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The Magnitude and Distance Decay of Trade in Goods and Services: New Evidence for European Countries

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Abstract

Using a newly assembled, consistent and disaggregated dataset (12 goods and 7 services) on internal and bilateral trade for 25 European countries, we analyse the difference between trade in goods and services. The measurement of both trade in goods and trade in services is improved over earlier research, allowing us to compare trade in goods and services in a coherent and systematic way. First, our dataset is made consistent with the domestic demand and production and the total exports and imports at the sector and product level. Second, we explicitly control for re-exports. We find that, although goods are more often bilaterally traded than services, the volume of bilateral trade in services does not attenuate less with distance than the volume of bilateral trade in goods.

Keywords: services, goods, trade costs, Europe

JEL-classification: F10, F14

1. Introduction

Over the past decades, we have witnessed a deindustrialisation and tertiarisation of the world economy. Services currently generate over 70% of the GDP and total employment in most developed countries (World Bank 2009). As indicated by Hoekman and Mattoo (2010), the increasing importance of services in the world economy can be attributed to several factors, including rising income levels, market expansion and liberalisation, changes in business practices leading to an increased demand for control and intermediation services, and the increasing complexity of the production process, resulting in the outsourcing of services to specialised providers. Notwithstanding the rise of the services sector, services exports nowadays only account for approximately 20% of all exports of goods and services (World Bank 2009) and this figure has only marginally increased over the past decades.[1] In addition, most research on international trade still focuses on trade in goods.[2] Kimura and Lee (2006) argue that there are two main reasons for the relative absence of services in the international trade literature. First, there has been a lack of internationally comparable data on services trade. Not until the early 2000s did the Organisation for Economic Co-operation and Development (OECD) and Eurostat release detailed tables on bilateral trade in services for a broad range of countries and only more recently, more refined data on trade in services have become available (Francois et al. 2009, Christen and Francois 2010). Second, there are several important differences between the characteristics of goods and services that make it difficult to unify these categories into one 'theory' of trade. In contrast to goods, services are intangible, jointly produced and non-storable. Accordingly, the modes of supply of goods and services in international trade are qualitatively different (Sampson and Snape 1985).[3]

However, when analysing (aggregate) bilateral trade and its effect on the allocation of resources and national welfare, it is neither desirable nor necessary to separate trade in goods and services or to omit one of the two categories from the analysis (Kimura and Lee 2006). In fact, Hoekman and Mattoo (2010) argue that the services sector contributes to economic growth by reducing transport, communication and transaction costs, serving as an input to economic activities, and coordinating economic processes (thereby allowing economic specialisation to occur). Given the expansion of the services sector, the performance of this sector is becoming increasingly important for the overall growth performance of countries. In this context, trade openness is supposed to be an important channel for improving the performance of the services sector by the introduction of new technologies and market competition (Hoekman and Mattoo 2010). Accordingly, a pivotal question is to what extent the determinants of trade in goods are different from the determinants of trade in services. As noted by Head et al. (2009) and Christen and Francois (2010), it can be expected that both trade in goods and trade in services are affected by the transactional distance between countries, in terms of transportation and coordination costs. In this context, it is also important to distinguish between the trade and the tradability of products (Lejour and Smith 2008). The fact that the growth in the share of services in world exports is lagging behind the growth of the share of services in the world GDP strongly indicates that the barriers to trade in services may be considerably higher than the barriers to trade in goods. If the barriers to trade in services are indeed very high, there may be a large unexploited potential for trade in services and, hence, economic growth.

In this article, we analyse the trade of goods *and* services within a New Economic Geography framework using a newly assembled, consistent and disaggregated dataset on bilateral trade for the 25 European countries and their main trading partners. This dataset combines information on bilateral trade patterns in goods and services with national accounts data on 59 NACE Rev. 1.1. sector and product categories for the year 2000. The trade data in our analysis are grouped into 12 types of goods and 7 types of services based on the NACE Rev. 1.1 and CPA 2-digit classification.[4] This breakdown means that trade in services is, similarly to trade in goods, assessed at a very detailed level.[5] To our knowledge, only Francois et al. (2009) and Christen and Francois (2010) assess bilateral trade in services at such a detailed level with respect to the different services products under observation.

Although the datasets presented in Francois et al. (2009) and Christen and Francois (2010) significantly improve on previous data collections by Eurostat and the OECD, no particular effort in the construction of these datasets is made to render trade in services and goods statistics more comparable. In this article, we make corrections to the measurement of trade in both goods and services that enable us to compare trade in goods and services in a coherent and systematic way. First, the dataset is made consistent with the domestic demand and production and the total exports and imports at the sector and product level. In other words, we use the information from national accounts (which follow SNA-ESA standard) and the valuation differences of the same trade flows when treated as exports or imports, hereby making bilateral trade data more reliable and better comparable among product categories. Second, using data from the different European bureaus of statistics, we explicitly control for re-exports (the imports that are directly exported without being used in domestic production) in our analysis. Re-exports can be substantial and affect both the pattern and the volume of trade (particularly in goods, not in services). The pattern of trade is affected because re-exports have been registered at a different destination than the final destination, and the volume of trade is affected because re-exports are counted twice. The presence of re-exports also affects the estimate for the internal trade in a country. Large re-exports may even result in exports that exceed the production for certain product categories and certain countries, rendering the estimates for internal trade in the country inaccurate if not impossible. Our dataset thus avoids the overestimation of the volume of trade and, thereby, an underestimation of the relative size of the internal trade within a country.

The remainder of this article is organized as follows. In the next section, we introduce our dataset, including a comparison with earlier datasets that include trade in services. Section 3 provides more background on the estimation of trade costs using a New Economic Geography framework. Section 4 presents the empirical results. We conclude with a discussion of our findings in section 5.

2. A Consistent and Disaggregated Dataset on European Trade in Goods and Services

To analyse the trade costs for goods and services, we use a newly assembled, consistent and disaggregated dataset on the exports and imports of goods and services for 25 European countries[6] for the year 2000. To compare, previous studies that have compared bilateral trade in goods with trade in services have predominantly used OECD and Eurostat data for a limited set of European countries.

In addition, there are several problems with available datasets from different statistical sources that lead to corrections in our dataset. The foremost problem is the substantial difference between the reported imports in country A from country B compared with the exports from country B to country A. Although these two flows should be the same, there are typically large discrepancies. These discrepancies are much larger than the difference in valuation (f.o.b. - exports valued *free on board* versus c.i.f. - imports reported as *costs* including *insurance* and *freight*) or a possible difference in prices (purchaser or producer prices). Nevertheless, in analysing trade patterns, the valuation and price differences also pose a potential problem that is important to address. The possibility of large re-export flows poses an additional problem, as trade patterns may no longer adequately represent the final destination or true origin of exports and imports, respectively, and internal trade within the country cannot be determined.

The dataset used in this paper combines information on bilateral trade patterns in goods (Feenstra et al. 2005) and bilateral trade patterns in services from Eurostat with national accounts data (also from Eurostat) for 59 sector and product categories for the year 2000. The resulting trade data were grouped into 12 types of goods and 7 types of services. The dataset is consistent with the national accounts of all European countries, thereby including the additional constraint that all bilateral imports and exports must add up to the overall national totals. In addition, consistency with the national accounts enables us to take valuation differences and corrections adequately into account. That is, the corrections that have been made on the trade data always involve double bookkeeping principles, which implies that the corrections are consistent not only with respect to the exports and imports but also with respect to domestic demand and production on the sector and product level. All of these consistency checks contain information, thereby add to the reliability of the data. A more detailed description of the construction of this dataset is provided in Appendix B and Thissen et al. (2013).

Francois et al. (2009) and Christen and Francois (2010) are the only studies that we are aware of that assess service trade at a level of detail similar to ours. The dataset introduced by Francois et al. (2009)[7] is most comparable to ours, since in this research Eurostat balance of payment data is also employed as one of the main sources for cross-border bilateral trade in services. However, the aim of the study by Francois et al. (2009) is to compare alternative modes of supply of services and this is reflected in the different methodology they use to enhance the Eurostat data. In particular, Francois et al. (2009) integrate additional bilateral service trade data points from OECD and exploit information on service trade totals from IMF balance of payments statistics (IMF BOPS) database to fill in missing data points. However, the dataset presented by Francois et al. (2009) focuses entirely on services. The study by Christen and Francois (2010) examines U.S. cross-border exports and affiliate sales in the services sector. Apart from the dataset presented by Francois et al. (2009), the authors utilize affiliate sales data obtained from the Bureau of Economic Analysis.[8]

Contrariwise, since our interest is to compare trade in services with trade in manufacturing, we made a significant effort in this direction. Consistency checks with national accounts of the considered countries, which report trade totals for both services and manufactured goods following the standard SNA-ESA system, implies a higher comparability among manufacturing and services. The same can be argued for c.i.f./f.o.b. adjustment and re-export corrections, since both problems affect mostly the pattern and volume of trade in goods.

2.1. Consistent Disaggregation of National Accounts Data on Exports and Imports

The starting point of the analysis consists of the available national account-compatible supply and use tables for the 25 member states of the European Union (excluding Cyprus) and Norway for the year 2000. The Feenstra trade data on goods and the Eurostat trade data on services have been used to distribute the total national accounts data on exports and imports over their respective destinations and origins. The services have been distributed using only 4 broad categories of services (transportation, travel, other business services and other services) because no more detailed information was available.

After the necessary adjustment in the valuation of exports and imports, these categories are comparable because they are presented in the same prices (purchaser prices, free on board). Moreover, *all* exports and imports have been distributed over all product categories and are accounted for. Therefore, the imports of a certain product of country A from country B should be exactly equal to the exports of the same product from country B to country A. However, substantial discrepancies remained between the two figures. To use the information that both figures should be the same *and* should be consistent with the national accounts, we have estimated the most likely trade between the countries. We have estimated the consistent trade dataset by minimising the absolute relative distance with respect to these two priors (the export and import estimates, which theoretically should be equal), taking the overall totals of exports and imports in the national accounts statistics as constraints. Following the literature on constructing consistent trade statistics (Oosterhaven et al. 2008; Bouwmeester and Oosterhaven 2009), the import estimates are assumed to be more reliable because of tariff and registration issues. Accordingly, we weigh the errors on the import estimates twice as much as the errors on the export estimates. The resulting trade matrix is consistent with respect to imports, exports, and the national accounts.

