The distance puzzle revisited: a new interpretation based on geographic neutrality*

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Abstract

One of the most remarkable features of globalization is the boost underwent by international trade triggered off by advances in technology that have contributed to reduce the cost of trade (e.g., transportation and communication costs). Under these circumstances, the importance of distance should have diminished over time, which would constitute a boon for countries located far from the main centers of economic activity. However, one of the best-established empirical results in international economics is that bilateral trade decreases with distance. This apparent contradiction has been labeled as the "missing globalization puzzle". We propose yet another explanation to this apparent contradiction based on the concept of geographic neutrality, which we use to construct international trade integration indicators for two different scenarios, namely, when distance matters and when it does not. Our results indicate that the importance of distance varies greatly across countries, as revealed by disparate gaps between distance-corrected and distance-uncorrected trade integration indicators for different countries. Some factors rooted in the literature explain away the discrepancies, but their importance varies according to the trade integration indicator considered—trade openness or trade connection.

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1. Introduction

The gravity model of bilateral trade is of primary importance in empirical analyses of trade patterns. Its simplest version states that trade interactions between two geographically defined economic entities (either countries or regions) are proportional to the size of these entities and inversely related to the distance between them (Combes, 2008). Not only has the model been utilized to further understand the underpinnings of trade flows in general but also to assess the role of their particular determinants such as distance, borders, currency unions, WTO membership, insecurity, institutions, etc. (Henderson and Millimet, 2008). According to these models, proximity is the main engine of trade between spatially distinct economic entities and, although this could *a priori* appear as an obsolete view of the world if one believes in the "death of distance" or the emergence of the "global village" (McLuhan and Fiore, 1968), there is a widespread reliance on the gravity model based both on its solid theoretical foundation, derived from several underlying theories (see, for instance, Anderson, 1979; Deardorff, 1998; Evenett and Keller, 2002) and the fact that it has proven empirically successful—explaining much of the variation in trade volume over time and space. In their meta-analysis study, Disdier and Head (2008) found that halving distance increased trade by 45%, and more recent analyses by these authors suggest that the distance effect has actually increased in recent years.

Based on these ideas, some authors such as Leamer and Levinsohn (1995) state that the gravity model provides "some of the clearest and most robust empirical findings in economics" (Leamer and Levinsohn, 1995, p.1384), whereas others such as Rose (2000) note that the gravity model provides a "framework with a long track record of success" (Rose, 2000, p.11). Anderson and van Wincoop (2003) concur: "The gravity equation is one of the most empirically successful in economics" (Anderson and van Wincoop, 2003, p.170). This successful performance of the gravity model for explaining bilateral flows has been recently boosted by the availability of a growing number of "natural experiments" in the form of regional trade agreements (Greenaway and Milner, 2002).

As recognized by the literature on international trade, the standard gravity models that are usually estimated in the log-linear form are unable to capture the significant decline in trade costs brought by globalization of the world economy. These ideas were initially noted by Leamer and Levinsohn (1995), who stated that "the effect of distance on trade patterns is not diminishing over time. Contrary to popular impression, the world is not getting dramatically smaller". Some authors refer to this as the "missing globalization puzzle" (Coe *et al.*, 2002, 2007). Other recent proposals refer to it as "the conservation of distance in international trade" (Berthelon and Freund, 2008), "the puzzling persistence of the distance effect on bilateral trade" (Disdier and Head, 2008), or the question is even more strongly posed when asking whether "has distance died?" (Brun *et al.*, 2005), or when stating that "it is alive and well" (Carrere and Schiff, 2005). The number of studies on the issue is substantial, and the meta-analysis by Disdier and Head (2008) provides a useful summary, concluding that the estimated negative impact of distance on trade rose around the middle of the twentieth century, has remained persistently high since then, and such a result holds even after controlling for the heterogeneity in samples and methods across studies.

In this paper we suggest yet another solution to the "missing globalization puzzle" in the gravity equation. We build on Arribas *et al.* (2009), who construct indices of international trade integration taking into account some relevant yet somehow "forgotten" ideas by the international economics literature, namely, the Standard of Perfect International Integration devised by Frankel (2000), and the concept of geographic neutrality (Kunimoto, 1977; Krugman, 1996). Considering also some ideas derived from network analysis theory, whose importance for trade has been recently revealed by Kali and Reyes (2007), Arribas *et al.* (2009) construct an indicator of international trade integration decomposable into two components aimed at measuring both how trade open and how connected economies are.

Our solution to the missing globalization puzzle is based on a modified version of Arribas *et al.*'s (2009) indicators of integration. Motivated by the robust empirical regularity that bilateral trade flows between pairs of countries are explained well by the product of their gross domestic products (GDPs) and, very importantly, their bilateral distance, we include the latter when building our measures of trade integration. Specifically, we construct indicators for which both inter-country and intra-country distances are taken into account, since both are relevant for countries' imports and exports as documented not only by the literature on gravity equations (in the case of inter-country distances) but also by Alesina and Spolaore (1997) (in the case of intra-country distances) and, in general, the literature on the home market effect hypothesis (big countries produce more of goods with scale economies). The comparison of both sets of indices (distance-corrected and distance-uncorrected) enables carrying out a new assessment of the role of distance for determining international trade flows.

The rest of the article is structured as follows. Section 2 presents the methodological contents of our approach to measure international trade integration. Sections 3 and 4 present the data set and empirical application, respectively, by considering data on exports of goods for a wide set of countries that account for most of world output and trade, and for a relatively long sample period (1967–2005). Section 5 explores the determinants of the discrepancies between the original and distance-corrected trade integration indicators. Finally, Section 6 concludes.

2. Defining distance-corrected integration indicators

The first component of international trade integration we consider is a modified version of the standard trade openness indicator ($(X + M)/GDP$). The second component is derived from the inclusion of the structure of the current trade relations between countries—what some authors have labeled the "architecture" of trade flows (Kali and Reyes, 2007). Relevant aspects of this architecture include the number of trade partners, the proportionality of trade flows to the size of the partners,[1] and the role of barriers—particulary distance.

In order to characterize a benchmark of trade integration, we define an extension of the concept of geographic neutrality (Kunimoto, 1977; Krugman, 1996; Iapadre, 2006) closely related to the Standard of Perfect International Integration (SPII) by Arribas *et al.* (2009):[2] "geographically neutral" trade exists when country B's share of A's exports is equal to B's share of gross world product outside A (Krugman, 1996, p.64). Our notion of integration shares with the SPII by Arribas *et al.* (2009) that it also verifies the properties of domestic neutrality, direct international neutrality and size, but differs in the consideration of the distance as a key factor. More precisely, our definition of SPII also integrates the Samuelson's (1954) standard iceberg assumptions, thus we consider that the flow between two economies not only is proportional to their relative sizes but also depends inversely on the distance between the economies. In short, under our neutrality assumption the following properties must be verified:[3]

Domestic neutrality: An economy whose domestic demand is proportional to its share of the world economy will have a higher level of integration.

Direct international neutrality: An economy that balances its direct relations with other individual economy, in proportion to their sizes and inversely to their distances will have a higher level of integration.

In order to analyze the extent to which economies meet the two properties mentioned above, we must define an integration index, and measure the gap between the current level of integration and the SPII. We will proceed in three stages, each one defining different indicators.

2.1. Notation

Let N be the set of economies and let i and j be typical members of this set. Even when the following definitions should be indexed by the year, to clarify notation that index will be dropped.

[1]This approach has several links with the literature on social networks. See, for instance, Annen (2003), Hanneman and Riddle (2005), Karlin and Taylor (1975), Wasserman and Faust (1992), or Wellman and Berkovitz (1988).

[2]See originally Frankel (2000).

[3]See Arribas *et al.* (2009) for further details

Let Y_i be the size of economy $i \in N$, for example its GDP, let d_{ij} be the geographic distance between the economies i and j, and let d_{ii} be economy i's internal distance.

