Gravity and international services trade: the impact of virtual proximity*

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Abstract

This paper analyses the determinants of bilateral trade in services, both for total services and its subcomponents, such as travel, financial or computer services. Our gravity model framework encompasses traditional variables such as distance, refined measures of linguistic similarity and most importantly, a novel variable capturing virtual proximity between countries, based on bilateral hyperlinks. We find that virtually-proximate countries trade significantly larger amounts of services in aggregate as well as in almost all subcategories of trade. Among the different types of services, we find that the effect of virtual proximity is greatest for information-intensive services such as financial, communication, IT, insurance and audiovisual services. Moreover our findings indicate that virtual proximity – next to its direct impact – alleviates negative distance effects in services trade substantially, thus raising the potential for offshoring.

Keywords: International services trade; information; distance effects; hyperlinks; internet

JEL Classification: F12, F15.

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1 Introduction

Services are the biggest contributor to global output, representing roughly two thirds of global GDP, with the services share being generally higher in more developed countries. In the euro area, for example, it amounted to 74% in 2009 and in the United States to 79%, while it only reached a value of 44% in China. At the same time, global services trade has become increasingly important, amounting to about a quarter of total trade. Francois and Manchin (2011) and Johnson and Noguera (2012) argue that the role of the services sector in international trade is much larger in value added terms than suggested by gross trade data. In the presence of global value chains, services have increasingly been outsourced as intermediate inputs (Head et al., 2009). Moreover, especially technology-intensive services such as ICT (information, computer and telecommunications services) or financial services have grown substantially over the past decade. While goods can be produced and consumed at different times and in different places, services often require proximity of producers and consumers. Hence, geographical factors such as distance carry additional costs, the so-called 'proximity burden' (Christen and Francois, 2016). As services are often relied on to facilitate transactions through space or time (Melvin, 1989) they frequently accompany trade in goods. One example are goods shipments, a margin service, which generally are those services which facilitate the exchange of products. The second type of services are transformation services in which a specific task changes the condition of a good, such as construction, for example.

The rise in services trade has coincided with the introduction of new technologies, in particular, the internet which should substantially reduce transactions costs and distance effects for many services. Due to their very nature, services are often traded directly via the world wide web or the transaction is mitigated via the web. Moreover, services and their quality are intangible and often 'experience products' which require a lot of information before consumption.

Our paper analyses bilateral, international patterns of trade in services in a gravity model framework for the full set of disaggregated services. We use the full register of gravity model variables and compare across services categories in order to gain insights on the most important drivers and deterrents for international services trade. In particular, we use a novel bilateral indicator for international information flows via the internet. Our hypothesis is that 'virtual proximity' exerts the largest, positive impact on bilateral services that require modern technologies as well as those that are highly information-sensitive. We expect that including virtual proximity reduces the negative effects on physical distance and proxies for information asymmetries for such services, but perhaps

also for other categories of traded services. Thereby we provide new evidence on the 'distance effect', highlighting the role of information next to traditional transactions costs, and their impact on international services trade and the related offshoring debate.

Our virtual proximity measure is based on Chung's (2011) data on bilateral webpage hyperlinks. The idea is to reflect, for instance, how often British or French internet users set links to websites from the United States (say the homepage of the New York Times). In case this indicator is, *ceteris paribus*, higher for the United Kingdom than for France, we interpret this as British citizens being virtually closer to the United States than the French. The underlying assumption is that information flows and virtual proximity of two countries increases with the interest shown in each others' web content. Similarly, one could imagine a potential customer inquiring about insurances or travel destinations on the web, querying the product of interest but also the market and country more generally. If this is the case, market participants will be more likely to obtain services from countries for which they have more information and to which they feel literally and figuratively connected.

In general, information and communication technology has become increasingly important, influencing almost all types of transactions, be it in a business or private setting. Most notably, the World Wide Web is becoming the predominant vehicle for accessing and transmitting information globally. A key advantage of using virtual proximity as a measure of information acquisition is that internet activities are relatively costless (in particular as they have zero variable trade costs), i.e. with few usage barriers in light of high and rising global internet penetration rates. As such, virtual proximity is a good measure for potentially asymmetric information flows between countries. It is important to note that virtual proximity goes beyond mere ease of access to information as it captures information flows between countries directly. Expanding the set of traditional measures of cultural proximity with information on international connectedness, allows us to capture more concretely how the internet bridges information asymmetries in international services trade. This is particularly important as services span a wide range of economic activities, are very heterogeneous and due to their intangible characteristics are inherently more information sensitive than goods. Therefore, virtual connectedness should reduce uncertainty about services procured from abroad. In light of the importance of the internet, such a web-based measure of revealed proximity can be expected to be more relevant than other variables traditionally used in gravity models.

Head et al. (2009) estimate a gravity-model for total services trade and different sub-categories (however, using a less granular breakdown than in our paper). They find

that services trade is subject to strong distance effects, implying that the possibility of off-shoring of services remains limited. The authors also find, however, that distance costs are declining over time. In our paper we will hence test if the rise of the internet could be an explanation for the waning distance effect. Kimura and Lee (2006) as well as Francois and Hoekman (2010) also estimate gravity equations for services. The former paper finds that services are better predicted by a gravity model than goods, while the latter also focuses on broad sub-categories of services. Moreover, there is a strand of literature focusing on particular categories of services trade, such as Culiuc (2014) on tourism, Hellmanzik and Schmitz (2015) for audiovisual services as well as Marvasti and Canterbery (2005) and Hanson and Xiang (2011) for US trade in movies.

The literature has analysed several factors beyond distance which shape bilateral services trade patterns. For example, a common language may facilitate international transactions which require quality monitoring, while in the event of disputes, resolution will be less complicated if both parties are subject to the same legal system (Freund and Weinhold, 2004). Freund and Weinhold (2004) find a significant effect of the internet (measured by growth in web hosts in a country) on growth of goods exports which is consistent with a theoretical model in which the internet reduces market-specific fixed trade costs. Regarding exports of services, Freund and Weinhold (2002) show that internet development in its partner countries has resulted in increased exports of services to the United States. Using data on bilateral webpage hyperlinks, Hellmanzik and Schmitz (2015) find that 'virtually-proximate' countries trade significantly larger amounts of audiovisual services and that virtual proximity has a larger impact on trade in audiovisual services than on total services trade. Based on a sample of US internet users, Blum and Goldfarb (2006) point out that a gravity model also holds for taste-dependent digital products such as music and games for which physical distance has a negative impact on their consumption. They attribute this finding to cultural differences that are increasing in geographic distance.