2.2. Dealing with Re-exports

Although, in international economics, trade is often conceptualised as domestically produced exports and imports, the administration of international trade flows follows a different logic and, accordingly, trade between countries can have many faces. International trade statistics are based on physical border-crossing combined with a change in ownership. Re-exports are products that have been imported into a country but that leave the country again in the same state as previously imported or after virtually no further processing (e.g., repackaging).[9] In contrast to 'true' transit trade, these products become the (temporary) property of the resident in the entrepôt country and, accordingly, are recorded in the national accounts and international trade statistics.[10] Although, in the mid-1980s, re-exports accounted only for 5% of the world exports, these transactions currently constitute over 17% of the world exports (Andriamananjara et al., 2004). In many developed countries, re-exports have grown faster than domestically produced exports (Mellens et al., 2007). The reasons for the rise of the proportion of re-exports include the rise of specialised agents that match buyers and sellers in international markets (Feenstra and Hanson, 2004), the economisation of transport costs by the creation of a hub-and-spoke system (Andriamanajara et al., 2004), and tariff evasion (Fisman et al., 2008).

Re-exports can be substantial, and they affect both the pattern and the volume of trade. The pattern of trade is affected because re-exports have been registered to a different destination than the final one, and the volume of trade is affected because re-exports are counted twice. Data from which re-exports are excluded enable the comparison of trade in goods and services in a coherent and systematic way because the true destinations are taken into account. Therefore, we correct the trade data by excluding the re-exports from the origin destination matrix, which is thereby changed into an origin-final destination matrix. The methodology used is a mixed survey and non-survey technique that combines information on re-exports by country with assumptions on the origins and destinations of re-exported goods and services.

Table 1: Net Re-Exports Correction as Share of Total Bilateral Trade of the 25 European countries by Product Variety

	%
Goods	***9.5***
Agriculture and fishing	6.9
Raw materials	6.1
Food and tobacco	4.2
Textiles, clothing, and leather	10.5
Wood and furniture	10.0
Paper and printed matter	4.2
Chemicals and petrochemicals	7.4
Rubber, plastic, and glass	5.9
Metals	6.9
Machinery	6.9
Electrical and optical equipment	17.0
Transport equipment	9.8
Services	***1.1***
Utilities	1.9
Construction	0.3
Wholesale, retail, and hotels	0.2
Transport services	2.8
Financial services	0.2
Business services	0.3
Non-Market services	1.6

Data on re-exports can be obtained from the import tables, which are available (typically upon request) from the statistical offices of most countries in Europe. In these tables, the division between domestic and imported use is included, providing us with information on the countries' re-exports by product category. We have used this information, together with the information on trade patterns, to remove the re-exports from the trade data, and we have obtained a dataset containing the 'true' trade between different nations. It should be noted that, although re-exports are of increasing importance in the trade of goods, these transactions are relatively unimportant for trade in services, as, due to the intangible nature of services, production and consumption must occur simultaneously**.**

Indeed, Table 1 shows that the trade in consumer goods (textiles, wooden products and furniture, electrical and optical equipment, and transport equipment) from and into the countries in our dataset is characterised by a particularly high degree of re-exports. The corrections for re-exports mainly affect the trade statistics of countries that have an entrepôt function (the Netherlands, Belgium, Germany, France) in that many goods enter and leave the European Union via their ports (most notably, Rotterdam, Antwerp, Hamburg and Le Havre).

3. Bilateral Trade Costs

3.1. New Economic Geography and Trade Costs

In New Economic Geography (NEG), trade costs are considered to be one of the main determinants of the volume of trade between countries and one of the key explanations why 'geography matters' (Head and Mayer 2004; Brakman et al. 2006). Within the NEG approach, trade costs are conceptualised by means of an iceberg-type transport cost function in a Dixit-Stiglitz-Krugman (Dixit and Stiglitz 1977) framework, in which the market structure is characterised by monopolistic competition.[11] In NEG models, it is assumed that varieties are imperfect substitutes, that consumers have a preference for variety, and that the consumers' utility depends on the number and quantity of each variety that is consumed. In the NEG, contrary to the 'classical' trade theory, it is not assumed that products are different based on the location of production, but the consumption of goods always inflicts trade costs with respect to the location of production. In an analogy to floating icebergs, it is assumed in this work that each trade variety includes a part that 'melts away' during the transport, which is assumed to be proportional to the distance that a variety has travelled and which corresponds to the trade costs involved (Samuelson 1952; Krugman 1991).

Accordingly, assuming constant elasticity of substitution (CES), that consumers do not have a bias toward certain countries in their preferences and that goods and services from the same country can be subject to different transport costs, the volume of trade in a product *p* between country *i* and country *j* can be thought of as depending on the supply capacity S_{ip} of the exporting country, the market capacity M_{jp} of the importing country, and the bilateral trade costs $T_{ijp}^{1-\sigma}$. Please note that, in this analysis, we aggregate the demand from consumers in country *j* for product *p* that is produced in the exporting country *i* (see also Bosker and Garretsen 2010). Formally,

$$E_{ijp} = S_{ip} M_{jp} T_{ijp}^{1-\sigma} = n_{ip} p_{ip}^{1-\sigma} E_{jp} G_{jp}^{\sigma-1} T_{ijp}^{1-\sigma} \quad (1)$$

In this equation, S_{ip} typically depends on the number of firms (n_{ip}) in the exporting country *i* producing the product *p* and on their price competitiveness $(p_{ip}^{1-\sigma})$. The market capacity M_{jp} depends on the total expenditures on the product in the importing country (E_{jp}) and the price index (cf. Fujita et al., 1999) in country *j* based on all sales of product *p* in country *j* $(G_{jp}^{\sigma-1})$ (including those produced in other countries than *i* and *j*). As indicated by Bosker and Garretsen (2010), the bilateral trade costs $T_{ijp}^{1-\sigma}$ consist of bilateral cost factors and cost factors that are specific to the importing or exporting country. The bilateral cost factors typically comprise the transport costs, tariffs, information costs, and cultural and institutional differences, whereas the importer- and exporter-specific cost factors are associated with the institutional and geographical features of a country. Note that, if the elasticity of substitution is higher or, alternatively, the product differentiation is lower, the relative prices and bilateral trade costs have a more profound impact on the volume of bilateral trade.

3.2. Estimating Trade Costs

A. Indirect Estimation

As indicated by Combes et al. (2008) and Bosker and Garretsen (2010), trade costs can be estimated indirectly and directly within the Dixit-Stiglitz-Krugman framework. Head and Ries (2001) and Baldwin et al. (2003) provide an indirect approach for estimating 'implied' trade costs that derives from equation (1) by comparing the internal trade flows with the bilateral trade flows, where the internal trade flows reflect the internal use or supply within a country. Assuming that the internal trade costs are a constant and the same for all countries and products, that there are no bilateral preferences, and that the trade costs for shipping from country *i* to country *j* are the same as the trade costs for shipping from country *j* to country *i*, the implied trade costs for a product *p* can be calculated as follows (Head and Ries 2001; Baldwin et al. 2003):

$$T_{ijp}^{1-\sigma} = \varphi_{ijp} = \sqrt{\frac{E_{ijp} E_{jip}}{E_{iip} E_{jjp}}}, \quad (2)$$

where the denominator represents the countries' internal trade, which can be derived from the total use of a product minus the sum of the exports to all other countries. In this equation, φ_{ijp} is also known as the indicator of the 'freeness' or 'phi-ness' of trade (cf. Baldwin et al. 2003) and typically ranges between 0 and 1, taking the value of 1 in the case of completely free trade (assuming free trade within countries) or when there is no difference between the internal and international trade costs. Although it is difficult – given the differences in the sizes of countries – to make cross-national comparisons of the integration of countries into the world economy using this indicator, a comparison of different products can be considered to be less problematic (Combes et al. 2008). In this equation, typically the median freeness of trade $\hat{\varphi}_{ijp}$ is estimated to compare the trade costs of different products.[12] Indirect estimations to compare trade costs in costs and services have been presented in the work by Helliwell (1998) and Coulombe (2005).

B. Direct Estimation

Alternatively, trade costs can be estimated directly. As indicated by Head et al. (2009) and rooted both in the 'old' international trade literature and in the general equilibrium modelling of trade patterns (see Bröcker 1989; Eaton and Kortum 2002; Anderson and Van Wincoop 2003; Feenstra 2004, Van Bergeijk and Van Marrewijk 2010), bilateral trade in both goods and services can then be represented by a gravity-like equation[13] in which the volume of bilateral trade is considered to be directly proportional to the product of the masses of the countries and inversely proportional to the trade costs that are involved in transporting the goods and services. Within the context of product trade, the mass of the exporting country can be related to its product supply capacity, the mass of the importing country can be related to its product market capacity, and the distance between the two countries can be related to the product-specific trade costs involved (Bosker and Garretsen 2010; see also equation 1). Studies that have used this approach to contrast trade in goods with trade in services include the work by Kimura and Lee (2006), Lejour and De Paiva Verheijden (2007), and Lennon (2008).