In order to compare economies that are not contiguous, we follow Samuelson's standard "ice-berg" assumption considering that if a economy j of size Y_j gets as close to economy i as possible, then its size will be reduced to Y_j/d_{ij}^{θ} (i.e., as stated by Samuelson (1954), "only a fraction of ice exported reaches its destination as unmelted ice"), where θ is a non-negative parameter which measures the impact of distance (the farther away economies are, the greater the reduction, with an intensity that depends on the θ parameter). In the extreme case in which $\theta = 0$ the "iceberg" effect disappears.

We define r_i as the economy i's relative weight with respect to a world economy where the correction through distance has been performed (distance corrected world) i.e., $r_i = (Y_i/d_{ii}^{\theta})/\sum_{j\in N}(Y_j/d_{ij}^{\theta})$. Notice that: (i) we also consider that there exists an iceberg effect on the home economy, (due to countries' differing geographic sizes) or, equivalently, that transportation cost exists both for inter- and intra-national trade; (ii) the above definition does not depend on the units of measurement for the distance between economies given that r_i can be written as $r_i = Y_i/\sum_{j\in N}(Y_j/(d_{ij}/d_{ii})^{\theta})$. This expression enables re-interpreting the effect of the geographic distance as the one given by a normalized distance matrix between economies where every internal distance of the economies is 1 and the distance from economy i to economy j is d_{ij}/d_{ii}, the times the geographic distance between these economies is bigger than the economy i's internal distance; and (iii) the impact of the distance depends on the θ parameter. In a world where the distance is irrelevant, $\theta = 0$ (geographic neutrality).[4]

Given a measurable relationship between economies, we define the flow X_{ij} as the intensity of this relationship from economy i to economy j. The flow between economies can be evaluated through either the imports or the exports of goods, capital, or any other flow measured in the same units as Y_i. Moreover, in general the flow will be asymmetric, so that X_{ij} will not necessarily be equal to X_{ji}, for all $i, j \in N$. We also assume that $X_{ii} = 0$ for all economy $i \in N$.[5] All definitions in the paper depends on the flow considered to measure the international integration.

2.2. Definitions

The following definitions are based on those in Arribas *et al.* (2009) but adapting them so as to control for distance—both internal and between countries. In this section we present the mathe-

[4]As suggested by one referee, the iceberg type transport costs could be modeled differently, by using $\tau^{\theta d_{i,j}}$ or $1+d_{ij}^{\theta}$. Although this alternative modeling could have some benefits, they are overshadowed by the costs of making a direct comparison with our proposal.

[5]Obviously, this is a remarkable assumption. However, we do not have this information for all 59 countries and the 1967–2005 period.

matical definitions and we address the readers to the article by Arribas *et al.* (2009) for further details.

Degree of Openness

First we characterize the *degree of openness* assuming that output is not domestically-biased—i.e., it is not biased towards domestic demand. In order to remove the domestic (or home) bias we define $\widehat{Y}_i$ as the flow from economy i to the world controlling for the weight in the distance-corrected world economy of the economy under analysis, namely, $\widehat{Y}_i = Y_i - r_i Y_i$. Then, we define the relative flow or **degree of openness** between economies i and j as $DO_{ij} = X_{ij}/\widehat{Y}_i$. Given that $X_{ii} = 0$, it follows that $DO_{ii} = 0$ for all $i \in N$.

Definition 1 *Given an economy $i \in N$, we define its* ***degree of openness****, DO_i, as*

$$DO_i = \sum_{j \in N} DO_{ij} = \frac{\sum_{j \in N} X_{ij}}{\widehat{Y}_i}. \tag{1}$$

We write DO instead of DO_i when general statements on the degree of openness are being made, or references to the variable itself, which do not hang on any specific economy. The same rule will be applied to the other indicators.

Degree of Balanced Connection

In the second stage we analyze the "trade architecture" (Kali and Reyes, 2007), i.e., whether the connection of one economy with others is proportional to their sizes in terms of GDP,[6] or whether this connection does not show geographical neutrality. Thus, we define the *degree of balanced connection* to measure the discrepancy between the trade volumes in the real world and those corresponding to the SPII.

In the trade network, the relative flow from economy i to economy j in terms of the total flow of economy i, α_{ij}, is given by

$$\alpha_{ij} = \frac{X_{ij}}{\sum_{j \in N} X_{ij}} \tag{2}$$

(recall that we are assuming $X_{ii} = 0$). Let $A = (\alpha_{ij})$ be the square matrix of relative flows: the component ij of matrix A is α_{ij}.

We consider that the distance-corrected world economy is perfectly connected if the flow between two economies is proportional to their relative sizes (geographically neutral trade). Thus, if the world trade is neutral (which would be a "perfectly connected world economy", following the

[6]The dependence of both the number and magnitude of exchanges on economy size is the focus of international trade analyses based on gravity models and widely used in the literature (Hummels and Levinsohn, 1995; Feenstra *et al.*, 1998, 2001; Rauch, 1999).

SPII nomenclature), then the flow from economy i to economy j should be equal to $\beta_{ij}\widehat{Y}_i$, where

$$\beta_{ij} = \frac{Y_j/d_{ij}^{\theta}}{\sum_{k\in N\setminus i}(Y_k/d_{ik}^{\theta})} \tag{3}$$

is the relative weight of economy j in a distance-corrected world where economy i is not considered.

Note that $\sum_{j\in N\setminus i}\beta_{ij} = 1$ and that β_{ij} is the degree of openness between economies i and j in the "perfectly connected world" (i.e., the world in which trade is geographically neutral), with $\beta_{ii} = 0$. Let $B = (\beta_{ij})$ be the square matrix of degrees of openness in the geographically neutral trade world ("perfectly connected world").

Definition 2 *Given an economy $i \in N$ we define the **degree of balance connection** of i, DBC_i, as*

$$DBC_i = \frac{\sum_{j\in N}\alpha_{ij}\beta_{ij}}{\sqrt{\sum_{j\in N}(\alpha_{ij})^2}\sqrt{\sum_{j\in N}(\beta_{ij})^2}}. \tag{4}$$

Degree of Integration

We construct the *degree of integration* by combining the degree of openness and the degree of balanced connection defined above:

Definition 3 *Given an economy $i \in N$ we define its **degree of integration**, DI_i, as*

$$DI_i = \sqrt{\min\{DO_i, 1/DO_i\}\cdot DBC_i} \tag{5}$$

Note that for both components of DI we set limits to the integration level achieved. Therefore, our indicators consider the two main regressors included in any gravity equation, i.e., the size of the trading partners, and the distance between them. One of their advantages is that, instead of providing us with information as to whether these variables are important for trade flows, it will be possible to measure the gap from the scenario of complete trade integration in goods under different hypotheses on the impact of distance (on the "iceberg" effect).[7]

3. Data presentation

We consider the international economic integration indicators defined above to study the evolution of international trade. Some modifications on the indices would enable analyzing also other types of integration such as international financial integration. Our application is restricted to trade

[7] We admit the way to aggregate both partial indices (DO and DBC) is somewhat *ad hoc*. However, our main point is that it is important for trade integration considering both effects, regardless of the way they are combined.

flows only, for which it is required information on the volume of activity (GDP) for each country together with their trade flows with the rest of the world.

Data on bilateral trade flows come from the data set `CHELEM`.[8] They correspond to 59 countries accounting for 96.7% of world output and 86.5% of international trade. The variable selected to measure the flows between countries is the volume of exports.[9]

The available information covers a relatively long period of time, from 1967 to 2005, covering entirely what some authors have labeled the second wave of globalization (O'Rourke and Williamson, 1999, 2002; Maddison, 2001). The data set also contained information for other countries, yet it was not available for all sample years, thus we finally decided not to include it.

