in the Distance*[a)] *of:*

Country/Region	Exports		Imports		Total Trade	
	Coeff	*p*-value	Coeff	*p*-value	Coeff	*p*-value
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
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
Others[b)]	– 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) $100*\beta$, with β from $\ln(DOT_{it}^{Z}) = \alpha + \beta t + \mu_{it}$, $t = 1..39$, 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.

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

	No Change (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*
non OECD (76/128)	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*

* Countries in a regional integration agreement.
No Change: $|\Delta DOT_i^X| < 5.5\%$ 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 $\Delta DOT_i^M < -5.5\%]$
Positive 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 $\Delta DOT_i^M > 5.5\%]$
Opposite Changes: $[\Delta DOT_i^X < -5.5\%$ 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.[1] 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.

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 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.[2] 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)

	Imports			Exports		
year	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).

1. 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 [2003]), reducing the average bulkiness of trade.

2. 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.