Following Santos Silva and Tenreyro (2006), we estimate equation 1 using two-way fixed-effects Poisson pseudo-maximum likelihood estimation (PPML). In contrast to the conventional log-normal specification of the gravity model of trade, PPML provides a natural way to address zero-valued trade flows, and PPML estimates are consistent in the presence of heteroscedasticity and reasonably efficient, especially for large samples (Burger et al. 2009). Accordingly, we state that the observed volume of trade in product p between countries i and j has a Poisson distribution with a conditional mean μ_{ijp} that is a function of the explanatory variables. More formally,

$$\Pr\left[E_{ijp}\right] = \frac{\exp(-\mu_{ijp})\mu_{ijp}^{E_{ijp}}}{E_{ijp}}, \left(E_{ijp} = 0,1,2...\right), \tag{3}$$

where the conditional mean μ_{ijp} is linked to an exponential function of a set of explanatory variables,

$$\mu_{ijp} = \exp\left(K_0 + \beta^{'} T_{ijp} + p_{ip} + \vartheta_{jp}\right), \tag{4}$$

where K_0 is a proportionality constant and T_{ijp} is a 1x*k* row vector of explanatory variables with the corresponding parameter vector β, which are associated with the bilateral product trade costs between countries *i* and *j* (such as physical distance and cultural distance, which are discussed in the section below). In this specification, the importer- and exporter-specific variables are replaced by importer and exporter dummies, denoted by ϑ_{jp} and p_{ip} respectively. Such two-way fixed-effects specification controls for country-specific fixed effects related to importers and exporters, such as the supply capacity, market capacity, and importer- and exporter-specific trade costs, which are often difficult to measure. However, omitting these terms from the specification may result in an omitted variables bias on the remaining parameters in the model. In addition, the two-way fixed-effects specification satisfies the constraints on total country-specific product inflows and outflows (Bröcker 1989).[14]

4. Estimating Trade Costs for Goods and Services

4.1. Geographical Scope of Trade and Implied Trade Costs

Table 2 provides summary statistics of the internal and bilateral trade for the different goods and services products that are present in the database. Turning to the geography of trade in services, Table 3 shows that, not surprisingly, the United Kingdom, Germany, France and Italy are the largest exporters and importers of services, together accounting for 58% of the exports in services of these 25 European countries and for 55% of the imports. At the same time, there are several smaller countries whose trading activities primarily consist of services trade. Most notably, over 50% of the Luxembourg (financial services) and Greece (tourism) export consists of service varieties. When comparing the total trade in services in our database with the trade in services in the dataset presented by Francois et al. (2009) for the year 2000, we find a moderate to strong correlation of 0.59 (based on 740 country pairs that were present in both datasets).

Table 2: Descriptive Statistics of Internal and Bilateral Trade (Millions of Euros) in Goods and Services for the 25 European Countries by Product Variety

	Mean	Standard Deviation	Min	Max	% 0's	N
Goods	**5804**	**52478**	0	**1232721**	**3.2**	1525
Agriculture and fishing	325	3429	0	71598	29.1	1525
Raw materials	221	1303	0	34739	27.0	1525
Food and tobacco	803	9127	0	189780	19.0	1525
Textiles, clothing, and leather	389	3938	0	105472	12.2	1525
Wood and furniture	321	3382	0	77179	16.2	1525
Paper and printed matter	333	3627	0	79383	27.2	1525
Chemicals and petrochemicals	846	7603	0	166764	12.1	1525
Rubber, plastic, and glass	328	3382	0	79770	17.1	1525
Metals	496	4926	0	117606	15.4	1525
Machinery	426	3414	0	97393	15.7	1525
Electrical and optical equipment	700	4951	0	143872	8.9	1525
Transport equipment	615	4940	0	135675	18.7	1525
Services	**8080**	**105183**	0	**2386803**	**4.2**	**1525**
Utilities	263	3563	0	77007	60.3	1525
Construction	842	11100	0	248126	68.5	1525
Wholesale, retail, and hotels	1600	20421	0	451399	26.4	1525
Transport services	885	10255	0	228726	8.7	1525
Financial services	572	7542	0	177301	26.0	1525
Business services	2032	27528	0	658090	14.1	1525
Non-Market services	1876	25419	0	606098	20.3	1525

Table 4 shows the external exposure and freeness of trade for the different goods and services by comparing the exports and imports of the 25 European countries with the domestic use and supply of the 25 European countries, respectively. In terms of export and import share in total use and supply, goods are generally more frequently exported and imported than services. The median freeness of trade, calculated for the 24*25 combinations of European countries in our dataset, provides an indirect measure of the trade costs for the 25 European countries.[15] Whereas goods are, on average, almost 4 times more internally traded than externally, services are over 17 times more internally traded than externally. These results are in line with earlier studies on Canadian-U.S. trade that found that the ratio of interprovincial to international trade is much larger for services than for goods (Helliwell, 1998; Coulombe, 2005).[16] In line with the findings on the external exposure of the different varieties, the median freeness of trade for services is generally lower than the median freeness of trade for goods. The freeness of trade of the most integrated variety of services (transport services) is at the level of the least integrated goods products (certain durable goods, such as agricultural products, raw materials, and food and tobacco). This observation once more implies that the trade costs of services are generally higher than the trade costs of goods.

Table 3: Services Trade of the 25 European Countries

	Volume Exports in Services	Services Exports as % of Total Use in Services	Services Exports as % of Total Exports	Volume Imports in Services	Services Imports as % of Total Supply in Services	Services Imports as % of Total Imports
United Kingdom	131314 (1)	5.7 (20)	31.3 (6)	99906 (2)	4.4. (19)	22.2 (9)
Germany	89301 (2)	3.6 (25)	15.0 (24)	137066 (1)	5.4 (15)	23.3 (6)
France	86925 (3)	4.7 (22)	22.3 (13)	60875 (3)	3.4 (25)	16.1 (17)
Italy	61577 (4)	4.0 (24)	19.2 (16)	56327 (4)	3.7 (24)	18.2 (13)
Spain	57707 (5)	7.1 (17)	31.5 (5)	33287 (7)	4.2 (21)	16.4 (15)
Netherlands	46690 (6)	8.5 (11)	24.1 (11)	38875 (5)	7.2 (11)	22.7 (8)
Belgium	35929 (7)	9.8 (8)	22.5 (12)	36795 (6)	10.0 (4)	24.1 (5)
Denmark	25935 (8)	11.9 (7)	37.3 (4)	20921 (10)	9.8 (5)	35.4 (3)
Austria	25280 (9)	9.7 (9)	28.4 (9)	18328 (11)	7.3 (10)	20.9 (10)
Sweden	25186 (10)	7.4 (16)	21.4 (14)	26136 (9)	7.6 (8)	25.5 (4)
Luxembourg	22854 (11)	49.3 (1)	78.1 (1)	16201 (12)	40.8 (1)	65.7 (1)
Greece	20780 (12)	12.5 (5)	61.7 (2)	11919 (13)	7.6 (9)	22.9 (7)
Ireland	17971 (13)	15.3 (4)	18.7 (18)	32379 (8)	24.5 (2)	39.4 (2)
Norway	15450 (14)	7.9 (13)	19.2 (17)	9640 (15)	5.1 (17)	20.0 (12)
Poland	9815 (15)	4.3 (23)	20.3 (15)	9841 (14)	4.3 (20)	16.4 (16)
Portugal	9747 (16)	6.1 (18)	26.8 (10)	6131 (17)	3.9 (23)	12.3 (22)
Finland	8767 (17)	5.5 (21)	15.6 (23)	8575 (16)	5.4 (16)	20.0 (11)
Czech Republic	6750 (18)	7.7 (15)	17.4 (22)	5348 (18)	6.2 (13)	13.2 (19)
Hungary	4720 (19)	7.8 (14)	12.7 (25)	4910 (19)	8.1 (7)	12.6 (21)
Slovakia	2942 (20)	9.3 (10)	18.2 (20)	1797 (20)	5.9 (15)	9.8 (25)
Slovenia	2112 (21)	8.2 (12)	18.3 (19)	1201 (21)	4.8 (18)	11.2 (24)
Latvia	1458 (22)	12.0 (6)	42.8 (3)	471 (25)	4.2 (22)	12.2 (23)
Estonia	1454 (23)	16.2 (3)	31.0 (7)	695 (23)	8.4 (6)	14.2 (18)
Malta	1200 (24)	24.8 (2)	30.8 (8)	559 (24)	13.3 (3)	13.0 (20)
Lithuania	781 (25)	6.0 (19)	18.1 (21)	852 (22)	6.5 (12)	16.4 (14)

Rank on each dimension between parentheses; volumes are expressed in millions of euros; the table is sorted on the volume of exports in services.

However, when considering the geographical scope of the bilateral trade (that is, excluding the internal use and supply) of the 25 European countries, a different pattern can be observed (see Table 5). Although goods are more often traded than services, bilateral trade in services is conducted over relatively longer distances than bilateral trade in goods. With respect to the bilateral trade in goods, the extra-European exports and imports account for approximately one-third of the total exports and imports of the 25 European countries. In comparison, the volume of the bilateral trade in services tends to attenuate less with distance: 40-45% of the exports and imports of the countries involve countries outside Europe (most notably, the United States and China). Most strikingly, approximately 50% of the countries' exports in wholesale and retail, transport services, and financial services are targeted at countries outside Europe.

Table 4: External Exposure and Median Freeness of Trade in Goods and Services for the 25 European countries

	Exports / Total Use (%)	Imports / Total Supply (%)	ϕ_{ij} (x100)
Goods	**29.3**	**29.5**	**0.47**
Agriculture and fishing	11.1	15.5	0.07
Raw materials	40.4	61.9	0.12
Food and tobacco	14.1	13.2	0.11
Textiles, clothing, and leather	24.4	28.2	0.42
Wood and furniture	19.3	20.2	0.29
Paper and printed matter	20.1	17.4	0.19
Chemicals and petrochemicals	31.8	29.0	0.33
Rubber, plastic, and glass	24.2	21.9	0.40
Metals	27.5	27.9	0.45
Machinery	43.8	37.4	0.62
Electrical and optical equipment	45.6	48.7	0.93
Transport equipment	45.5	42.3	0.37
Services	**5.9**	**5.4**	**0.05**
Utilities	1.4	1.9	0.00
Construction	0.4	0.6	0.00
Wholesale, retail, and hotels	8.0	0.5	0.01
Transport services	13.6	10.5	0.12
Financial services	9.6	6.6	0.05
Business services	6.0	6.0	0.04
Non-Market services	2.6	4.9	0.02
Shown percentages are weighted averages across the 25 European countries			

4.3. Gravity Equations

Similar results are obtained when estimating trade costs directly within the framework of a gravity model (Anderson and Van Wincoop, 2004). In this section, we look at the trade of 25 European countries with themselves, other member states and the most important trading partners of the European Union.[17] Employing two-way fixed-effects PPML on the exports and imports of the 25 European countries, we closely follow the specifications of Santos Silva and Tenreyro (2006) and Head et al. (2009) to compare the trade costs of goods and services.[18]

As a proxy for the trade costs of goods and services, we included a variety of explanatory variables in the gravity equation, which affect trade patterns by increasing or decreasing the transactional distance between countries (De Groot et al. 2004; Linders et al. 2008; Head et al., 2009). The physical distance between two countries creates transaction costs in terms of transportation (of goods and people) costs, communication costs and time costs. In line with Head et al. (2009), *physical distance* is measured as the population-weighted average of the straight line distance ('as the crow flies') between the 20 largest cities in the origin and destination countries and obtained from CEPII.[19] As indicated by Mayer and Zignagno (2006), this method can be used to measure both intra-national and international distances. To account for the national border effect, we include a Boolean *national border dummy variable*, which takes the value of one if the trade is internal ('intra-national'). The *time zone difference* between two countries is calculated as the average number of hours separating the two countries. Following Head et al. (2009), the time zone difference can either have a negative impact (due to coordination difficulties with colleagues in different time zones; 'synchronisation' effect), or a positive effect on the volume of trade (offering a 24-hour working day; 'continuity' effect).