The same institution providing data on trade flows and GDP (CEPII, Paris) provides also other relevant pieces of required information such as distance. Two types of distances are considered. The distance from country i to country j (external distance, d_{ij}) is measured by the distance between the main city of the country which, in most cases, is the capital of the country. The data set also provides data for *internal* distances (d_{ii}), as also required by our indices. See Head and Mayer (2002) for details.[10]

Our analysis is restricted to trade in goods. Since specialization patterns vary across countries, there is a bias for our indices which will affect countries differently. However, extending the analysis to account for trade in services is not possible, since there is no services equivalent to the matrix of trade in goods between country pairs.

4. Results

4.1. Degree of openness, degree of balanced connection and degree of integration

As indicated in Figure 1.a, on average, the degree of openness has more than doubled (for $\theta = 0$) and almost tripled (for $\theta = 1$) from 1967 to 2005. Comparing $DO_i^{\theta=0}$ to $DO_i^{\theta=1}$, accounting for distance makes the degree of openness increase from 32.09% to 40.71% (year 2005). Figure 1.a shows the evolution of $DO^{\theta=0}$ and $DO^{\theta=1}$ summary statistics (mean, weighted mean, and median). In all cases there is a sharp increase, although the effect is dimmed for the larger countries (weighted mean), especially under geographic neutrality ($\theta = 0$).

Results for the degree of global openness (DGO) correspond to the evolution of the weighted

[8] Information on `CHELEM` (*Comptes Harmonisés sur les Echanges et l'Economie Mondiale*, or Harmonised Accounts on Trade and The World Economy) database is available at `URL` `http://www.cepii.fr/anglaisgraph/bdd/chelem.htm`. Data compiled by CEPII, Paris.

[9] The computations for indicators based on imports do not alter the general results, although they may differ for some specific countries. These results are not reported due to space limitations, but are available from the authors upon request.

[10] See also `www.cepii.fr/anglaisgraph/bdd/distances.htm`.

mean in both upper panels in Figure 1. They are also reported in Table 1. The values are reported explicitly given our specific interest in measuring trade integration. It would suggest *how open* the world economy is, and it is apparent that if we recognize that distance matters (including it explicitly to construct the indicators), the level of openness is higher. In both instances, however, the degree of openness advances at a similar pace: in the economy where distance is irrelevant ($\theta = 0$), the increase is from 8.03% to 20.84%, and in case location mattered ($\theta = 1$), the increase is higher (from 12.13% to 32.27%). However, the analysis by subperiods discloses additional results: under $\theta = 0$, the highest increase took place after 1986, whereas for $\theta = 1$ it occurred before. This finding may be explained by the role of countries such as Japan, which is big in GDP terms (therefore its behavior affects the evolution of DGO), which is distant, and whose $DO_i^{\theta=0}$ increased sharply before 1986.

Figure 1.b displays results for the degree of balanced connection under the two scenarios ($DBC_i^{\theta=0,1}$). The most apparent feature is that they are much closer to the economies' theoretical full potential for connection (100%) than DO, particularly when distance matters ($\theta = 1$). However, the average increases have been more modest than in the degree of openness case, also because initial levels were already high. These tendencies are common under geographic neutrality and $\theta = 1$, although the increase has been even more modest in this last case. The values corresponding to the degree of global balanced connection $DGBC$ are also reported in Table 1. In contrast to the result obtained for the degree of openness, the wealthier countries (as indicated by the weighted mean) are those with the highest degrees of balanced connection. These values peaked before the 1990s. The most interesting results, however, emerge when dropping the physical irrelevance assumption and distance enters the analysis, since now all countries lie above $DBC = 70\%$. Therefore, once the downward impact of distance on the volume of trade is controlled for, countries export more "proportionally" to the size of their trading partners. In other words, if as found and predicted by gravity models distance matters, and its importance does not seem to diminish strongly over time despite the decline in transportation costs, the current level of balanced connections would already be high. However, the balance would be lessened from the perspective of a global village, where the role of remoteness disappears.

The degree of integration results from combining the effects of the DO and the DBC. The evolution of the basic summary statistics is reported in Figure 1.c. The relevant message is not only that it indicates the level of international trade integration achieved by each country but, more importantly, that it indicates how far each country is from its theoretical full potential for integration. In general, countries are more integrated when controlling for distance, although there are some exceptions to this rule, whose degrees of integration decrease. The interpretation for these particular cases is straightforward: these are countries whose export flows suffer from a "distance bias", the major trading partners for these countries are remotely located—i.e., in the case of distance being relevant, they should export more to their geographic neighbors. Therefore, it is obvious that this type of result only arises for countries sharing several characteristics, among which we might consider the fact of being surrounded by developing countries (e.g., Algeria, Gabon, Nigeria, Pakistan and, to a lesser extent, Chile) or being highly exporting countries whose trading partners are physically distant (China, Malaysia and Singapore). The specific values for the degree of global integration (DGI) are reported in Table 1. The general assessment of the level of world integration (DGI) as of 2005 is that, in the case of distance still being relevant, we are already halfway to the theoretical full potential for global trade integration. However, from the "global village" perspective in which distance becomes an irrelevancy, the process is still in a previous stage, since the degree of global integration decreases sharply (from 50.96% to 35.48%). However, the variety of behaviors is wide: the standard deviation (not reported) has increased sharply (although the coefficient of variation has declined due to the growing average), and probability mass becomes increasingly spread, suggesting that some countries are quite close to the unity, yet many others are still far—although the prevailing picture is that trade integration is advancing.

5. Analyzing the determinants of the distance trade bias

Figure 2 provides a preliminary view on the changing role of distance over the 1967–2005 period. It shows the evolution of the $DGO^{\theta=1}/DGO^{\theta=0}$, $DGBC^{\theta=1}/DGBC^{\theta=0}$ and $DGI^{\theta=1}/DGI^{\theta=0}$ ratios, which has been rather disparate. Whereas all three indicators departed from similar values (ranging in the $]1.4, 1.6[$ interval), the $DGO^{\theta=1}/DGO^{\theta=0}$ increased until the mid nineties, and then decreased to virtually the initial value. The evolution of the $DGBC^{\theta=1}/DGBC^{\theta=0}$ has been opposite, but much more attenuated. $DGI^{\theta=1}/DGI^{\theta=0}$ shows their combined effect.

We consider that large discrepancies among distance-corrected and distance-uncorrected values of our trade integration indicators constitute an equivalent to the persistence of the distance coefficient in gravity equations. The basic version of these models considers that trade between country i and a number of partner countries j, T_{ij}, is a function of GDP of both country i (Y_i) and country j (Y_j), and geographic distance between the two countries, $DIST_{ij}$. Therefore, the following model and the like are generally estimated,

$$\ln T_{ij} = \beta_0 + \beta_1 \ln(DIST_{ij}) + \beta_2 \ln(Y_i) + \beta_3 \ln(Y_j) + \varepsilon_{ij} \tag{6}$$

where ε_{ij} is the error term. The r.h.s. in Equation (6) is usually enlarged so as to control for common language, land border, and colonizer, the condition of being landlocked, the existence of a free trade area, and sometimes a common currency.

As we have documented, discrepancies among distance-corrected and uncorrected trade integration indicators vary a great deal both on average but, most importantly, across countries. This entails that the effect of distance *is not homogeneous* across countries and, therefore, the estimated β_1's in Equation (6) might be country-dependent implying that, when tackling the issue of whether "distance has died" or not, we should temper the statements by adding that distance is still significant *on average*. Some authors have indeed pointed out that nonlinearity may be the problem. For instance, Coe *et al.* (2007) estimate a gravity equation with an additive error term and find that there was some decline in the distance coefficient. Other authors also point out this varying effect across countries, by considering that geographic distance is a proxy for unfamiliarity and that exporters in high uncertainty-aversion countries are more sensitive to informational ambiguity (Huang, 2007).