Moreover, measures of language and cultural preferences for a particular trading partner have received a lot of attention in recent years. Melitz (2008) and Melitz and Toubal (2014) compile and analyse an extensive dataset on the importance of language in trade which greatly expands on previously-existing measures. They find that countries of the same linguistic roots tend to be closer trading partners in terms of goods. A proxy that bears similarity to our virtual proximity measure, but is only available for European countries, was introduced by Felbermayr and Toubal (2010) in the form of bilateral scores in the Eurovision song contest; this is also an annual, bilateral and bidirectional

measure of cultural proximity. However, measuring information flows between countries directly comes at the advantage that we do not only capture revealed preferences for a trading partner but also the actual informational proximity between countries which in all likelihood is the biggest cost driver as well as barrier to international services trade.

The remainder of the paper proceeds as follows: in Section 2 we present the data and stylised facts on trade in services across sectors, Section 3 introduces the gravity model underlying our estimations, while the empirical results are shown in Section 4. Section 5 concludes.

2 International trade in services

2.1 Anatomy of the data

The data on international trade in services used in this paper come from three sources: Eurostat, the OECD Statistics on International Trade in Services and the UN Services Trade database. These institutions provide a detailed geographical breakdown of bilateral trade flows for an increasing number of reporter and partner countries. In general, they follow the Extended Balance of Payments Services Classification (EBOPS) methodology as set up in 2002 and recently updated in the Manual on Statistics in Trade in Services 2010 (outlining the EBOPS 2010 methodology). Data on trade in international services are collected by national authorities from two main sources which are often combined to generate the final statistics: International Transactions Reporting System (ITRS) and enterprise surveys. In the ITRS, international payments channelled through domestic banks, and information on the purpose of a payment, are reported to the statistical agencies. Enterprise surveys enquire about all international transactions from a representative sample of service providers. For instance, in the United Kingdom, statistics on trade in services are based on a survey covering 14,500 businesses in an annual sample (Office for National Statistics, 2015). Some countries collect additional data on travel based on surveys on migration or tourism statistics.

Since 1995, trade in commercial services is covered by the WTO General Agreement on Trade in Services (GATS). The GATS specifies four modes of supply in which cross-border services may be provided abroad:

1. Cross-border supply, where only the service crosses the border (for example financial, insurance and telecommunications services)

2. Consumption abroad, where non-residents consume services outside their country (for example travel)

3. Commercial presence abroad, where a branch or subsidiary is opened abroad to provide services there (for example a branch of a bank)

4. (Temporary) movement of (natural) persons to provide services (for example construction services)

The EBOPS 2002 comprises 11 components of international trade in services which we investigate in this paper:[1]

1. Transportation (such as carriage of passengers)

2. Travel (such as goods and services acquired by a tourists or business travellers abroad)

3. Communication (such as telecommunication services)

4. Construction (such as construction works performed by an employee of a foreign company)

5. Insurance and pension services (such as provision of insurances)

6. Financial services (such as financial intermediation services)

7. Computer and information services (such as computer software)

8. Royalties and license fees (such as franchising)

9. Other business services (such as legal, research and development services)

10. Personal, cultural and recreational services (such as audio-visual services)

11. Government goods and services (such as embassies and consulates)

In order to maximise the number of observations for our empirical analysis, we employ the mirror data approach as is commonly done in the services trade literature (Francois and Pindyuk, 2013). In case a country does not report bilateral data vis-a-vis a certain partner country, the gap is derived by using the data reported by the partner country (if available).

[1]EBOPS 2010 data include two more categories, namely manufacturing services on physical inputs owned by owners and maintenance and repair services not included elsewhere, which were formerly recorded in the goods account. We do not cover these in this paper due to lack of data availability.

2.2 Stylised facts on international trade in services

Global services trade – both as share of GDP and relative to total trade – has increased since 2005 (Figure 1). Taking a longer term perspective, services exports relative to global GDP increased from around 3% in 1975 to around 6.5% in 2014, while the share of services in total export increased from 17% to 22% over the same period. Francois and Manchin (2011) and Johnson and Noguera (2012) argue that the role of the services sector in international trade is much larger in value added terms than suggested by gross trade data, while Francois et al. (2009) suggest that international services flows account for about 45% of global trade, with commercial presences abroad included.[2]

While services trade overall has been more dynamic than goods trade over the past decade, there are important differences within services (Figure 2). Exports of sectors, such as insurance and financial as well as ICT-related services, grew by more than 30% between 2004 and 2015, while the increase in transport services – which are closely linked to the shipment of goods – has been less than 5%. Travel services (as a percentage of GDP) even declined over this period. These developments toward more technology-intensive services are also reflected by the fact that the share of ICT services in total services has surpassed the one of travel since 2004 (Figure 3).

The largest services exporter globally is the United States, followed by the United Kingdom, Germany, France and China (Figure 4). The composition of services trade is heterogenous across these countries. In the United States (Figure 5), travel remains the largest component of exports, closely followed by royalties. Within royalties, exports from the United States are biggest to Ireland, reflecting the strong presence in Ireland of subsidiaries of US-owned companies in the high-tech and pharmaceutical sectors. Exports from the UK (Figure 6) are highest in the 'other' business category, within which trade links are strongest with EU countries such as Germany and the Netherlands. Remarkably, for the UK's other main export sectors such as transportation and travel, the largest bilateral flows are recorded to the United States. In the cases of Germany and France (Figures 7 and 8) 'other' business exports are also the biggest sectors; for Germany, these flows are highest with the United States, while in the case of France intra-EU exports are the biggest category (led by Belgium and Germany).

In fact, among the top-10 services exporters depicted in Figure 4, the largest categories are either transportation, travel or other business services, with the exception of India where computer and information services are the most important category. More than 80% of these exports flow to the United States, reflecting the offshoring of many software

[2]This third mode of cross-border supply of services is not included in trade statistics.

related activities by US companies.