Table 5: Geographical Scope of Bilateral Trade from and into the 25 European countries

	Extra-European Exports / Total Exports (%)	Extra-European Imports / Total Imports (%)
Goods	**30.3**	**32.2**
Agriculture and fishing	14.4	40.1
Raw materials	31.1	57.9
Food and tobacco	25.5	22.7
Textiles, clothing, and leather	26.3	42.0
Wood and furniture	34.1	37.1
Paper and printed matter	22.4	13.7
Chemicals and petrochemicals	30.3	21.2
Rubber, plastic, and glass	24.1	18.3
Metals	22.5	18.0
Machinery	39.5	25.0
Electrical and optical equipment	37.6	48.8
Transport equipment	29.3	25.5
Services	**44.4**	**39.5**
Utilities	27.4	43.2
Construction	37.3	49.4
Wholesale, retail, and hotels	50.2	28.7
Transport services	52.1	37.4
Financial services	46.2	28.6
Business services	40.5	40.7
Non-Market services	20.9	52.3
Shown percentages are weighted averages across all 25 European countries		

In addition to physical distance and time zone differences, we include a number of variables that are intended to measure trade-fostering linkages or the absence of intangible barriers to trade. The cultural-historical distance is measured by whether countries have the same official language, same legal system, same religion, and historical ties.[20] All these variables have been obtained from the CEPII gravity database. The Boolean *shared language dummy* takes the value of one if a language is spoken by at least 9% of the population in both countries. The Boolean *shared legal systems dummy,* which takes the value of one if the legal systems in the two countries have the same origins and measures the ease of signing contracts between the two countries, is obtained from

Head et al. (2009). The *shared common religion* variable is based on the work by Alesina et al. (2003) on religious fractionalization and has previously been used in the work of Disdier and Mayer (2007). The religion similarity index is defined for each religion using its family and sub-family and takes the value 1 if two religions are similar, 0.5 if two religions are part of the same sub-family, 0.25 if they are part of the same family, and 0 if they are part of different families. The index of religious proximity between countries is then estimated as the sum of the products of the share of each religion weighted by the religion similarity index, for all religions practiced by at least 3% of the population in each country. Finally, the Boolean *shared history dummy* takes the value of one if two countries had, or have, a colonial relationship or if they were ever part of the same country. In the remainder of the analysis, we are mainly interested in the effects of physical distance and national borders on the volume of product trade, as these trade costs are most directly observable through their effects on the costs or quantities of trade, in terms of transport costs and tariffs.

Table 6 shows the results of the estimation of the PPML models using clustering on both importing and exporting countries.[21] Comparing trade in goods and services, including both internal and bilateral trade, it can be concluded that the volume of trade in services attenuates somewhat less with distance than the volume of trade in goods. A 1% increase in the physical distance leads to a decrease in trade in goods of approximately 1.1% and to a decrease in trade in services of approximately 0.75%. The distance elasticity for trade in goods is in line with the conventional gravity literature, which, on average, has found a distance elasticity of about −0.9 (Disdier and Head, 2008). The difference between the distance effects for goods and services are in line with the findings of Lejour and De Paiva Verheijden (2007) and Lennon (2008), who also find that the negative relationship between physical distance and volume of trade is less strong for services. On the contrary, Kimura and Lee (2006) obtained that geographical distance is consistently more important for services than for goods trade.

At the same time, we find that the border effect for services is considerably larger than the border effect for goods. The internal trade in goods is, on average, a factor of 10 higher than the bilateral trade in goods, whereas the internal trade in services is, on average, a factor of 150 higher than the bilateral trade in services. Although we are not aware of empirical studies have researched the international border effect of services, our result on the international border effect for goods is in line with previous studies that have been conducted for EU countries for the late 1990s, which found that the international border effect for goods ranges between 6 and 11 (Head and Mayer, 2000; Nitsch, 2000; Chen, 2004).

A shared common language has a significant and positive effect on the volume of trade in goods and services. Although a shared common religion has only a positive and significant effect on the volume of trade in goods, the effect is not significantly larger than the shared common religion effect on trade in services. Accordingly, it can be concluded that there are few differences between the effects of socio-cultural variables on bilateral trade in services and on bilateral trade in goods, in that the direction, magnitude and significance of the effects are comparable. The findings with regard to differences the socio-cultural variables are in line with the results presented in Lejour and De Paiva Verheijden (2007), but differ from the results presented by Kimura and Lee (2006) and Lennon (2008), which report that linguistic distance is more detrimental for trade in services than for trade in goods.

Table 6: PPML on Internal and Bilateral Exports and Imports of the 25 European countries

	Exports		Imports	
	Goods	***Services***	***Goods***	***Services***
Physical distance (ln)	-1.13 (.09)**	-0.69 (.13)**	-1.02 (.11)**	-0.81 (.13)**
National border effect	2.29 (.11)**	5.07 (.13)**	2.38 (.12)**	4.96 (.14)**
Time zone difference	0.11 (.08)	0.21 (.11)	0.10 (.08)	0.18 (.13)
Shared language	0.59 (.08)**	0.60 (.18)**	0.58 (.10)**	0.73 (.18)**
Shared legal origins	0.04 (.09)	0.14 (.12)	0.07 (.09)	0.09 (.13)
Shared religion	0.43 (.21)*	0.38 (.22)	0.58 (.22)*	0.38 (.30)
Shared history	-0.13 (.16)	-0.02 (.18)	0.06 (.12)	-0.11 (.15)
Observations	900	900	900	900
Origin fixed effects	YES	YES	YES	YES
Destination fixed effects	YES	YES	YES	YES
Clustering	Exporter and Importer	Exporter and Importer	Exporter and Importer	Exporter and Importer
*p<0.05, **p<0.01; robust standard errors between parentheses. All models are estimated using Newton-Raphson (NR) algorithm.				

We now turn our attention to how physical distance affects the volume of trade of the different goods and services products. In this analysis, the PPML models presented in Table 6 were estimated for twelve different goods and seven different services categories. Figures 1A and 1B present the border effects, including 95% confidence intervals, for the exports from and imports into the 25 European countries. As can be observed from these figures, the border effect for the different services is much larger than for the different goods, for both exports and imports.[22]

Figure 1A: Asymmetries in border effects for PPML estimations on exports of the 25 European countries

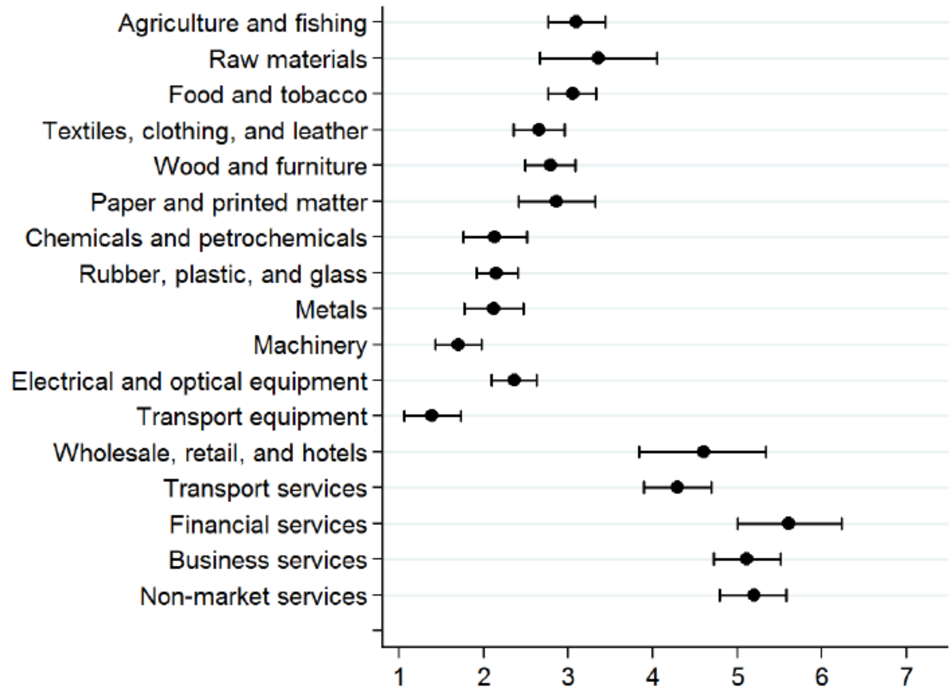


Figure 1B: Asymmetries in border effects for PPML estimations on imports of the 25 European countries