We explore now some covariates which could contribute to explain the different role of distance for different countries. Some of them are variables capturing the existence of regional trade agreements. Although there is a wide range of different forms of integration arrangements, including free trade areas, customs unions, and preferential trading areas, we use RTAs as a generic descriptor (Greenaway and Milner, 2002). Some authors consider regionalism might enhance short-distance trade and therefore be the most obvious explanation for the non-declining role of distance (Berthelon and Freund, 2008), whereas technological improvements might favor long-distance trade. Indeed, Hummels (1999) finds that containerization reduced the relative cost of distance. As indicated by Alesina and Spolaore (1997), trade blocs (which they label as political integration) harm economic integration, which is the reason why economic integration is usually found to be low for members of free trade agreements.

Although there are currently more, we consider only the most important RTAs, namely, the European Union, NAFTA, MERCOSUR and ASEAN. These are major RTAs in Europe, America and Asia, although a relatively small but growing number apply to the trade of developing countries. Most applications of the gravity model have also searched for evidence of actual or potential effects by adding dummy variables for membership of a particular RTA. We add a related variable whose importance is not always considered by the literature, namely, the number of years each country has been member of its corresponding RTA. By including this dummy variable, we will be able to test whether there is an identifiable RTA effect, and to recognize those variables on which the RTAs' dummies may have stronger effects. In addition, it constitutes a good proxy for the depth of the commercial links between the different trading partners.

We also include in our regressions the GDP of each country—recall that since we have constructed country-specific indicators we do not use bilateral information. Gravity equations find generally that the economic size of each partner is a significant explanatory variable for the trade volumes between them. In our specific setting, the equivalent result would be that country i's GDP is significant. Not only has the general literature on gravity equations documented this issue but also Alesina and Spolaore (1997) among others, who argue that bigger domestic markets constitute important incentives for large countries to trade less. As also indicated by Brun *et al.* (2005), trade tends to constitute a smaller percentage of GDP for larger countries.

We include in our regressions some of each country's specialization patterns. There is a vast literature on the effects of specialization on trade (see, for instance Redding, 2002). The changing composition of trade has been found to be an explanation for the stability over time of the estimated distance coefficients in gravity equations (Coe *et al.*, 2002). As indicated by Berthelon and Freund (2008), the increase in the importance of distance, estimated using aggregate gravity regressions could be due to an increase in the share of trade accounted by distance-sensitive products. Indeed, these authors find that distance has become more important for *some* industries. Thus, this information is crucial for explaining whether the effect of distance is still there or not, since there are some products which will be traded intensely regardless of where trading partners are located. In addition, in many cases the countries surrounding the main producers of these products have similar specializations, which makes the role of distance even more prominent.

One of the most widely accepted indicators of a country's trade specialization is the Balassa (1965) "Revealed Comparative Advantage" (RCA) index (see further discussion in, for instance Leamer and Levinsohn, 1995), defined as:

$$RCA_{ij} = \frac{X_{ij}/\sum_j X_{ij}}{\sum_i X_{ij}/\sum_i \sum_j X_{ij}} \tag{7}$$

where the ratio in the numerator is the share of country j in sector i world exports, whereas the ratio in the denominator represents the same share for total merchandise exports. Those cases where the index takes values less than 1 indicate these are sectors in which a country is relatively less specialized with respect to the world economy. Values of the index greater than 1 denote sectors in which a country is relatively more specialized with respect to the world economy. However, although this index has the advantage of being a comprehensive indicator of the concept of specialization, there are no clear theoretical foundations for this measure (Brasili *et al.*, 2000).

Although it was possible to consider a sectoral classification with highest level of detail, our data covers 10 sectors, which coincides (in terms of number of sectors) with previous studies such as Chen *et al.* (2009). We consider this is a reasonable balance, since reducing the number of sectors would imply aggregating some relevant information. These sectors include construction, basic metals, textiles, wood paper, metal products, chemicals, mining, energy, agriculture, and food products. It also includes a miscellaneous category for the remainder.

Therefore, we estimate three basic models, since we analyze the impact of the selected covariates in our three main indicators (openness, connection, integration). We also analyze some of their variants, by combining in different ways the set of determinants. If we refer to the ratio $D^{\theta=1}/D^{\theta=0}$ as the general expression for the three ratios $DO^{\theta=1}/DO^{\theta=0}$, $DBC^{\theta=1}/DBC^{\theta=0}$ and $DI^{\theta=1}/DI^{\theta=0}$, then the model to be estimated presents the following general form:

$$D_{it}^{\theta=1}/D_{it}^{\theta=0} = \alpha_i + \beta_1 GDP_{it} + \gamma' \sum_j RCA_{ijt} + \beta_4 YRTA_{it} + \beta_5 RTA_{it} + \varepsilon_{it} \tag{8}$$

where GDP_{it} is the logarithm of country i GDP in year t, RCA_{ijt} is the Balassa Revealed Comparative Advantage index for country i, sector j and year t, $YRTA_{it}$ are the numbers of years country i is member of its corresponding RTA (if this applies) in year t, and RTA_{it} is a dummy variable which takes the value of 1 for countries members of the RTA considered. We include the t subscript so as to account for the time dimension of the role of distance. As indicated by Brun *et al.* (2005), if using cross-section to estimate Equation (8) and the like, there are potential problems. Some of them are related to the heterogeneity not captured by dummy variables, which could cause biased estimates. Others are related to the omitted-variables bias to which typical ordinary least squares estimates may be prone to. Therefore, we estimate Equation (8) using cross-section fixed effects, which are included in the α_i parameter, so that the unobservable heterogeneity is partly addressed.

However, the impact of the different RTAs on distance might be involved, since RTAs differ in many respects. For instance, in Europe integration goes beyond merely establishing a free trade area, since both capital and labor can move freely and there is an even more ambitious initiative for political integration with the European Constitution. This is a big contrast with the features of NAFTA, where free flow of labor across member estates is not possible. Therefore, we consider relevant to analyze separately each particular RTA might affect distance by considering four simpler versions of Equation (8) in which the RTA variable is substituted by EU, $NAFTA$, $ASEAN$ and $MERCOSUR$ variables.

Table 2 shows estimation results for Equation (8) in which the dependent variable is $DO^{\theta=1}/DO^{\theta=0}$, whereas Table 3 and Table 4 show the same information for $DBC^{\theta=1}/DBC^{\theta=0}$ and $DI^{\theta=1}/DI^{\theta=0}$, respectively. Table 2 indicates that the effect of GDP on distance—as measured by larger discrepancies among $DO^{\theta=1}$ and $DO^{\theta=0}$—is positive. This implies that for big economies openness is strongly affected by distance, as heavily documented in the literature (home market effect hypothesis). This coefficient is positive and significant at the 1% significant level throughout.

In contrast, the share of total energy in each country's exports ($ENERGY$) affects negatively and significantly throughout the discrepancies between $DO^{\theta=1}$ and $DO^{\theta=0}$. This result is reasonable, implying that high energy-exporting countries are those whose openness is less affected by distance (their volume of exports is not determined by the location of their trading partners), whereas the opposite pattern holds for low energy-exporting countries. This effect does not hold for other specializations such as $AGRICULTURE$ and $FOOD\_PRODUCTS$, whose sign is positive throughout—albeit not significant.

The variables related to free trade areas must be commented on jointly, given there are non-negligible interactions among them. Countries with the highest $DO^{\theta=1}/DO^{\theta=0}$ ratios are those more affected by distance when evaluating their openness. However, as indicated by the last column in Table 2 (corresponding to Model 5), being member of a regional trade agreement (RTA variable) affects negatively $DO^{\theta=1}/DO^{\theta=0}$ or, equivalently, countries adhered to RTAs are less affected by distance in their degrees of openness. This sign is dominated by the negative and significant coefficient (at the 1% level) found for EU (Model 1), and constitutes a reasonable result, given that many EU countries are quite open—especially to their RTA partners. Yet not all RTAs contribute in the same amount, since only EU and $ASEAN$ show significant relationships (in the case of $ASEAN$, at the 10% significance level only), whereas both $NAFTA$ and $MERCOSUR$ are negative albeit non-significant. Therefore, one may easily infer it is relevant to consider the different trade agreements separately due to their varying effects on the dependent variable. Finally, we also analyze the "depth" of the free trade agreements, as measured by $YRTA$, whose sign is negative and significant (1%) throughout, i.e., the longer the durability of the RTA, the less relevant the effect of distance—as revealed by lower discrepancies between $DO^{\theta=1}$ and $DO^{\theta=0}$. Therefore, it seems that once a particular country becomes member of a RTA, the effect of distance shortly turns as relevant as for older members.