3 Empirical framework

3.1 The gravity model

Following the literature on bilateral trade flows, we estimate the following gravity model (in line with Kimura and Lee (2006) for total services and Hellmanzik and Schmitz (2015) for audiovisual services):

$$ln(services)_{ij} = \alpha_i + \alpha_j + \delta log(\mathbf{Z}_{ij}) + e_{ij} \tag{1}$$

We use bilateral imports of international services $ln(services)_{ij}$ of country i from country j (in logs of millions US dollars) as the dependent variable and employ a cross-sectional approach – as usually done in the literature – mostly focusing on the year 2009. We carry out estimations for bilateral holdings of total services and the sub-categories mentioned in Section 2.1.[3] The estimations include importer (α_i) and exporter fixed effects (α_j) as well as bilateral factors $\mathbf{Z}_{ij}$ affecting trade in services. The exporter and importer fixed effects control for any unobservable country-specific factors affecting services trade flows. Moreover, by focusing on bilateral factors while controlling for export and import country characteristics, we capture the 'multilateral resistance' term. In line with Baldwin and Taglioni (2006), this removes the cross-sectional 'omitted price' bias. We assume the following functional form for bilateral factors:

$$\begin{aligned}\mathbf{Z}_{ij} = {} & virtual\,proximity_{ij}^{\phi_1}\, distance_{ij}^{\phi_2}\, migrants_{ij}^{\phi_3} \\ & + exp(\phi_4 contiguous_{ij} + \phi_5 time_{ij} + \phi_6 common\,law_{ij+\ldots})\end{aligned} \tag{2}$$

The analysis' main focus is to examine the effect of virtual proximity – a direct measure of bilateral information flows between countries – on trade in services (see Section 3.2 for details). Our hypothesis is that virtual proximity exerts the largest positive impact on information- and technology-intensive services and that it reduces the coefficients on physical distance and potentially other proxies for information asymmetries. Since virtual proximity measures total bilateral hyperlinks between two countries, it should not be

[3] In addition to the eleven sub-categories, we also run estimations for *audiovisual* services separately (a sub-category of *personal, cultural and recreational* services).

significantly endogenous to services trade activity. Nevertheless, we also run instrumental variable estimations to account for potential endogeneity and reverse causality issues.

Conventional transportation costs are proxied by physical distance ($distance_{ijt}$), time zone difference ($time_{ijt}$) and the existence of common borders ($contiguous_{ijt}$). Moreover, we include an indicator of the similarity of legal systems as legal fees might be substantially lower if the trading partners have similar legal structures (*common law*). In the same vein, this applies to interpretation and communication costs if countries have similar languages (*common language*). Moreover, bilateral relationships between countries are likely to be closer and of higher mutual trust if countries' religions are similar (*common religion*) and bilateral migration stocks are large (*migrants stock*). In addition, we control for both countries being Member States of the EU. Moreover, we control in robustness estimations for common colonial history, regional trade agreements, common currency zones and cultural distance based on Hofstede (2013).[4]

3.2 Virtual proximity data

To capture information flows via the internet, we follow the approach of Hellmanzik and Schmitz (2015) for the case of audiovisual services trade, and use bilateral, inter-domain hyperlinks that internationally connect webpages in country A to webpages in country B. Our source on hyperlinks data is Chung (2011), who provides data on bilateral hyperlinks for two years (2003 and 2009) for up to 87 countries. Chung conducted his analysis in May 2009 with the help of Yahoo's search function and LexiURL Searcher, a social science web analysis tool developed by Thelwall (2009). At the time, Yahoo had indexed about 47 billion websites, among which Chung found more than 9.3 billion hyperlinks included in 33.8 billion sites from 273 different top-level domains.

Due to the bidirectional nature of the data, bilateral hyperlinks reflect the number of links from websites with domain .xx (i.e. from the country with domain .xx) to domain .yy (i.e. to the country with domain .yy) and vice versa. In 2009, the largest number of bilateral hyperlinks arose from webpages hosted in the US, which contained about 49 million links to websites in the UK (Appendix Table I), followed by hyperlinks from the US to Japan (44 million) and from the US to Germany (41 million). As long as we are using country top-level domains (ccTLD), such as *.de* for Germany or *.it* for Italy, classifying source and host countries is an easy task. However, determining the host and source countries for non-national domain names, such as *.org* or *.edu*, is technically not

[4]Appendix Table I provides an overview of the country sample used in our analysis.

straightforward. In particular, how to deal with the popular *.com* domain, which most international businesses use, is a crucial issue and due to the magnitude of the effect, is not negligible. For the year 2009, Chung (2011) developed an attribution method which 'cracks', and thereby uniquely identifies, the host country of a *.com* domain for his sample of 87 countries.[5] This makes the data much richer and allows for a more complete and accurate picture of internet connectivity in light of the popularity of the *.com* domain.[6]

In Table 1, we show the correlation coefficients between our 'benchmark' virtual proximity measure (com-cracked bilateral hyperlinks for 2009), alternative measures of virtual proximity and conventional measures of cultural and geographic proximity. These correlation coefficients are small in magnitude, which highlights the novelty of the new virtual proximity measures. The correlation between physical distance and virtual proximity is negative, while being positive for time-zone difference. Measures of cultural proximity, such as language or religion, are positively correlated with virtual proximity. Equivalently, cultural distance as defined by Hofstede (2013) is negatively correlated with virtual proximity.

3.3 Standard gravity model variables

The standard geographic variables as used in equation (2) are provided by the CEPII dataset: *distance* captures the bilateral physical distance between two countries' capitals, while *time* refers to the time zone difference between two countries. We also employ indicators for countries which share a common border (*contiguous*) or have a common legal origin (*common law*).

The *Common language index* is an aggregate index constructed by Melitz and Toubal (2014) summarising evidence about linguistic influences including common official language, common native language and linguistic proximity. It thus goes beyond traditionally used measures of common language and Melitz and Toubal (2014) find that it has a strongly positive impact on goods trade. We also use the measure of religious proximity (*common religion*) computed by Melitz and Toubal (2014), which is mainly based on the CIA Factbook. The stock of migrants data (*migrants stock*) are obtained from the World Bank International Bilateral Migration Stock database in order to control for demand by

[5]For the United States, usually the sum of the domains *.edu, .us, .mil and .gov* has been used (Barnett, Chon and Rosen, 2001) in the literature. In previous studies (e.g. Barnett and Sung, 2005), the *.com* domain had either been disregarded or completely attributed to the United States.

[6]An alternative approach would be to use bilateral data on internet bandwidth, for example provided by TeleGeography. However, bandwidth data often reflect the fact that countries act as internet hubs and hence do not qualify as a good measure of virtual proximity.

major immigrant groups in the host country. Furthermore, we use a dummy variable for joint EU membership and control in robustness estimations for common colonial history, regional trade agreements, common currency zones (all provided by the CEPII dataset) and cultural distance based on Hofstede (2013). Data on GDP per capita, population and the share of internet users are retrieved from the World Bank's World Development Indicators.