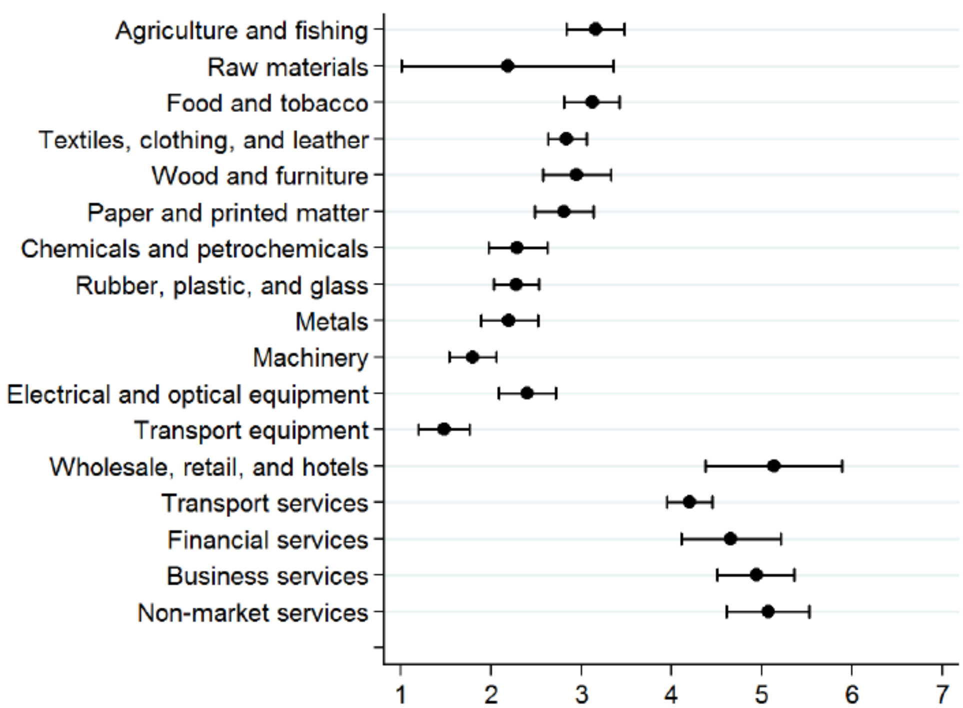


Figure 2A: Asymmetries in distance effects for PPML estimations on exports of the 25 European countries

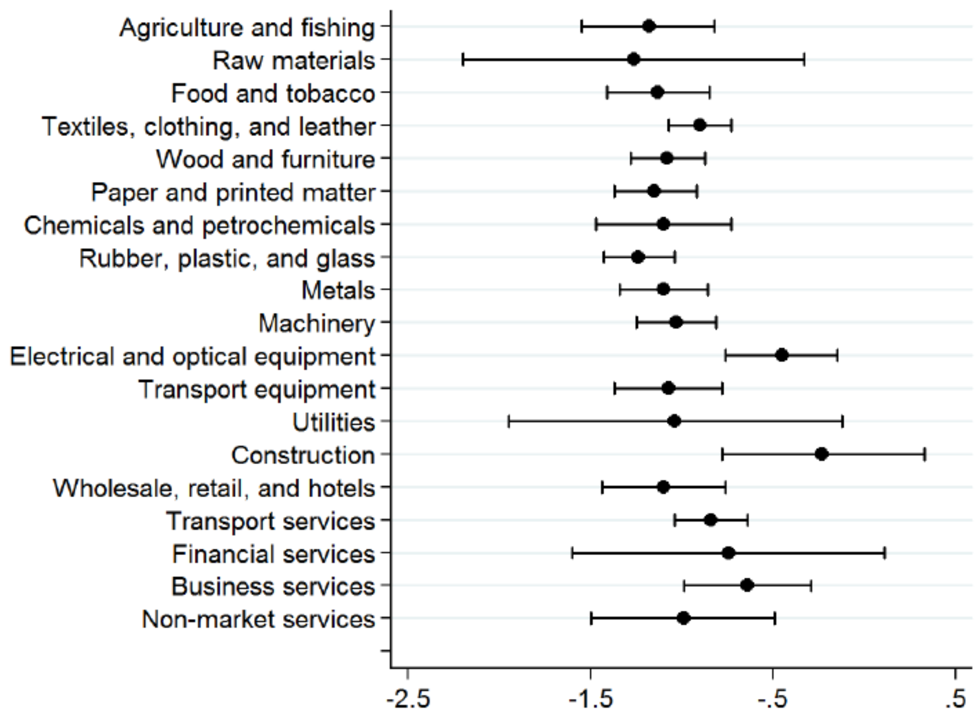
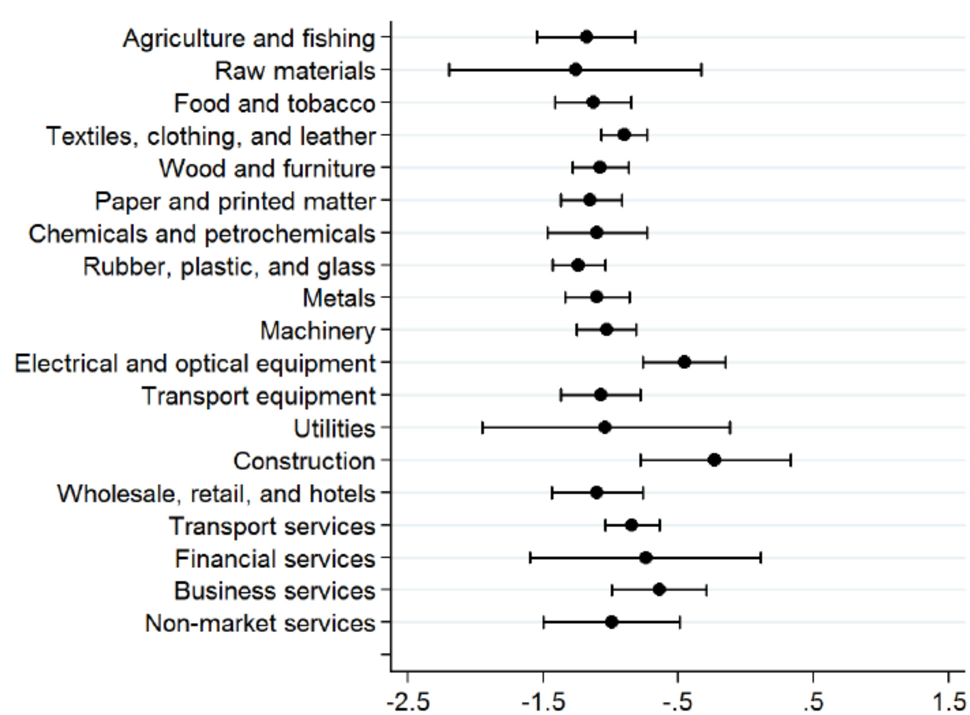


Figure 2B: Asymmetries in distance effects for PPML estimations on imports of the 25 European countries



Even the border effects for financial and business services are much larger than the border effects for all goods products. Under PPML estimation, the internal trade in financial and business services is, on average, a factor of over 200 higher than the bilateral exports of these services, whereas the internal trade in knowledge-intensive manufactured goods, such as transport equipment and machinery, is, on average, a factor of 5 higher than the bilateral exports of these knowledge-intensive manufactured goods.

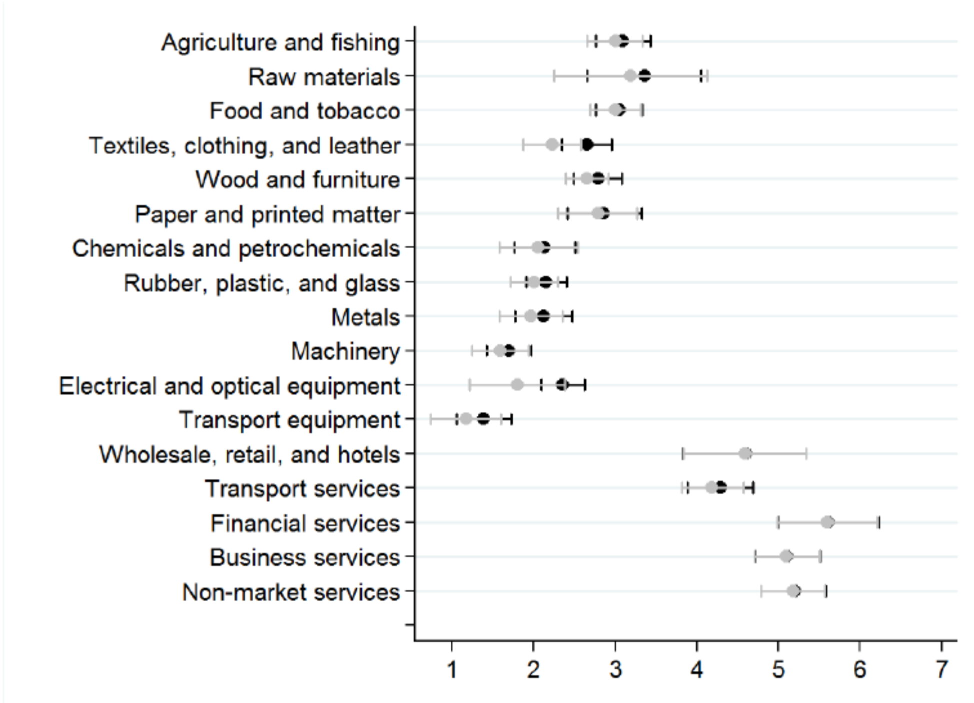
However, Figures 2A and 2B show that most services products have lower distance decays than most goods products. In this respect, the commercial services products (wholesale, transport services, communications, business services and financial services) behave similarly to the goods varieties characterised by a knowledge-intensive production process, such as chemical products and electronics. Financial services exports have the lowest distance decay (0.04), but the large confidence interval indicates that there is a marked uncertainty about the true value of this parameter.

4.3. The Impact of the Re-Export Correction

Figure 3 compares the border effects, including 95% confidence intervals, for the exports from 25 European countries, including and excluding re-exports. As can be observed from this Figure, the border effect is considerably higher for certain goods when not correcting for re-exports: for textiles, electronics and transport equipment, the point estimates of the border effect are 18%-31% larger for these goods varieties. For services, there is hardly any difference with respect to the border effect when estimating including the re-exports. This result is not surprising, as re-exports are relatively unimportant for the trade in services (see also Table 1). Accordingly, the border effect difference between goods and services becomes less pronounced when excluding re-exports.