We now turn to the analysis of the impact of each covariate on $DBC^{\theta=1}/DBC^{\theta=0}$. In general, as revealed by Table 3, results vary remarkably with respect to those in Table 2, constituting further evidence on how different the economic meanings of the degree of openness and the degree of balanced connection are. Indeed, in many instances the sign of the relationships is reversed, corroborating that DO and DBC are but different ways through which economies become more trade integrated.

The impact of GDP on $DBC^{\theta=1}/DBC^{\theta=0}$ is negative and significant throughout. Countries for which this discrepancy is high are those whose trading partners (both in terms of number and *proportionality*) are close—i.e., once we control for distance, the DBC increases sharply. This means that large countries, in terms of GDP, export more *proportionally*, both in terms of distance and size of their trading partners. This finding might constitute a certain surprise for some large countries like the US, whose exports to Canada are higher than those to distant and large countries such as Germany. However, for some some other big economies, not only Germany itself but also Japan, China or India, exports are more geographically neutral—these countries export regardless of the location of the importing countries, and in proportion to their relative sizes.

The specialization variables are not entirely coincidental either when comparing Table 2 and Table 3, and some results are intricate. However, in some cases the sign of the coefficient is what one may *a priori* expect. For instance, although the coefficient of $AGRICULTURE$ is not significant in Table 2, in Table 3 it is positive and significant at the 1% level, implying that for those countries more specialized in agriculture (according to the RCA index of specialization) distance is quite relevant—the DBC index rises sharply when comparing $DBC^{\theta=0}$ and $DBC^{\theta=1}$. Therefore, these countries, given their specialization in agricultural products (generally perishable, and object of preferential trade agreements), use to export to their neighbors, and consequently are not affected by geographically-neutral trade.

The variables related to free trade area membership do also show dissimilar patterns when comparing results in Table 2 and Table 3. The general effect (RTA) is not reversed, but it loses significance entirely. However, this outcome is the combination of opposed effects. On the one hand, analogously to what was found for DO (Table 2), the effect of $ASEAN$ is negative and significant—but now the significance is much higher (1%). In contrast, all EU, $MERCOSUR$ and $NAFTA$ not only are significant but, most importantly, the sign of the coefficient is positive. Again, the effect of free trade area membership varies across the different trade agreements. In the particular case of EU, $MERCOSUR$ and $NAFTA$ the positive effect indicates that the architecture of trade relations of their members is positively biased towards other members of the agreement. In the case of $ASEAN$, however, the effect is the opposite, and the bias exists towards non-members of the free trade agreement.

Table 4 shows the effect on $DI^{\theta=1}/DI^{\theta=0}$ of the different explanatory variables. Since DI is constructed as a square root of the product of DO and DBC, the results in Table 4 are those one might expect by combining results in Table 2 and Table 3. However, since the degree of openness and the degree of connection convey different economic meanings, results in Table 4 are involved, consisting basically of a dominance effect—i.e., the sign of each coefficient is derived from the effect that actually dominates the relationship.

In those cases in which the effects are opposite, significance is generally lost. That is the case of

GDP, whose impact on $DI^{\theta=1}/DI^{\theta=0}$ is negative, albeit non-significant—as a result of a positive and significant effect on $DO^{\theta=1}/DO^{\theta=0}$ and a negative and significant effect on $DBC^{\theta=1}/DBC^{\theta=0}$. In the case of some particular specializations such as $ENERGY$, its negative and strongly significant effect on the degree of balance connection dominates, resulting into a positive and significant effect on the degree of integration in all models. However, there were other cases such as $CHEMICALS$ and, to a lesser extent, $MINING$ in which both the sign of the relationship and the significance coincided and, therefore, the impact on the degree of integration is maintained.

The impact of the free trade area variables is more involved. In general, the sign of the relationship coincides with the sign and significance found for the degree of connection (Table 3), with the exception of RTA for which significance is lost. Therefore, it seems for these variables (EU, $NAFTA$, $ASEAN$, $MERCOSUR$ and the summary variable, RTA), the importance of the degree of openness is dimmed with respect to the degree of connection.

6. Conclusions

Since the emergence of the study by Leamer and Levinsohn (1995), many research initiatives have debated about the apparent inconsistency of declining trade-related costs (at least for some products) and a highly negative and significant coefficient of distance in gravity equations, which does not diminish over time. Some authors (Anderson and van Wincoop, 2004) claim such inconsistency might not be real when realizing that technology growth in shipping advanced more slowly than the rest of the economy during the XX[th] century and, consequently, transport costs might have increased as a fraction of average marginal production costs. However, this interpretation has not been widely accepted, and there is a non-negligible body of the literature that has explored different explanations for this inconsistency (since with globalization one would expect the distance coefficient to decline over time).

We provide yet another explanation for this "missing globalization puzzle", as coined by Coe *et al.* (2002), also labeled as "the conservation of distance in international trade" (Berthelon and Freund, 2008). Much of this evidence is framed within the context of gravity equations, as indicated by the meta-analysis by Disdier and Head (2008). Alternatively, we adopt a different stance, basing our explanation on the construction of two sets of indicators on economic integration, one of them controlling for distance, the other distance-uncorrected. These indicators are based on the geographical neutrality concept by Krugman (1996) and the Standard of Perfect International Integration by Frankel (2000).

Results indicate that the discrepancies found among both sets of indicators (distance-corrected and distance-uncorrected) have a non-negligible dynamic component, since the importance of distance increased until the mid-nineties, but has returned to 30 years ago levels. This implies that, according to our indicators, the role of distance, *on average*, is still there.

However, it is a more interesting result that discrepancies among distance-corrected and distance-uncorrected indicators differ a great deal across countries, i.e., the effect of distance is there, but the impact on each country's level of integration is varying. A mere cursory look to the different levels on integration for the different countries in our sample will promptly suggest that the pattern might not be entirely random. Accordingly, we explore some factors (without establishing a proper theory) that might explain these discrepancies, finding that GDP, specialization and regional trade agreements contribute to explain the heterogeneity. Yet for some of the explanatory variables the relationship is rather involved, since RTA membership affects distance depending on each particular RTA.

References

Alesina, A. and Spolaore, E. (1997). On the number and size of nations. *Quarterly Journal of Economics*, 112:1027–56.

Anderson, J. E. (1979). A theoretical foundation for the gravity equation. *American Economic Review*, 69:106–116.

Anderson, J. E. and van Wincoop, E. (2003). Gravity with Gravitas: A Solution to the Border Puzzle. *The American Economic Review*, 93(1):170–192.

Anderson, J. E. and van Wincoop, E. (2004). Trade costs. *Journal of Economic Literature*, 42(3):691–751.

Annen, K. (2003). Social capital, inclusive networks, and economic performance. *Journal of Economic Behavior & Organization*, 50:449–463.

Arribas, I., Pérez, F., and Tortosa-Ausina, E. (2009). Measuring globalization of international trade: Theory and evidence. *World Development*, 37(1):127–145.

Balassa, B. (1965). Trade liberalisation and "revealed" comparative advantage. *The Manchester School*, 33(2):99–123.

Berthelon, M. and Freund, C. (2008). On the conservation of distance in international trade. *Journal of International Economics*, 75:310–320.