4 Empirical analysis

4.1 Baseline results

We start by running the log-linear gravity equation (1) for imports of total services as well as their sub-categories using 2009 data. We base our findings on the year 2009 as this is the year for which Chung's (2011) com-cracked hyperlink variable is available. In Table 2, we do not yet include virtual proximity in the model, but as a starting point use only those observations for which the virtual proximity indicator is available in order to ensure comparability across estimations.[7]

Overall we find, that services are well described by the gravity model (in line with e.g. Head et al., 2009; Kimura and Lee, 2006) and that there are interesting patterns across the various categories. For all services there is a strongly significant, negative impact of distance despite the fact that not all categories involve physical shipment. Our distance effect for total services trade (-0.81) is in line with the one reported by Head et al. (2009) who assume a trend decline in the distance effect. Distance matters for margin as well as transformation services alike, with coefficients ranging from -.33 for government services to -1.25 for construction services. Moreover, a common legal origin is positive and significant across all services categories (except for royalty and licenses services), in line with the findings by Head et al. (2009). In addition, the number of bilateral migrants from the exporting country living in the importing country has a positive and significant impact across all categories.

Interesting insights can also be gained from those effects which are heterogenous across services categories. For language similarity, the impact varies with significant and positive coefficients found for travel, other business, transportation and communication services. This can be explained by the fact that these services require physical presence or consumption in the exporting country, or at least intensive communication as in the case

[7]Nevertheless, even if we run the model with the full set of observations regardless of this restriction the results of Table 2 remain largely unchanged.

of other business and communication services. The existence of a common border has a positive effect for the import of insurance and travel services, while time zone difference bodes negatively for travel, communication, audiovisual and government services. While the overall impact of common religion is negative and significant – albeit at the 10% level only – with a coefficient of .25, religion similarity has a positive impact for construction and royalty services. It seems that religion is reflecting cultural preferences in these instances and perhaps serves as a proxy for trust. Similarly, EU membership only has a favourable impact for travel services which might be reflective of a successful European policy in terms of integrating institutions as well as facilitating travel by eliminating bureaucratic as well as exchange rate hurdles. Nevertheless, the overall estimation seems to suggest a significant and relatively big, positive effect from both trading partners being EU countries.

4.2 The role of virtual proximity

Next, we re-run the cross-sectional specifications including our 'virtual proximity' measure (in logs, measuring how many hyperlinks are set from the importing country to the exporting country). We include virtual proximity in the regression in order to test whether bilateral online information flows have an impact on services imports (Table 3). First, we see that bilateral hyperlinks indeed are a significant and positive determinant for services imports with a one percent increase in bilateral hyperlinks set from the importing country to the respective exporting country being associated with a .14 percent increase in total bilateral services imports. Thus, services are highly responsive to internet connectedness and informedness about trading partners. This highlights the relevance of information for services especially in light of their heterogenous nature and ex-ante hard to assess quality.

Considering the different categories of services an interesting pattern emerges. We find that services which either require a lot of information or technological involvement also have a greater coefficient on virtual proximity. In particular, financial services stand out with an elasticity to virtual proximity of .54. This finding is in line with Hellmanzik and Schmitz (2016) who find a significant positive effect of virtual proximity for cross-border portfolio investment, and in particular for information-intensive equity securities. Given the high sensitivity to both information as well as technological promptness, it is not surprising that we find the biggest effect in this sector – especially when contrasted with the fact that the internet bears no significant impact on government as well as construction services which are sectors that are not as fast paced or volatile. The next largest coefficients are found for communication, insurance, personal as well as audiovisual

services and reflect the sensitivity of these business areas with an elasticity in the range of .3 to .4, while travel and computer services as well as royalties have a significant coefficient in the range of .2 to .3 indicating that the internet also play an important role for these services.

Among the standard gravity model variables the most interesting changes happen to physical distance once virtual proximity is included in the estimation: the internet renders the coefficient on distance smaller across all categories, highlighting a negative bias (i.e. over-estimation of the distance effect) in the estimation of the distance-coefficient when not controlling for virtual proximity. Considering the individual service categories, the largest decrease in the elasticity with respect to physical distance is found for financial services (Table 3, column 7, the coefficient decreases by .14), followed by insurance and audiovisual services (columns 6 and 12, the coefficients decline by .1) and communication and IT services (columns 4 and 8, the coefficient decreases by .08). The internet seems to matter less in terms of altering the negative impact of distance for other services, such as transportation and construction services. These types of services require an actual shipment of goods or movement of people, thus even if virtual proximity increases trade in these services per se, it does not significantly alleviate the negative impact arising from physical distance. Nonetheless, we find evidence that the possibility to offshore services increase with greater virtual proximity, as physical distance plays less of a deterrent role. This holds precisely for those professional services for which offshoring is most feasible, such as financial, insurance and IT services.

Moreover, including virtual proximity as a determinant in the gravity model decreases the coefficients on the language similarity which is particularly interesting as linguistic differences are usually considered a big impediment to international trade. The elasticity on language decreases by around a quarter to 0.54 for total services. Similarly, the positive and significant language coefficients reported for transportation, travel and other business services in Table 2, are smaller and even insignificant in the case of communication services, once virtual proximity enters the model. For these services the internet and associated information flows reduce the importance of similarity in languages. This is not surprising, if one considers that the prime international business and internet language is English and therefore having the same language as the trading partner is no longer the *sine qua non* to enter international services markets. Moreover, the coefficients on common border turn insignificant once we introduce virtual proximity, while the coefficients and associated significance levels for bilateral migration, common legal origin, EU membership, religion similarity and time zone difference are largely unaffected compared

with Table 2.

Our new proxy is indicative of the fact that virtual proximity indeed matters for international trade in services and expands on the list of determinants in a gravity model. Particularly, given the information-intensity in the services sector, especially in such sectors as insurances, financial as well as computer and IT services, and the increasing frequency of virtual exchanges in conducting business, it appears that the inclusion of virtual proximity is an important addition to the literature. This is especially the case as the intensity of hyperlinks between countries reveals information flows between trading partners, therefore highlighting the role of information asymmetries and associated transaction costs. In particular for information- and technology intensive sectors, greater virtual proximity is accompanied by a less detrimental role of physical distance, implying a greater possibility to offshore services.

4.3 Robustness analysis

4.3.1 Lagged and IV estimations

In our estimations, virtual proximity and international services flows are measured for the same year, thus, implicitly, the estimation treats internet connectivity as exogenous, which might raise concerns as individuals and firms choose the number of hyperlinks. Virtual proximity could thus be endogenous to services trade. For instance, when foreign consumers increase their research activities on insurances or investments abroad or download more music, these online activities might increase the number of hyperlinks to trading partners. Given the unique and novel nature of our virtual proximity measure, valid instruments are not available. To investigate potential contamination of our results by such reverse causality, we opt for using lagged proximity measures in two ways to address the potential reverse causality problem.