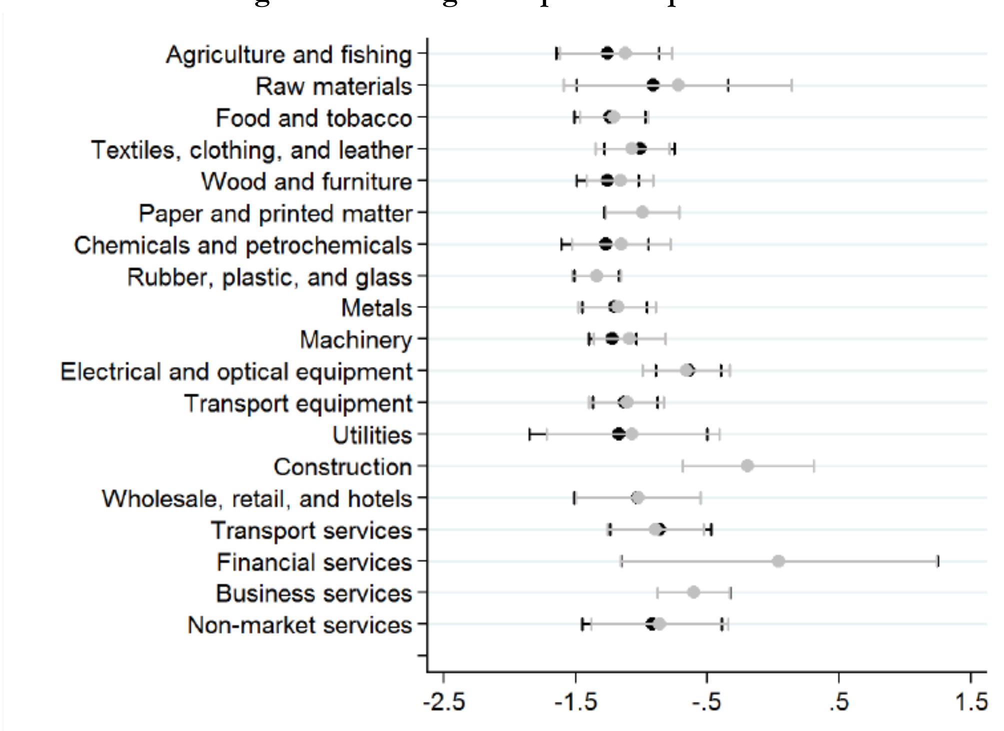
Figure 4 compares the distance effects, including 95% confidence intervals, for the exports from the 25 European countries including and excluding re-exports. With respect to the different goods, the point estimate of the distance decay is between 6% (food and tobacco) lower to 19% (raw materials) higher when not correcting for the re-exports in the trade statistics. Again, the most notable differences between estimations including and excluding re-exports are found for goods with a high share of re-exports in the total trade (electronics, textiles, machinery and transport equipment); the differences for services are negligible. Overall, when correcting for re-exports, the difference between goods and services becomes less pronounced.

Figure 3: Border effects for PPML estimations on exports of the 25 European countries – Excluding and Including Re-exports compared



Grey: Including Re-Exports, Black: Excluding Re-Exports

Figure 4: Distance effects for PPML estimations on exports of the 25 European countries– Excluding and Including Re-exports compared



Grey: Including Re-Exports, Black: Excluding Re-Exports

5. Discussion and Conclusions

In our article, we compare the magnitude and distance decays of trade in goods and services using a newly assembled, consistent and disaggregated dataset on the internal and bilateral trade in goods and services for 25 European countries. The measurement of both trade in goods and trade in services is improved over earlier research, allowing us to consistently compare trade in goods and services. First, trade in goods and services is analysed at a more detailed product level. Second, the dataset is consistent with the domestic demand and production and the total exports and imports at the sector and product levels. Third, we explicitly control for re-exports in our analysis, as these transactions distort the trade patterns of goods (not so much of services), leading to an overestimation of the volume of trade and, thereby, an underestimation of the relative size of the internal trade within a country.

The construction of a bi-country dataset on trade in goods and services requires a large amount of information from different sources. The combination of these different data sources provides trade data with re-exports excluded, with exports and imports valued in the same prices, and consistent with respect to the destination of exports and the origin of imports. Data such as import, supply and use tables only become available after a substantial delay and rarely for a complete set of countries, such as presented in this analysis. This lack of data explains why the dataset was only constructed for the year 2000, the year for which the largest amount of necessary data was available. An update of the data for more recent years will only be possible if the same data sources are available. An additional bottleneck is the incorporated Feenstra (2005) dataset, which ends in the year 2000. An alternative would be to switch to different data sources over time for those data that are not available. However, this strategy would render the trade data not comparable over time. Despite these difficulties, we hope to extend the dataset with information on trade in more recent years in the near future.

Both indirect and direct estimation of trade costs show that the border effects for trade in services are generally high. Once services are traded bilaterally, though, the attenuation with distance and the relation with other explanatory variables, such as shared language or shared legal systems, do not differ much from those of traded goods. Accordingly, there may be a large unexploited potential for trade in services that can be stimulated by reducing trade costs by technological improvements and market liberalisation. However, our results also suggest that many services are, to a large extent, non-tradable because the trade costs become too high and services firms need other channels for international transactions, such as FDI. Indeed, Christen and Francois (2010) show that the local presence of multinationals increases relative to cross-border trade with increased transactional distance between countries. Despite improvements in transport technologies, moving people around is still very costly. Hence, provision by the local presence of a supplier may be a more viable option than cross-border trade for effective international services transactions. Using this dataset, future research can extend the empirical analysis by scrutinising the underlying costs of trade in services, focussing on direct measures of extant policies that apply at the border and along logistics chains. Databases at the World Bank (Doing Business)[23], UNCTAD (TRAINS – Tariff and Non-Tariff Barriers to Trade)[24], and OECD (Indicators of Product Market Regulation)[25] provide such information on the goods and services sectors. Undertaking such analyses would further enhance our understanding of why trade in services is still relatively limited in a world economy dominated by services.

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Appendix A:

Classification of Goods and Services Products in the Data

NACE 1.1. Code	Name
A+B	**Agriculture, Hunting and Forestry; Fishing**
1	Products of Agriculture, Hunting and Related Services
2	Products of Forestry, Logging and Related Services
5	Fish and Other Fishing Products; Services Incidental To Fishing
C	**Mining and Quarrying**
10	Coal and Lignite; Peat
11	Crude Petroleum and Natural Gas; Services Incidental To Oil and Gas Extraction, Excluding Surveying
12	Uranium and Thorium Ores
13	Metal Ores
14	Other Mining and Quarrying Products
DA	**Manufacture of Food Products, Beverages and Tobacco**
15	Food Products and Beverages
16	Tobacco Products
DB + DC	**Manufacture of Textiles, Textile Products and Leather**
17	Textiles
18	Wearing Apparel; Furs
19	Leather and Leather Products
DD + DN	**Manufacture of Wood and Wood Products; Manufacturing n.e.c.**
20	Wood and Products of Wood and Cork (Except Furniture); Articles of Straw and Plaiting Materials
36	Furniture; Other Manufactured Goods n.e.c.
37	Secondary Raw Materials
DE	**Manufacture of Pulp, Paper and Paper Products; Publishing**
21	Pulp, Paper and Paper Products
22	Printed Matter and Recorded Media
DF + DG	**Manufacture of Chemicals and Petrochemicals**
23	Coke, Refined Petroleum Products and Nuclear Fuel
24	Chemicals, Chemical Products and Man-Made Fibres
DH + DI	**Manufacture of Non-Metallic Mineral Products**
25	Rubber and Plastic Products
26	Other Non-Metallic Mineral Products
DJ	**Manufacture of Basic Metals and Fabricated Metal Products**
27	Basic Metals
28	Fabricated Metal Products, Except Machinery and Equipment
DK	**Manufacture of Machinery and Equipment n.e.c.**
29	Machinery and Equipment n.e.c.
DL	**Manufacture of Electrical and Optical Equipment**
30	Office Machinery and Computers
31	Electrical Machinery and Apparatus n.e.c.
32	Radio, Television and Communication Equipment and Apparatus
33	Medical, Precision and Optical Instruments; Watches and Clocks
DM	**Manufacture of Transport Equipment**
34	Motor Vehicles, Trailers and Semi-Trailers
35	Other Transport Equipment
E	**Electricity, Gas and Water Supply**

40	Electrical Energy, Gas, Steam and Hot Water
41	Collected and Purified Water; Distribution Services of Water
F	**Construction**
45	Construction Work
G + H	**Wholesale and Retail Trade; Hotels and Restaurants**
50	Trade, Maintenance and Repair Services of Motor Vehicles and Motorcycles; Retail Trade Services of Automotive Fuel
51	Wholesale Trade and Commission Trade Services, Except of Motor Vehicles and Motorcycles
52	Retail Trade Services, Except of Motor Vehicles and Motorcycles; Repair Services of Personal and Household Goods
55	Hotel and Restaurant Services
I	**Transport, Storage and Communication**
60	Land Transport and Transport Via Pipeline Services
61	Water Transport Services
62	Air Transport Services
63	Supporting and Auxiliary Transport Services; Travel Agency Services
64	Post and Telecommunication Services
J	**Financial Intermediation**
65	Financial Intermediation Services, Except Insurance and Pension Funding Services
66	Insurance and Pension Funding Services, Except Compulsory Social Security Services
67	Services Auxiliary To Financial Intermediation
K	**Real Estate and Business Services**
70	Real Estate Services
71	Renting Services of Machinery and Equipment Without Operator and of Personal and Household Goods
72	Computer and Related Services
73	Research and Development Services
74	Other Business Services
L+M+N+O+P	**Non-Market Services**
75	Public Administration and Defence Services; Compulsory Social Security Services
80	Education Services
85	Health and Social Work Services
90	Sewage and Refuse Disposal Services, Sanitation and Similar Services
91	Membership Organization Services n.e.c.
92	Recreational, Cultural and Sporting Services
93	Other Services
95	Services of Households As Employers of Domestic Staff

Appendix B:
The Construction of a National Accounts and Bilateral Consistent Trade Dataset

To analyse the trade costs for goods and services, a consistent and disaggregated dataset has been constructed on the exports and imports of goods and services for 25 European countries for the year 2000. These countries are Austria, Belgium, the Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, the Netherlands, Norway, Poland, Portugal, Slovakia, Slovenia, Spain, Sweden, and the United Kingdom. In this appendix, we present the methodology used to construct the trade dataset used in this paper and available from the website of the Review of World Economics. The purpose of this appendix is twofold. The first purpose is to give an account for the data used in this paper and their reliability. The second purpose is to present the methodology in clear mathematics, such that the data can be reproduced for the year 2000, the year of the dataset, and may be used by others when more data become available in the near future. We followed a mixed survey methodology to construct the dataset, which is an extension of the work of Oosterhaven et al. (2008) and Bouwmeester and Oosterhaven (2009).