Brasili, A., Epifani, P., and Helg, R. (2000). On the dynamics of trade patterns. *De Economist*, 148(2):233–258.

Brun, J., Carrere, C., Gillaumont, P., and de Melo, J. (2005). Has distance died? Evidence from a panel gravity model. *World Bank Economic Review*, 19:99–120.

Carrere, C. and Schiff, M. (2005). On the geography of trade: distance is alive and well. *Revue Economique*, 56:1249–1274.

Chen, N., Imbs, J., and Scott, A. (2009). The dynamics of trade and competition. *Journal of International Economics*, 77(1):50–62.

Coe, D. T., Subramanian, A., and Tamirisa, N. T. (2007). The missing globalization puzzle: Evidence of the declining importance of distance. *IMF Staff Papers*, 54(1):34–58.

Coe, D. T., Subramanian, A., Tamirisa, N. T., and Bhavnani, R. (2002). The missing globalization puzzle. Working Paper 02/171, IMF, Washington.

Combes, P.-P. (2008). Gravity models. In Durlauf, S. N. and Blume, L. E., editors, *The New Palgrave Dictionary of Economics*. Palgrave-Macmillan, London, 2^{nd} edition.

Deardorff, A. (1998). Determinants of Bilateral Trade: Does Gravity Work in a Neoclassical World? *The Regionalization of the World Economy*, pages 7–22.

Disdier, A. and Head, K. (2008). The puzzling persistence of the distance effect on bilateral trade. *Review of Economics and Statistics*, 90:37–48.

Evenett, S. and Keller, W. (2002). On theories explaining the success of the gravity model. *Journal of Political Economy*, 110:281–316.

Feenstra, R. C., Markusen, J. R., and Rose, A. K. (1998). Undertstanding the home market effect and the gravity equation: The role of differentiating goods. Working Paper 6804, NBER, Cambridge, Massachusetts.

Feenstra, R. C., Markusen, J. R., and Rose, A. K. (2001). Using the gravity equation to differentiate among alternative theories of trade. *Canadian Journal of Economics*, 34(2):430–447.

Frankel, J. A. (2000). Globalization of the economy. Working Paper 7858, NBER, Cambridge, Massachusetts.

Greenaway, D. and Milner, D. (2002). Regionalism and gravity. *Scottish Journal of Political Economy*, 49(5):574–585.

Hanneman, R. and Riddle, M. (2005). Introduction to Social Network Methods. Technical report, University of California at Riverside, Department of Sociology.

Head, K. and Mayer, T. (2002). Illusory border effects: distance mismeasurement inflates estimates of home bias in trade. Working Paper 01, CEPII, Paris.

Henderson, D. and Millimet, D. (2008). Is gravity linear? *Journal of Applied Econometrics*, 23:137–172.

Huang, R. (2007). Evaluating the real effect of bank branching deregulation: Comparing contiguous counties across US state borders. *Journal of Financial Economics*, 87:678–705.

Hummels, D. (1999). Have interational transport costs declined? University of Chicago.

Hummels, D. and Levinsohn, J. (1995). Monopolistic competition and international trade: Reconsidering the evidence. *Quarterly Journal of Economics*, 110(3):799–836.

Iapadre, L. (2006). Regional integration agreements and the geography of world trade: measurement problems and empirical evidence. In De Lombaerde, P., editor, *Assessment and Measurement of Regional Integration*, pages 65–85. Routledge, London.

Kali, R. and Reyes, J. (2007). The architecture of globalization: a network approach to international economic integration. *Journal of International Business Studies*, 38:595–620.

Karlin, S. and Taylor, H. M. (1975). *A First Course in Stochastic Processes*. Academic Press, New York.

Krugman, P. R. (1996). Regionalism versus multilateralism: analytical notes. In de Melo, J. and Panagariya, A., editors, *New Dimensions in Regional Integration*, CEPR, chapter 3, pages 58–89. Cambridge University Press, Cambridge.

Kunimoto, K. (1977). Typology of trade intensity indices. *Hitotsubashi Journal of Economics*, 17(2):15–32.

Leamer, E. and Levinsohn, J. (1995). International trade theory: The evidence. In Grossman, G. and Rogoff, K., editors, *Handbook of International Economics*, volume 3, chapter 26, pages 1339–1394. Elsevier.

Maddison, A. (2001). The World Economy: A Millenial Perspective. Development Centre Studies, OECD.

McLuhan, M. and Fiore, Q. (1968). *War and Peace in the Global Village: An Inventory of the Current Spastic Situations That Could Be Eliminated by More Feedforward*. Bantam Books/Random House, New York.

O'Rourke, K. H. and Williamson, J. G. (1999). *Globalization and History: The Evolution of a 19th Century Atlantic Economy*. MIT Press, Cambridge, Massachusetts.

O'Rourke, K. H. and Williamson, J. G. (2002). When did globalization begin? *European Review of Economic History*, 6:23–50.

Rauch, J. E. (1999). Networks versus markets in international trade. *Journal of International Economics*, 48:7–35.

Redding, S. (2002). Specialization dynamics. *Journal of International Economics*, 58(2):299–334.

Rose, A. (2000). One money, one market: the effect of common currencies on trade. *Economic Policy*, 15(30):7–46.

Samuelson, P. (1954). The Transfer Problem and Transport Costs, II: Analysis of Effects of Trade Impediments. *The Economic Journal*, 64(254):264–289.

Wasserman, S. and Faust, K. (1992). *Social Network Analysis: Methods and Applications*. Number 8 in Structural Analysis in the Social Sciences. Cambridge University Press, Cambridge.

Wellman, B. and Berkovitz, S. (1988). *Social Structure*. Cambridge University Press, Cambridge.

Table 1: *DGO*, *DGBC*, *DGI*, distance-uncorrected and distance-corrected indices (%)

Year	$DGO^{\theta=0}$	$DGO^{\theta=1}$	$DGBC^{\theta=0}$	$DGBC^{\theta=1}$	$DGI^{\theta=0}$	$DGI^{\theta=1}$
1967	8.03	12.13	57.66	82.42	20.30	30.41
1968	8.44	12.91	58.96	83.90	21.02	31.53
1969	8.90	13.67	58.26	84.22	21.32	32.45
1970	9.53	14.65	60.38	83.21	22.34	33.30
1971	9.53	14.70	59.46	84.60	22.22	33.47
1972	9.80	15.31	61.12	86.20	22.78	34.37
1973	11.04	17.34	63.97	86.67	24.76	36.83
1974	13.27	20.87	64.29	87.24	27.37	40.49
1975	12.25	18.94	62.56	88.11	26.00	38.97
1976	12.76	20.02	63.04	89.04	26.58	40.13
1977	12.81	20.59	62.74	89.52	26.62	40.66
1978	12.87	21.79	65.23	90.72	27.26	42.13
1979	14.18	22.81	65.55	90.69	28.73	43.38
1980	15.11	24.20	66.32	89.38	30.04	44.40
1981	14.63	24.75	66.93	89.05	29.63	44.59
1982	14.07	23.33	67.57	88.69	29.02	43.27
1983	13.84	23.58	66.90	89.65	28.55	43.51
1984	14.63	25.73	67.75	90.66	29.69	45.53
1985	14.25	24.92	67.33	89.78	29.10	44.48
1986	13.53	25.66	67.13	89.66	28.24	44.66
1987	13.99	26.69	68.02	90.07	28.92	45.82
1988	14.18	28.25	69.47	91.44	29.53	47.56
1989	14.62	28.33	70.38	91.28	30.13	47.85
1990	14.81	27.42	70.27	90.67	30.43	47.21
1991	14.52	27.84	69.63	90.82	30.14	47.58
1992	14.54	28.20	68.84	90.66	30.14	47.97
1993	14.38	29.61	67.11	90.16	29.55	48.81
1994	15.25	31.12	67.03	90.15	30.32	50.11
1995	16.38	32.42	67.16	89.76	31.37	51.13
1996	16.61	30.60	67.47	89.42	31.73	49.90
1997	17.51	31.63	66.90	89.08	32.47	50.67
1998	17.47	30.59	66.99	89.45	32.39	50.09
1999	17.41	31.24	67.20	89.29	32.40	50.61
2000	18.85	34.37	67.70	88.78	33.74	52.80
2001	18.28	31.44	67.66	89.54	33.12	51.08
2002	18.24	30.35	66.87	89.56	32.98	50.13
2003	18.78	30.38	65.89	89.48	33.19	49.91
2004	20.12	32.01	65.22	89.08	34.16	50.93
2005	20.84	32.27	67.10	88.80	35.48	50.96