First, we estimate a gravity equation based on 2012 data, while our virtual proximity measure still refers to 2009 (Table 4). We find that for almost all categories of services trade the results remain equivalent with the exception of royalties and other business services (columns 9 and 10) which turn insignificant. All other categories, however, produce consistent results when employing 'lagged' bilateral hyperlinks data and therefore remove a potential simultaneity bias from the estimation.

Second, we follow Felbermayr and Toubal's approach (2010) and use the 2003 virtual proximity measure as an instrument for the 2009 virtual proximity measure in the equation based on trade data from 2009. This allows for using the time dimension of our virtual

proximity data to estimate the effect of an exogenous change in virtual proximity. It is reasonable to assume that past bilateral hyperlinks (i.e. from 2003) are pre-determined and unaffected by future shocks to bilateral trade volumes. This implies that current shocks in the gravity equation are uncorrelated with lagged virtual proximity values and thus qualify as valid instruments. Table 5 presents the results based on 2SLS instrumental variable estimation (IV). Using the 2003 (non-.com-cracked) virtual proximity measure as an instrument for contemporaneous bilateral links actually increases the size of the overall coefficient slightly and also on the individual categories the effect is greater in magnitude compared to the OLS specification with the coefficients on bilateral hyperlinks remaining the largest for financial services as well as communication and audiovisual services. However, using 2003 data as an instrument for virtual proximity renders the impact on four services areas insignificant (transportation, insurances, royalties and personal services). For these estimations, the sample size is significantly reduced which might be partly driving the results. Nevertheless, the IV results support the contemporaneous impact of virtual proximity on bilateral trade in services. In fact, the presented IV evidence suggests that the OLS results bias the effect of virtual proximity downwards. This is in line with the findings of Felbermayr and Toubal (2010) for the effect of European Song Contest scores on trade in goods and lends further proof to the significance of virtual proximity for international services trade.

4.3.2 PPML estimation

Another common concern in the literature are zero trade flows, which are often observed in international trade statistics. Trade flows recorded with a value of zero disappear in conventional logarithmic estimations. This could give rise to selection problems, for example in the case that virtual proximity had only a significant role in explaining non-zero trade flows. For comparison with our main findings based on OLS estimation, we use a remedy in dealing with this phenomenon, namely the Poisson quasi-maximum likelihood estimation method (PPML) as proposed by Santos Silva and Tenreyro (2006), which includes services trade in levels rather than in log form. This removes the zero trade flow problem as the dependent variable does not require a logarithmic transformation, therefore increasing the number of observations slightly to those used in the previous estimations. Silva and Tenreyro (2006) point out that PPML estimators perform better in the presence of heteroskedasticity as OLS estimators are not efficient in this case. In our PPML estimations, we follow the same empirical approach as shown in Table 3.

In the PPML results (Table 6), the coefficients on bilateral hyperlinks becomes slightly

larger for most categories of services trade and are significant with the exceptions of royalties and personal services (columns 9 and 11). Moreover, the negative impact of physical distance on services trade is substantially smaller across all types of services (with the exception of audiovisual services). In the case of financial services, the coefficient on distance even becomes insignificant. Thus our findings based on the PPML estimations indicate that role of virtual proximity, both its direct impact as well as its impact in alleviating negative distance effects, are potentially even larger than found in the OLS estimations.[8]

4.3.3 Internet penetration

In a cross-sectional framework we can introduce country-specific characteristics of the importing country while continuing to use fixed effects for the exporting countries (or vice versa). Thus – apart from standard controls such as GDP per capita and population size – we include the percentage of internet users in the importing country (or exporting country, respectively) next to our virtual proximity indicator in Table 7 (and Table 8 for the exporting country, respectively). Internet penetration thus far is the most widely used indicator of a country's web activity although it merely captures a country's internet infrastructure and therefore potential access to information, without considering any cross-border information flows. We include it in our estimation in order to verify that virtual proximity which reflects actual bilateral internet traffic and thereby revealed preferences across countries has a greater explanatory power than internet penetration *per se* and to test whether it is robust to the inclusion of this more commonly used internet variable.

We find that a higher share of internet users in the total population of the importing country is indeed significantly associated with more services imports overall and in most sub-categories (Table 7), while controlling for bilateral hyperlinks. This result is in line with Freund and Weinhold (2002). Crucially, bilateral hyperlinks are robust to the inclusion of internet penetration and our findings remain qualitatively unaltered. Interestingly, a lot of the coefficients actually increase in magnitude. This underpins the important role of the internet as information provider and communication facilitator. Thus, our paper qualifies the findings of Choi (2010) who finds that the share of internet users in a country has a significant impact on total services trade. Moreover, when mirroring this analysis

[8]We also use the PPML IV estimator as proposed by Windmeijer and Santos Silva (1997). Using the 2003 bilateral hyperlinks measure as an instrument confirms the significance of virtual proximity for total services and most of the subcategories.

and including the exporter's internet penetration rate in the estimation instead (Table 8), we find that bilateral hyperlinks are still positive and significant across all sectors, while internet penetration has a significant positive impact on most categories of services.

4.3.4 Other robustness checks (unreported)

In other robustness estimations, we expand the set of traditionally-used gravity model determinants by including country-pair dummy variables for common colonial history, common currency and participation in the same regional trade agreement. These three variables fail to be significant for overall services and most subcategories, while not changing the main findings and significance levels of our benchmark regression.

Next, we explicitly control for cultural factors by including data on cultural distance from Hofstede (2013), as for example employed by Davies, Ionascu and Kristjansdottir (2008) for foreign direct investment. This index combines different dimensions of the cultural environment, namely individualism, masculinity, power distance and uncertainty avoidance. We construct this variable based on Kogut and Singh's (1988) method of measuring deviations along each dimension between all bilateral country pairs. The resulting indicator is often significant, however with a positive sign, indicating that culturally more distant countries – according to Hofstede's measure – trade more services with each other. The results on virtual proximity remain unaltered.

Third, the dominance of the United States in the services industry and the internet might affect our findings. Hence, we run our benchmark regressions excluding the United States as a trading partner. The findings on virtual proximity still hold, while most of the other coefficients are also in line with the previous estimations. Consequently, there is no evidence that the United States is driving the general results of our analysis.