The starting point for the dataset consists of the national accounts compatible supply and use tables for the abovementioned countries made available by Eurostat (2010). The year 2000 was chosen because it is the year for which the most tables are available and it is the last year in the Feenstra (2005) trade database. Those tables that were not available for the year 2000, i.e., Latvia and Greece, have been updated using the commonly applied RAS method (or bi-proportional updating method). The necessary row and column sums for the supply and use tables of Latvia and Greece are available from Eurostat.[26]

The supply and use tables of these 25 countries contain estimates of the exports and imports for 59 goods and services categories according to the CPA product classification (see the Eurostat website for the definitions at http://ec.europa.eu/eurostat/ramon/). To construct a consistent bi-regional trade dataset from these national data, we have performed the following 4 steps, which will be explained in detail below:

1) Direct purchases abroad are distributed over the different product categories, such that all imports and exports in the national accounts are accounted for.
2) Where necessary, the imports have been changed from c.i.f. (including *cost, insurance* and *freight*) to f.o.b. (*free on board*) such that both imports and exports are valued in the same way and are therefore comparable.

3) The destination country of the different products has been added, using an aggregation of detailed product trade data (Feenstra, 2005) and services trade data (Eurostat, 2010) and the data have been made consistent. The exports at the detailed product and services level from country A to country B should equal the imports into country B from country A while maintaining consistency with the national accounts statistics as published in the supply and use tables.

4) The re-exports have been excluded from the trade data, such that all observed trade flows are from the country of production to the country of consumption.

Below, we discuss these four steps in the construction of the dataset in more detail.

A.1 Direct Purchases Abroad

In most statistics, direct purchases abroad are not included in the export and import statistics, although they may constitute a large part of the trade in the tourism industry and may become increasingly important with the possibility of direct purchases abroad via the internet. Although the importance of these purchases may still have been limited in the year 2000, direct purchases form a substantial amount of the total trade and should therefore be accounted for. In most countries, these direct purchases have been added to the exports and imports of hotel and restaurant services, recreational, cultural and sporting services proportional to the present expenditures. In both Hungary and Luxembourg, purchases in the domestic territory by non-residents have also been added to the expenditures on food and real estate services. From the national account statistics, it was clear that these categories were the only product groups that had a considerable share in the direct purchases abroad category because they were the only ones that had a large enough domestic production to cover the total amount of direct purchases abroad in those countries. To be more precise, we will describe the reallocation of the direct purchases abroad using mathematics. Let direct purchases abroad by the residents of country c be described by Dp_c, and the purchases in the domestic territory of country c by non-residents as Pd_c. Both items can be found in a row of the Eurostat use and supply tables. We also have goods g, exports $E_{c,g,d}$ and imports $M_{c,g,d}$, of which the destination or origin d can be the EU15 $eu15$ or the rest of the world row. The target products into which the direct purchases must be divided in are described as tg, and we have the share $\gamma_{c,tg}$ of the final household consumption $HC_{c,tg}$ of these goods from the use tables and the share of imports $\eta_{c,tg}$, where

$$\gamma_{c,tg} = \frac{HC_{c,tg}}{\sum_{tg'} HC_{c,tg'}} \quad and \quad \eta_{c,tg,d} = \frac{I_{c,tg,d}}{\sum_{tg'} I_{c,tg',d}} \tag{5}$$

Now the following corrections must be made to the exports and the imports in the supply and use tables.

$$E_{c,tg,d} = E_{c,tg,d} + \gamma_{c,g} \frac{E_{c,tg,d}}{E_{c,tg,eu15} + E_{c,tg,row}} Pd_c \tag{6}$$

$$I_{c,tg,d} = I_{c,tg,d} + \eta_{c,g,d} Dp_{c,d} \tag{7}$$

In those tables in which the destinations of exports and the origins of imports were not subdivided into $eu15$ and row, we used the total of the destinations to divide the direct purchases. We leave out the corrections to other parts of the supply and use tables to create consistent supply and use tables without the direct purchases abroad because these transactions are not used to create the trade data, are complex considering the Eurostat methodology and would therefore unnecessarily complicate this appendix.

A.2 The Valuation of Exports and Imports

The valuation of exports and imports and the adjustment of the direct purchases abroad are typical issues common in the Input-Output literature and, more specifically, the documentation on the construction of supply and use tables (see Eurostat 2008 and Miller and Blair 2009). In general, both exports and imports are given in the same prices in the Eurostat supply and use tables. However, the imports of Germany, Estonia, Spain, Finland, Hungary, Italy, Lithuania, Poland, Portugal and Sweden are reported c.i.f. with a correction factor in the column such that only the totals are f.o.b. This format choice is due to the flexibility in the ESA95 methodology prescribed by Eurostat (2008), in which only the *total* imports should be f.o.b. To express the imports in f.o.b. at the product level, we had to distribute the correction factor over the different product and services categories.

The correction for the valuation appears to be straightforward. We have the total transport costs used domestically, which is part of the imports in the supply tables. These costs must be distributed over the goods, and the only information we have is the shares of transport costs for the produced goods that remain within the country. We can therefore use these shares as a proxy for the imported goods. However, this is not the complete story. There are also transport costs from the origin countries (the exporter) to the border of the destination country (the importer) that will be incurred by foreign transport companies. This component of the transport costs is not taken into account in the correction factor in the use tables and is not available elsewhere. However, from transport statistics, we know that for the Netherlands and for the total of all products, the proportion of foreign transport versus domestic transport is 35% versus 65%. We use these figures for all of the countries and increase the transport margins that are part of the imports in the use tables by another 53%.

We will describe the adjustments made using mathematics, such that they can be reproduced by others. Let $TR_{c,g}$ be the total transport costs involved in the domestic trade of a good g in country c represented by the column in the use table, let CF_c be the c.i.f./f.o.b. adjustments on imports as given in the supply table, and let κ be the abovementioned ratio of foreign to domestic transport costs. We define $\tau_{c,g}$ as the share of the total transport costs such that

$$\tau_{c,gnr,d} = \frac{TR_{c,gnr,d}}{\sum_{gnr'} \sum_{d'} TR_{c,gnr',d'}} \qquad (8)$$

where gnr stands for all of the products and services except the transport services gr. These transport services include land transport, water transport and air transport services. The corrections on all of the imports are now equal to

$$I_{c,gnr,d} = I_{c,gnr,d} - \tau_{c,gnr,d} \left(1 + \kappa\right) CF_c \qquad (9)$$

We have now split off all of the transport costs from the imports and thus obtained the f.o.b. imports. However, we must still correct the accounts for the transport services. We define $\tau r_{c,gr}$ as the share of transport used from the transport service gr [27] such that

$$\tau r_{c,gr,d} = \frac{TR_{c,gr,d}}{\sum_{gr'} \sum_{d'} TR_{c,gr',d'}} \qquad (10)$$

The imports of transport services are now corrected as

$$I_{c,gr,d} = I_{c,gr,d} + \tau_{c,gr,d} \left(\kappa\right) CF_c \qquad (11)$$

whereas the other component of the transport costs is actually an export of transport services, and that part of the correction goes to the export column in the use table, as follows:

$$E_{c,gr,d} = E_{c,gr,d} - \tau_{c,gr,d} CF_c \qquad (12)$$

Additionally, with respect to the valuation corrections on the imports, we leave out the corrections to other sections of the supply and use tables that are not relevant in the presented analysis. In those tables in which the destinations of exports and the origins of imports were not subdivided into $eu15$ and row, we used the total of the destinations to divide the transport margins in the imports.

A.3 Consistency of Imports and Exports

After these adjustments, exports and imports are comparable. Both types of transaction are presented in the same prices (purchaser prices, free on board), and *all* exports and imports have been distributed over all product categories. Now we must determine the specific destinations and origins of the Exports and Imports of all goods and services. We started by creating priors of these destinations and origins. We created these priors from the total exports and imports per product category multiplied by the origin or destination shares. These origin and destination shares for products were taken directly from the Feenstra (2005) data for 2000. To aggregate the Feenstra data into the CPA classification used in the supply and use tables, we used the concordances available from the Eurostat RAMON website http://ec.europa.eu/eurostat/ramon/). The origin and destination shares are simply the percentages of exports and imports from a country in our database to another country or group of countries in our database. It is more difficult to obtain these shares for the services categories. For the year 2000, only 4 broad categories of bilateral services trade data (for transportation, travel, other business services and other services) were available from the Eurostat website on trade in services. These data had many missing values, and we therefore pooled the data from the years 2000 to 2004 to obtain a full matrix of bilateral trade data for the abovementioned 4 services categories. We therefore used the same shares for the subcategories that belonged to the same broad category for which we had data. Thus, we obtained the export priors $E_{i,g,j}^{prior}$ of a good g from country i to country j and the import priors $I_{i,g,j}^{prior}$ of a good g to country i from country j.

All of the exports and import of a region are accounted for and consistent with the national accounts. Therefore, the imports of a certain product of country A from country B should be exactly equal to the exports of the same product from country B to country A. However, substantial discrepancies remained between the two priors. To use the information that both figures should be the same *and* should be consistent with the national accounts, we have estimated the most likely trade between the countries. We have estimated the consistent trade dataset by minimising the absolute relative distance with respect to these two priors given the overall totals of exports and imports from the national accounts. We have given the error in import estimates three times as much weight as the error on the export prior, following the literature on constructing consistent trade statistics (Oosterhaven et al. 2008; Bouwmeester and Oosterhaven 2009), in which the import estimates are commonly assumed to be more reliable because of tariff and registration issues.