Table 2: Determinants of the distance effect, degree of openness, 1967–2005

	Dependent variable: $DO^{\theta=1}/DO^{\theta=0}$				
	Model 1	Model 2	Model 3	Model 4	Model 5
Coefficients					
(Intercept)	−1.466***	−1.460***	−1.454***	−1.449***	−1.476***
	(0.243)	(0.244)	(0.244)	(0.244)	(0.243)
GDP	0.237***	0.238***	0.236***	0.236***	0.239***
	(0.016)	(0.016)	(0.016)	(0.016)	(0.016)
CONSTRUCTION	−0.039*	−0.049**	−0.049**	−0.050**	−0.040*
	(0.016)	(0.016)	(0.016)	(0.016)	(0.016)
BASIC_METALS	−0.034**	−0.035**	−0.035**	−0.034**	−0.032**
	(0.011)	(0.011)	(0.011)	(0.011)	(0.011)
TEXTILES	−0.040***	−0.039***	−0.040***	−0.040***	−0.040***
	(0.007)	(0.007)	(0.007)	(0.007)	(0.007)
WOOD_PAPER	−0.099***	−0.085***	−0.083***	−0.085***	−0.095***
	(0.015)	(0.014)	(0.014)	(0.014)	(0.015)
METAL_PRODUCTS	0.011	0.010	0.017	0.011	0.013
	(0.032)	(0.032)	(0.032)	(0.032)	(0.032)
CHEMICALS	−0.141***	−0.142***	−0.144***	−0.142***	−0.142***
	(0.027)	(0.027)	(0.027)	(0.027)	(0.027)
MINING	−0.004	−0.004	−0.004	−0.004	−0.004
	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)
ENERGY	−0.021***	−0.021***	−0.021***	−0.021***	−0.021***
	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)
AGRICULTURE	0.008	0.006	0.006	0.006	0.009
	(0.007)	(0.007)	(0.007)	(0.007)	(0.007)
FOOD_PRODUCTS	0.004	0.005	0.005	0.005	0.004
	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)
MISC	0.017***	0.016***	0.017***	0.016***	0.017***
	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)
YRTA	−0.003**	−0.004***	−0.004***	−0.004***	−0.003**
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
EU	−0.133***				
	(0.031)				
NAFTA		−0.064			
		(0.049)			
ASEAN			−0.149*		
			(0.062)		
MERCOSUR				−0.001	
				(0.058)	
RTA					−0.101***
					(0.024)
R^2	0.195	0.188	0.190	0.188	0.194
σ	0.239	0.240	0.239	0.240	0.239
F	190.438	188.736	189.134	188.565	190.345
p	0.000	0.000	0.000	0.000	0.000
Log-likelihood	69.344	60.463	62.548	59.568	68.860
Deviance	126.843	127.826	127.594	127.925	126.896
AIC	9.311	27.074	22.904	28.863	10.281
BIC	434.153	451.916	447.745	453.704	435.122
N	2301	2301	2301	2301	2301

*, ** and *** denote significance at 10%, 5%, and 1% significance levels, respectively.

Table 3: Determinants of the distance effect, degree of balanced connection, 1967–2005

	Dependent variable: $DBC^{\theta=1}/DBC^{\theta=0}$				
	Model 1	Model 2	Model 3	Model 4	Model 5
Coefficients					
(Intercept)	4.370***	4.364***	4.290***	4.349***	4.330***
	(0.398)	(0.400)	(0.380)	(0.400)	(0.400)
GDP	−0.204***	−0.206***	−0.205***	−0.202***	−0.201***
	(0.026)	(0.027)	(0.025)	(0.026)	(0.026)
$CONSTRUCTION$	0.088***	0.105***	0.112***	0.106***	0.111***
	(0.026)	(0.026)	(0.024)	(0.026)	(0.026)
$BASIC\_METALS$	0.125***	0.126***	0.122***	0.123***	0.127***
	(0.019)	(0.019)	(0.018)	(0.019)	(0.019)
$TEXTILES$	0.074***	0.073***	0.068***	0.074***	0.073***
	(0.011)	(0.011)	(0.011)	(0.011)	(0.011)
$WOOD\_PAPER$	0.035	0.014	0.032	0.012	0.009
	(0.024)	(0.024)	(0.023)	(0.024)	(0.024)
$METAL\_PRODUCTS$	0.188***	0.189***	0.250***	0.184***	0.189***
	(0.052)	(0.052)	(0.050)	(0.052)	(0.052)
$CHEMICALS$	−0.128**	−0.127**	−0.149***	−0.128**	−0.128**
	(0.044)	(0.044)	(0.042)	(0.044)	(0.044)
$MINING$	−0.026***	−0.025***	−0.026***	−0.026***	−0.025***
	(0.007)	(0.007)	(0.007)	(0.007)	(0.007)
$ENERGY$	0.072***	0.072***	0.071***	0.072***	0.073***
	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)
$AGRICULTURE$	0.054***	0.057***	0.063***	0.057***	0.059***
	(0.012)	(0.012)	(0.011)	(0.012)	(0.012)
$FOOD\_PRODUCTS$	0.012	0.011	0.012	0.011	0.011
	(0.007)	(0.007)	(0.007)	(0.007)	(0.007)
$MISC$	−0.045***	−0.043***	−0.036***	−0.044***	−0.043***
	(0.007)	(0.007)	(0.007)	(0.007)	(0.007)
$YRTA$	−0.001	0.001	0.003	0.001	0.002
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
EU	0.218***				
	(0.050)				
$NAFTA$		0.125			
		(0.080)			
$ASEAN$			−1.502***		
			(0.097)		
$MERCOSUR$				0.112	
				(0.094)	
RTA					−0.045
					(0.039)
R^2	0.177	0.171	0.251	0.171	0.171
σ	0.391	0.392	0.373	0.392	0.392
F	76.931	76.142	87.621	76.091	76.089
p	0.000	0.000	0.000	0.000	0.000
Log-likelihood	−1064.744	−1073.184	−956.036	−1073.735	−1073.760
Deviance	339.911	342.414	309.264	342.578	342.585
AIC	2277.489	2294.367	2060.071	2295.470	2295.519
BIC	2702.330	2719.209	2484.912	2720.312	2720.360
N	2301	2301	2301	2301	2301

*, ** and *** denote significance at 10%, 5%, and 1% significance levels, respectively.