5 Conclusion

This paper analyses a wide range of categories of services trade in a gravity model framework. In particular, we explore the role of a novel indicator for international internet linkages which we dub virtual proximity and which captures bilateral hyperlinks between countries. With this indicator we can test whether bilateral information flows have a significant impact on services imports. Our hypothesis is that the role for such information flows is greater in industries which are very information sensitive or which rely heavily on technology. Especially for services which are very heterogenous in nature and whose

quality is often hard to assess ex-ante information flows via the internet should matter significantly and foster trade as well as reduce negative distance effects.

We indeed find our virtual proximity measure to be a very significant determinant of trade as 'virtually-proximate' countries trade significantly larger amounts of services overall as well as in most subcategories of trade. This finding is robust to a wide range of tests, such as IV and PPML estimations, and to the inclusion of a host of further control variables to the model. In particular, we find that the effect is greatest for financial services, probably the most notoric sector which experienced tremendous global integration in the last 30 years, not least through the world wide web. But also communication, insurance, IT and audiovisual services reflect the sensitivity to online information flows with relatively large elasticities, while virtual proximity does not have a significant impact on government and construction services. This is indicative of the fact that the internet indeed helps to alleviate information asymmetries or reduce costs associated with obtaining information. Moreover our findings indicate that virtual proximity – next to its direct impact – alleviates negative distance effects substantially, thus for example raising the potential for offshoring. Consequently, our paper may provide an explanation for the trend decline in the distance effect on international services trade found by Head et al. (2009).

More generally, our paper highlights the importance of the internet for economic transactions. With the growth of the internet and the various mitigating and mediating roles it has taken on, it is important to obtain a better understanding of the impact it has on international trade. As services are a sector which experiences continuous growth and gains in importance for GDP and trade, it is particularly important to understand for which sectors international online information flows matter most, not least to obtain an understanding of future developments in these sectors.

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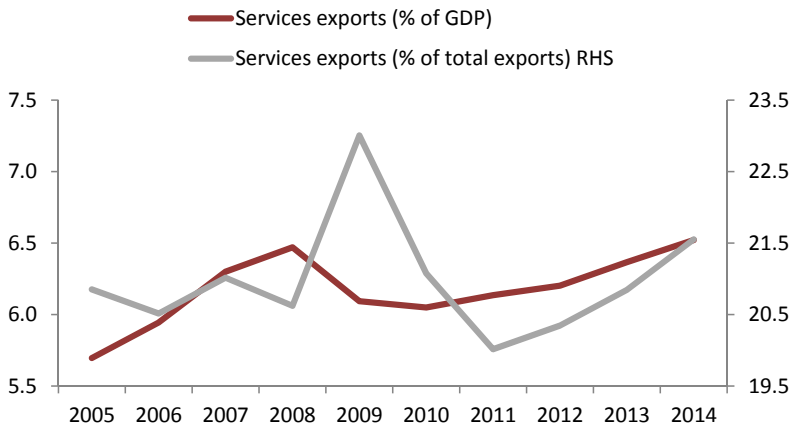
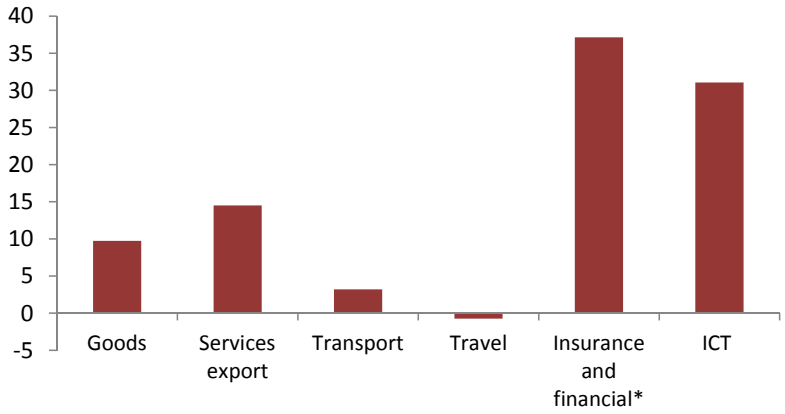
Figure 1: The role of services in global trade



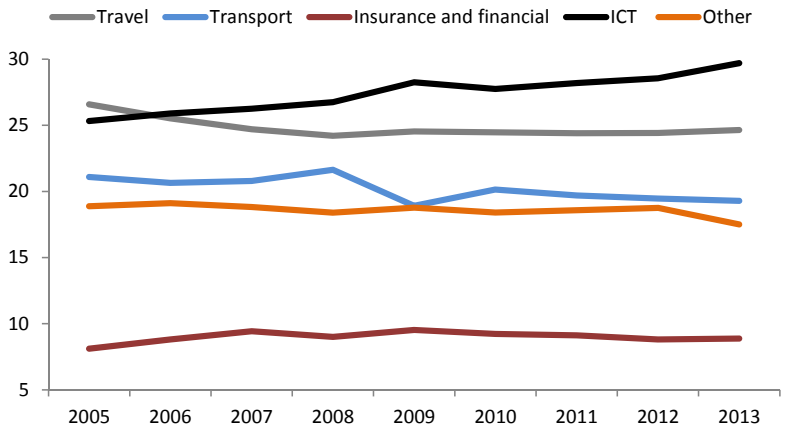
Sources: World development indicators; own calculations

Figure 2: Growth rate of global exports, 2005 to 2014



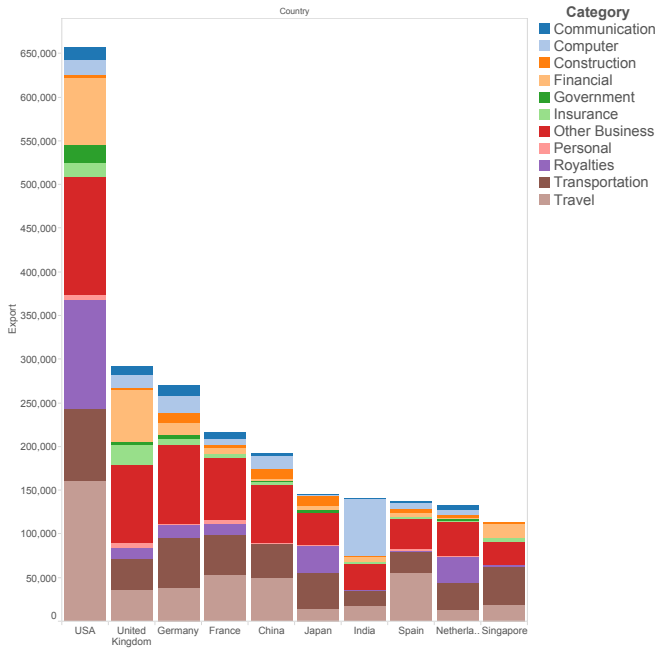
Sources: World development indicators; own calculations.
Notes: Growth rate of trade figures relative to global GDP. ∗ Up to 2013. ICT includes computer and communications services and information services.