The mathematical optimisation problem that must be solved to obtain the trade matrix $T_{g,i,j}$ of a good g from country i to country j can be described as

$$Min\ Z = \left| \frac{E^{prior}_{i,g,j} - T_{i,g,j}}{\frac{1}{4}E^{prior}_{i,g,j} + \frac{3}{4}I^{prior}_{j,g,i}} \right| + 3\left| \frac{I^{prior}_{i,g,j} - T_{j,g,i}}{\frac{1}{4}E^{prior}_{j,g,i} + \frac{3}{4}I^{prior}_{i,g,j}} \right| + \left| \frac{E^{prior}_{i,g,eu15} - T_{i,g,eu15}}{E^{prior}_{i,g,eu15}} \right| + 3\left| \frac{I^{prior}_{i,g,eu15} - T_{eu15,g,i}}{I^{prior}_{i,g,eu15}} \right|$$

$s.t.$

$$\begin{aligned} &1)\quad T_{i,g,eu15} = \sum\nolimits_{j=eu15} T_{i,g,j} \\ &2)\quad T_{eu15,g,i} = \sum\nolimits_{j=eu15} T_{j,g,i} \\ &3)\quad E_{i,g,total} = \sum\nolimits_{j=} T_{i,g,j} \\ &4)\quad I_{j,g,total} = \sum\nolimits_{i=} T_{i,g,j} \end{aligned} \tag{13}$$

The last two absolute relative errors that are minimised in the procedure are only applied if the priors $E^{prior}_{i,g,eu15}$ and $I^{prior}_{i,g,eu15}$, describing total exports to and imports from the EU15, were directly available from the supply and use tables. The last two constraints guarantee consistency with the national accounts. This optimisation problem has been solved with the GAMS mathematical software. The resulting trade matrix is consistent with respect to imports, exports, and the national accounts.

A.4. Dealing with Re-exports

After the optimisation procedure, we obtained a consistent trade matrix. However, this matrix still contains the re-exports. Both the pattern and the volume of trade are affected by the re-exports. We therefore exclude the re-exports from the trade data using information from the import matrix that was made available by the bureaus of statistics of the analysed EU countries. The resulting trade matrix is an origin-final destination matrix. The methodology used is a mixed survey and non-survey technique that combines information on re-exports by country with assumptions regarding the origins and destinations of re-exported goods and services.

The method of excluding the re-exports from the trade matrix can be applied for every product separately. We therefore leave out the goods indices from the equations below. We start by defining the export destination shares e_{ij}^{c} from country i to country j such that

$$e_{ij}^{c} = \frac{E_{ij}}{\sum_{j \neq c} E_{ij}} \tag{14}$$

We define the import shares m_{ij} that country i receives from country j, such that

$$m_{ij} = \frac{I_{ij}}{\sum_{j} I_{ij}} \tag{15}$$

The total re-exports (for every product) RE_i for country i are taken from the import tables. This information is sufficient to estimate the pattern of re-exports ρ_{ij}^{c} from country i to country j via country c as

$$\rho_{ij}^{c} = RE_c m_{ci} e_{cj}^{i} \tag{16}$$

Here we see the importance of excluding country c from the summation in equation 14. This exclusion forestalls the possibility, in equation 16, that re-exports are being re-sold in the origin market. Once the re-export matrix ρ_{ij}^{c} has been identified, the values of the re-exports need to be subtracted and summed in different parts of the original trade matrix. The trade flow between the origin i and the intermediate country c must be removed. The same is true for the flow of the same size from the intermediate country c to the destination country j. This trade flow, which is removed twice, from i to c and from c to j, is then added as an export from origin i to destination j. In mathematics, this operation can be summarised as

$$X_{ij} = X_{ij} + \sum_{c} R_{ij}^{c} - \sum_{c} R_{ic}^{j} - \sum_{c} R_{cj}^{i} \tag{17}$$

After excluding the re-exports from the trade data, we had to make several final corrections:

1. We have developed a methodology for excluding the re-exports from the trade data independent of the order of countries to which you apply the method because we maintain the original trade matrix as a reference. The disadvantage of this approach is that certain export flows may become smaller than zero. A solution is to recalculate the shares of imports and exports (e_{ij}^{c} and m_{ij}) after every country's adjustment. However, the method would in that case become dependent on the order of countries to which the correction is applied. We therefore chose for a practical correction and changed any small negative exports into imports.
2. In certain cases, re-exports may cause the exports of a product to be larger than the production in the country. Due to incorrect data on the size of the re-exports, it is possible that, after the correction procedure was applied, the exports of certain products were still larger than the production. We therefore repeated the correction algorithm, defining the missing re-exports as the excess of the exports over production.
3. A final correction is required because the two problems mentioned in (1) and (2) may interact. That is, correction 1 may cause the exports to become larger than the production, whereas correction 2 may cause negative export flows. The solution was to programme the corrections 1 and 2 in a loop. After two loops, the problem was solved.

Notes

[1] Nevertheless, it can be expected that a considerable amount of trade in services remains under the radar, as it occurs through the FDI. These transactions do not appear in the balance of payments and official trade statistics. However, it is contended that this channel is very important for international sales in services (Christen and Francois, 2010; Hoekman and Mattoo 2010).

[2] However, the literature on trade in services is rapidly expanding. A recent overview of the literature can be found in Francois and Hoekman (2010) and Goswami et al. (2011).

[3] In the General Agreement in Services (GATS), these ways to provide services are better known as modes 1, 2, and 4 and jointly constitute cross-border sales in services. Mode 3 of service supply entails service provision through the commercial presence of a supplier in the territory of any other country and falls under the header of Foreign Direct Investment by multinationals. As indicated by Christen and Francois (2010), the trade costs are so high for these types of services that they must be locally supplied. However, Mode 3 services sales do not appear in the balance of payments and trade statistics and are therefore beyond the scope of this article.

[4] Unfortunately, we are not able to present a more detailed level of aggregation.

[5] An overview of the goods and services included in the database can be found in Appendix A.

[6] These countries include Austria, Belgium, the Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, the Netherlands, Norway, Poland, Portugal, Slovakia, Slovenia, Spain, Sweden, and the United Kingdom.

[7] More recently, Francois and Pindyuk (2013) have provided an update of this database.

[8] The focus of Christen and Francois (2010) is markedly on comparing cross-border trade and affiliate sales. In the subsection in which manufacturing and services are compared, their aim partially overlaps with ours, but we note that their main focus remains on the comparison between modes of supply, so that they analyse the effect of distance on the share of affiliate sales on total sales.

[9] In practice, this definition means no change in the product codes. However, there are certain exceptions to this rule.

[10] This excludes transito trade, e.g., American Tupperware bought by a British resident and transported directly to Australia, and as such does not cross the British border. In this example, only the financial transaction occurs in the United Kingdom. As such, this form of trade does appear in the British services export statistics.

[11] Good overviews of trade costs in New Economic Geography are provided by Combes et al. (2008) and Bosker and Garretsen (2010).

[12] Empirical applications of this indicator can be found in Head and Ries (2001), Head and Mayer (2004), and Brakman et al. (2006).

[13] Other studies that use a gravity-like equation to compare trade in goods and services include Kimura and Lee (2006), Lejour and De Paiva Verheijden (2007), and Lennon (2008).

[14] Please note that we cannot control for multilateral resistance (Anderson and Van Wincoop, 2003) using country-pair fixed effects since we analyze a cross-section. However, it should be noted that coefficients considerably change when including the origin and destination fixed effects, in the expected direction. Most notably, while the coefficient for physical distance is positive and significant (for both trade in goods and services) when estimating the model without fixed effects, the coefficient becomes negative and significant when including fixed effects.

[15] For representation, the median freeness of trade is multiplied by 100.

[16] Similar differences between goods and services were found when examining different subsets of countries (available on request).

[17] More specifically, we included Australia, Canada, China, Hong Kong, Japan, Korea, the Russian Federation, Singapore, Switzerland, Turkey, and the United States in the analysis.

[18] A condition of the PPML model is equidispersion, in that the conditional variance should be equal to the conditional mean. However, most often the PPML model suffers from overdispersion, meaning that the conditional variance is higher than the conditional mean. This effect, in turn, can result in inefficient estimates (Gourieroux et al. 1984). To remedy the problem of overdispersion, a negative binomial regression model can be employed (for applications in trade studies see, e.g., Burger et al., 2009; Head et al., 2009). However, as shown by Bosquet and Boulhol (2010), negative binomial estimation is inappropriate when applied to continuous dependent variables, as the results are dependent on the scale of measurement used (e.g., thousands, millions or trillions of euros). We also checked for excess zeros (see also Burger et al. 2009), the situation in which the incidence of zero counts is greater than is expected for the Poisson distribution, but the Vuong statistic (Vuong 1989) indicated that the zero-inflated Poisson model was not favoured above its non-zero-inflated counterpart and yielded similar parameter estimates.

[19] http://www.cepii.org; see Mayer and Zignagno (2006) for a more elaborate description of the data.

[20] To assess whether two countries share a similar language, we use a database collected by Haveman that distinguishes fourteen languages. These data have been expanded using the CIA's World Factbook to cover even more countries and languages (see also Linders et al., 2008).

[21] The models were estimated using Jeroen Weesie's grobust option in Stata, which is able to compute sandwich-style standard errors for complex data structures, including one-, crossed, and multiway clustering, multiple membership, and proximity structures.

[22] For graphical representation, the very large border effects for construction (exports: b=8.89, se=0.73 ; imports: b=8.77, se = 0.82) and utilities (exports: b=6.20, se=0.56; imports: b=5.86, se= 0.41) are not displayed in these graphs

[23] The World Bank's Doing Business database is available at http://www.doingbusiness.org

[24] The UNCTAD's TRAINS database is available at the WITS website http://wits.worldbank.org/wits/

[25] The OECD's Indicators of Product Market Regulation database is availabe at www.oecd.org/economy/pmr.

[26] The RAS method is a biproportional updating procedure to obtain an 'updated' matrix given an old matrix and new row and column totals of the matrix. This procedure can be mathematically described as $A_1 = \hat{r} A_0 \hat{s}$ where A_1 is the updated matrix, A_0 is the original matrix and $\hat{r}$ and $\hat{s}$ are two diagonal matrices, of which the elements are determined using an iterative algorithm such that the row and column totals of A_1 satisfy the predetermined row and column totals. See Miller and Blair (2009) for an elaborate discussion of the methodology.

[27] Please notice that the total use of transport sevices is put with a negative sign in the same column as the transport use of all of the products, but in the row of the transport services. In this way, the column will, by definition, add up to zero.