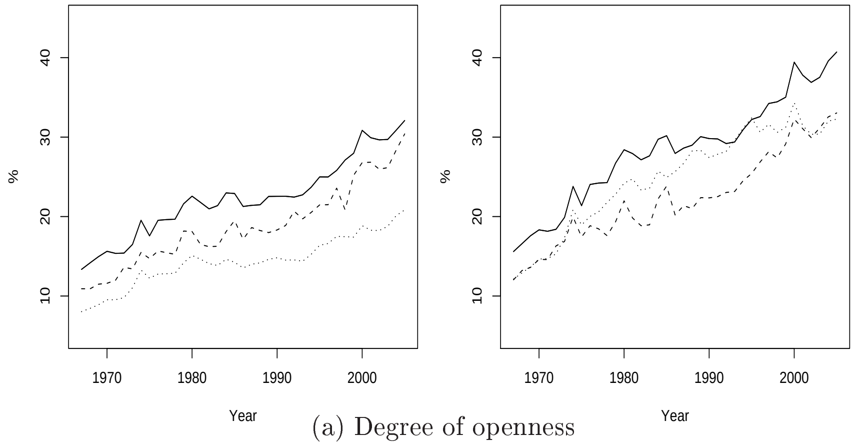
Table 4: Determinants of the distance effect, degree of integration, 1967–2005

	Dependent variable: $DI^{\theta=1}/DI^{\theta=0}$				
	Model 1	Model 2	Model 3	Model 4	Model 5
Coefficients					
(Intercept)	1.862***	1.864***	1.839***	1.858***	1.858***
	(0.134)	(0.135)	(0.131)	(0.135)	(0.135)
GDP	−0.005	−0.007	−0.005	−0.004	−0.005
	(0.009)	(0.009)	(0.009)	(0.009)	(0.009)
$CONSTRUCTION$	0.033***	0.039***	0.041***	0.039***	0.037***
	(0.009)	(0.009)	(0.008)	(0.009)	(0.009)
$BASIC\_METALS$	0.024***	0.024***	0.023***	0.022***	0.023***
	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)
$TEXTILES$	0.013***	0.013**	0.011**	0.013***	0.013**
	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)
$WOOD\_PAPER$	−0.021**	−0.028***	−0.024**	−0.030***	−0.027***
	(0.008)	(0.008)	(0.008)	(0.008)	(0.008)
$METAL\_PRODUCTS$	−0.007	−0.006	0.009	−0.010	−0.007
	(0.018)	(0.018)	(0.017)	(0.018)	(0.018)
$CHEMICALS$	−0.079***	−0.078***	−0.084***	−0.079***	−0.079***
	(0.015)	(0.015)	(0.014)	(0.015)	(0.015)
$MINING$	−0.009***	−0.008***	−0.009***	−0.009***	−0.009***
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
$ENERGY$	0.021***	0.021***	0.021***	0.021***	0.021***
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
$AGRICULTURE$	0.016***	0.017***	0.018***	0.016***	0.017***
	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)
$FOOD\_PRODUCTS$	0.004	0.004	0.004	0.004	0.004
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
$MISC$	−0.004	−0.003	−0.002	−0.004	−0.004
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
$YRTA$	−0.003***	−0.003***	−0.002***	−0.003***	−0.003***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
EU	0.074***				
	(0.017)				
$NAFTA$		0.064*			
		(0.027)			
$ASEAN$			−0.389***		
			(0.033)		
$MERCOSUR$				0.089**	
				(0.032)	
RTA					0.020
					(0.013)
R^2	0.139	0.133	0.181	0.134	0.132
σ	0.132	0.132	0.128	0.132	0.132
F	127.866	126.922	136.167	127.077	126.681
p	0.000	0.000	0.000	0.000	0.000
Log-likelihood	1436.559	1429.703	1495.177	1430.834	1427.943
Deviance	38.651	38.882	36.731	38.844	38.942
AIC	−2725.118	−2711.406	−2842.355	−2713.667	−2707.886
BIC	−2300.277	−2286.564	−2417.514	−2288.826	−2283.044
N	2301	2301	2301	2301	2301

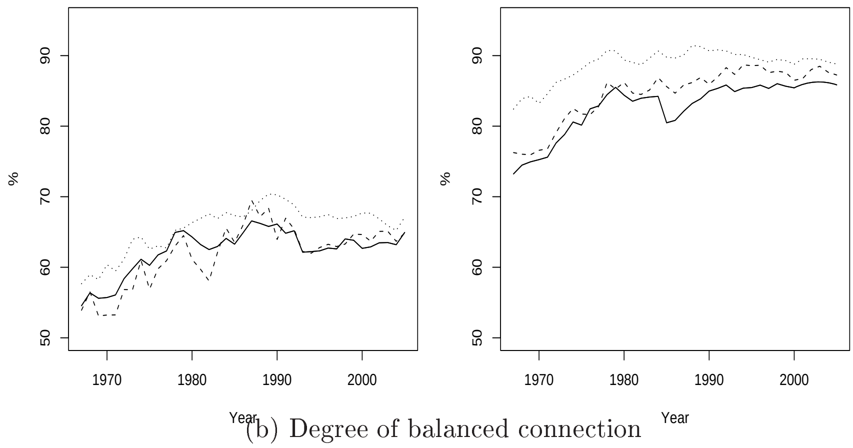
*, ** and *** denote significance at 10%, 5%, and 1% significance levels, respectively.

Figure 1: Degree of openness (DO), degree of balanced connection (DBC), and degree of integration (DI), 1967–2005

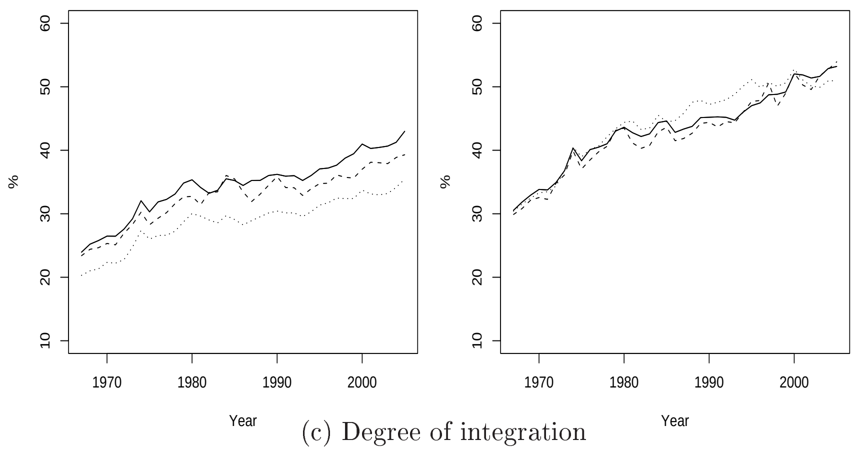
$\boldsymbol{\theta = 0}$ $\boldsymbol{\theta = 1}$



(a) Degree of openness



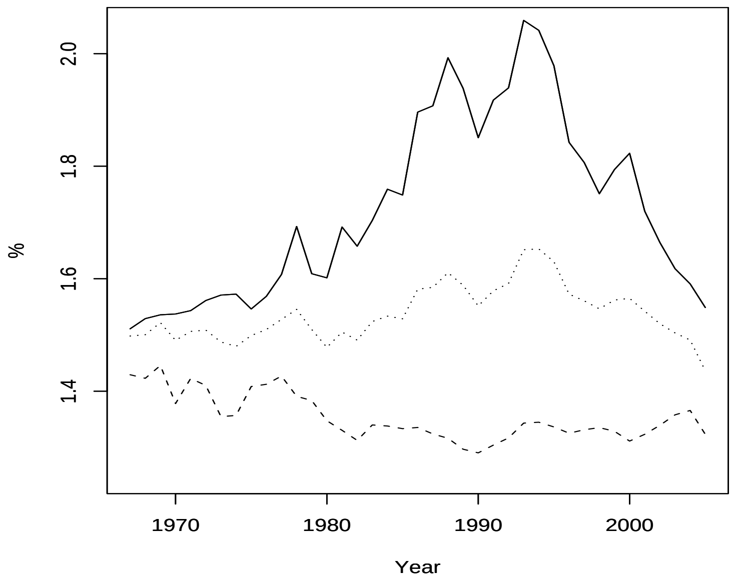
(b) Degree of balanced connection



(c) Degree of integration

—— Unweighted mean ------ Median ······· Weighted mean

Figure 2: The role of distance, time trend (1967–2005)



—— $DGO^{\theta=1}/DGO^{\theta=0}$ ------ $DGBC^{\theta=1}/DGBC^{\theta=0}$ ······· $DGI^{\theta=1}/DGI^{\theta=0}$