Figure 3: Composition of global services exports, shares in percent



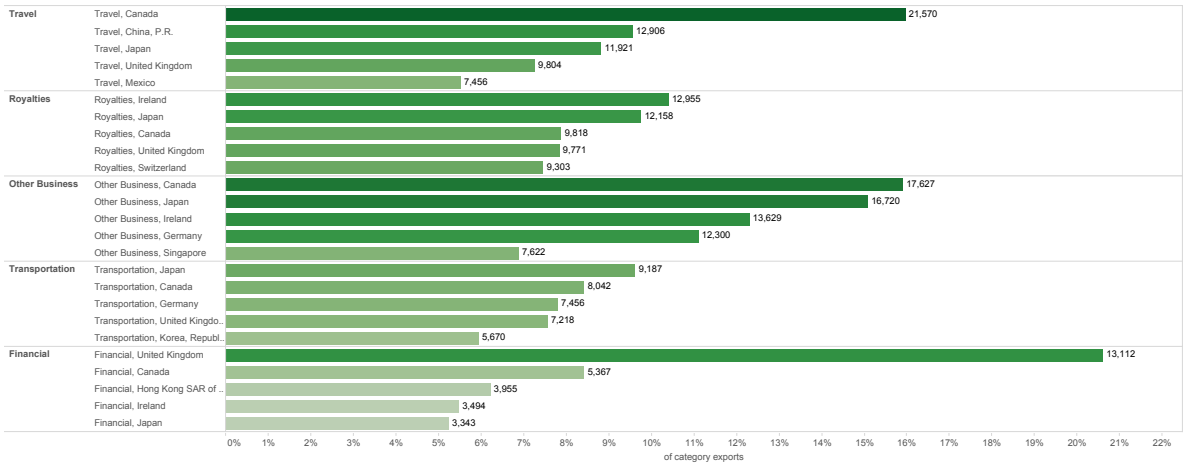
Sources: World development indicators; own calculations.
Notes: ICT includes computer and communications services and information services.

Figure 4: The largest services exporters



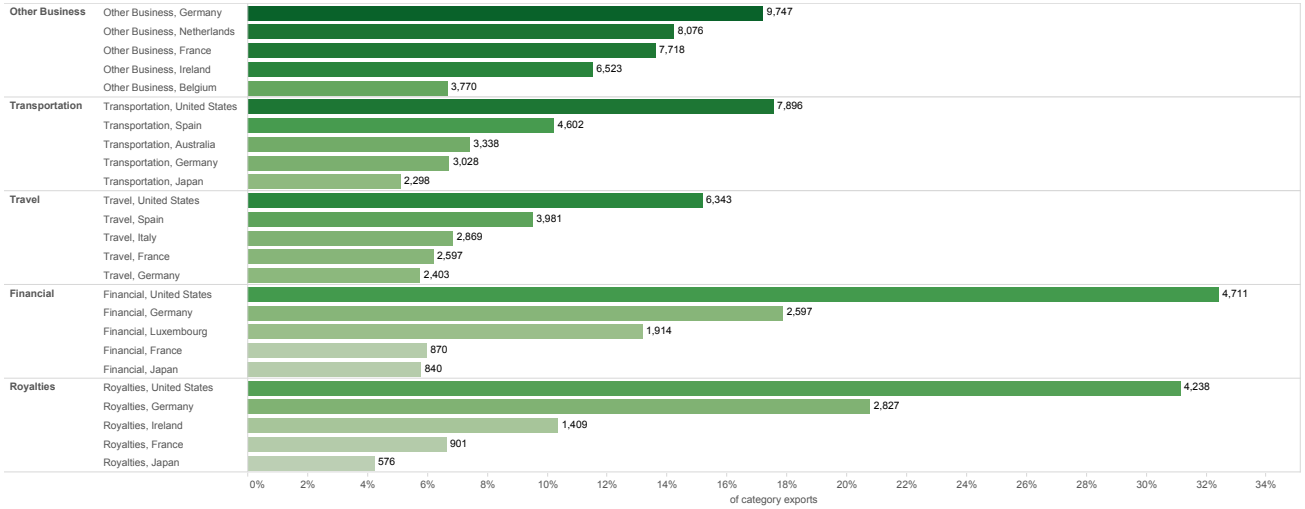
Sources: Eurostat, OECD and UN; own calculations.
Notes: Figures expressed in millions of US dollar and refer to 2012.

Figure 5: United States, largest categories of services exports and bilateral counterparts



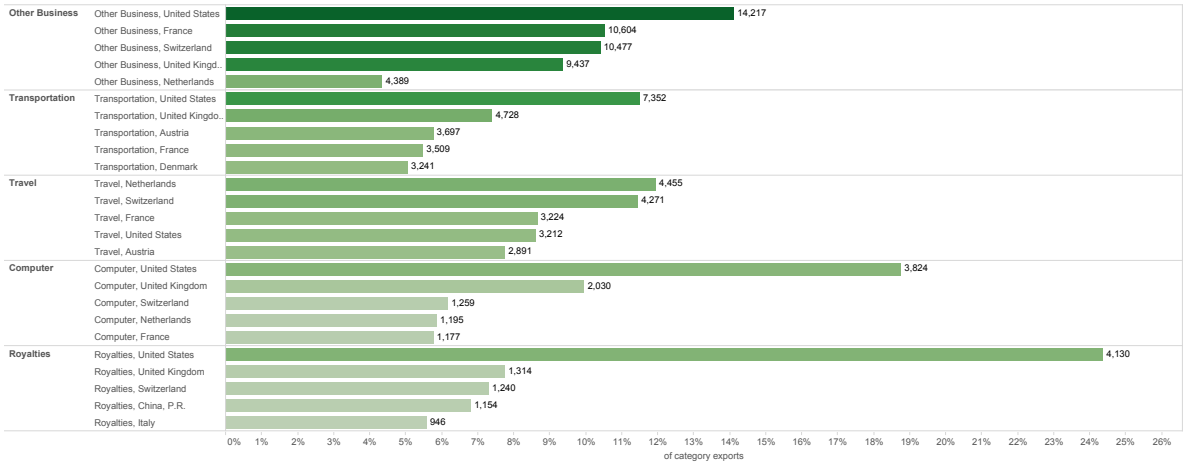
Sources: Eurostat, OECD and UN; own calculations.
Notes: Figures expressed in millions of US dollar and refer to 2012.

Figure 6: United Kingdom, largest categories of services exports and bilateral counterparts



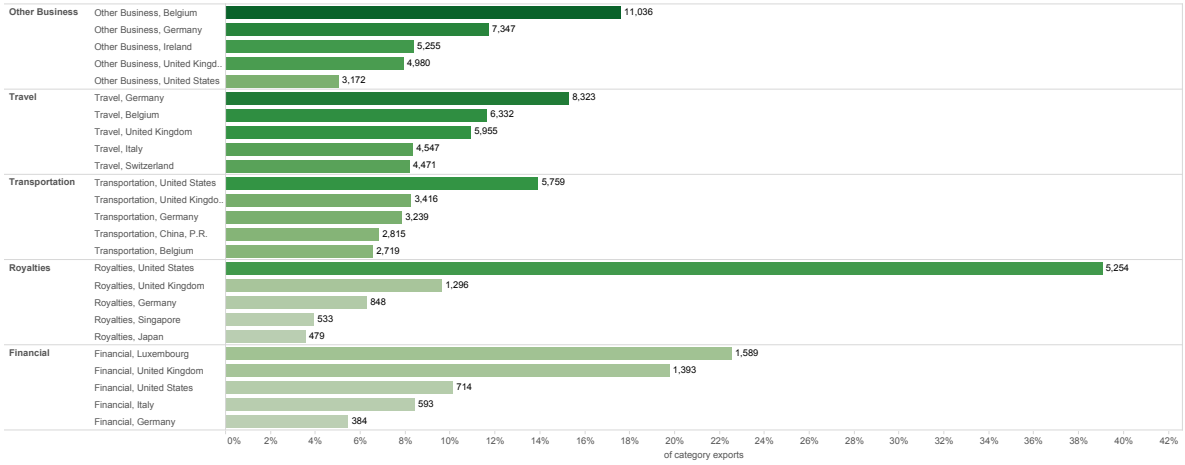
Sources: Eurostat, OECD and UN; own calculations.
Notes: Figures expressed in millions of US dollar and refer to 2012.

Figure 7: Germany, largest categories of services exports and bilateral counterparts



Sources: Eurostat, OECD and UN; own calculations.
Notes: Figures expressed in millions of US dollar and refer to 2012.

Figure 8: France, largest categories of services exports and bilateral counterparts



Sources: Eurostat, OECD and UN; own calculations.
Notes: Figures expressed in millions of US dollar and refer to 2012.

Table 1: Correlation coefficients of different measures of cultural proximity

	Bilateral hyperlinks 2009 (.com cracked)
Distance (log)	-0.062
Common border	0.206
Time zone difference	0.086
Common legal origin	0.104
Common religion	0.198
Common language Index	0.272
Migrants (log)	0.552
Bilateral hyperlinks 2003	0.668
Cultural distance (Hofstede)	-0.236

Table 2: Services, imports, 2009, without virtual proximity

VARIABLES	(1) Total	(2) Transp.	(3) Travel	(4) Commun.	(5) Constr.	(6) Insur.	(7) Fin.	(8) Comp.	(9) Royal.	(10) Oth. bus.	(11) Pers.	(12) Audio.	(13) Gov.
Distance (ln)	-0.81***	-1.01***	-0.94***	-0.79***	-1.25***	-0.94***	-0.99***	-0.90***	-0.93***	-0.84***	-1.00***	-0.81***	-0.33***
	(0.07)	(0.09)	(0.09)	(0.10)	(0.17)	(0.13)	(0.14)	(0.11)	(0.13)	(0.09)	(0.14)	(0.16)	(0.11)
Common border	0.06	-0.16	0.28*	-0.10	-0.19	0.42**	0.16	-0.28*	-0.16	-0.34**	0.17	-0.03	-0.00
	(0.15)	(0.17)	(0.16)	(0.16)	(0.24)	(0.18)	(0.21)	(0.17)	(0.19)	(0.14)	(0.19)	(0.23)	(0.19)
Time zone difference	-0.02	-0.01	-0.07***	-0.09***	0.08	-0.02	-0.04	-0.02	0.00	-0.02	-0.00	-0.09*	-0.07***
	(0.02)	(0.02)	(0.02)	(0.02)	(0.05)	(0.03)	(0.03)	(0.03)	(0.03)	(0.02)	(0.04)	(0.05)	(0.03)
Common legal origin	0.59***	0.48***	0.38***	0.40***	0.36**	0.38***	0.60***	0.39***	0.18	0.39***	0.43***	0.31*	0.40***
	(0.06)	(0.08)	(0.07)	(0.10)	(0.18)	(0.11)	(0.12)	(0.12)	(0.12)	(0.08)	(0.13)	(0.18)	(0.09)
Common religion index	-0.25*	-0.10	0.21	0.27	0.56*	0.22	0.15	0.27	0.52*	0.03	0.23	-0.01	-0.73***
	(0.14)	(0.18)	(0.17)	(0.20)	(0.33)	(0.21)	(0.27)	(0.25)	(0.27)	(0.17)	(0.28)	(0.38)	(0.22)
Common language index	0.70***	0.66***	1.04***	0.54*	0.35	0.54	0.30	0.31	0.68	0.73***	-0.11	0.96*	-0.43
	(0.20)	(0.25)	(0.22)	(0.30)	(0.49)	(0.35)	(0.38)	(0.34)	(0.44)	(0.27)	(0.38)	(0.50)	(0.32)
EU	0.43***	0.13	0.40**	-0.03	0.44	-0.18	0.39	-0.07	-0.01	0.14	-0.47*	-0.15	0.29
	(0.13)	(0.20)	(0.18)	(0.19)	(0.42)	(0.27)	(0.27)	(0.26)	(0.25)	(0.17)	(0.27)	(0.36)	(0.23)
Migrants (ln)	0.15***	0.12***	0.14***	0.21***	0.20***	0.11***	0.15***	0.15***	0.13***	0.18***	0.13***	0.10**	0.18***
	(0.02)	(0.02)	(0.02)	(0.02)	(0.04)	(0.03)	(0.04)	(0.03)	(0.04)	(0.02)	(0.03)	(0.04)	(0.03)
Observations	2,703	1,599	1,464	1,363	1,018	1,271	1,191	1,296	1,223	1,558	1,129	867	1,221
R-squared	0.87	0.82	0.85	0.83	0.65	0.78	0.81	0.82	0.81	0.86	0.77	0.73	0.75
Exporter fixed effects	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
Importer fixed effects	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes

Notes: The dependent variable is services imports (in natural log form); the explanatory variables are distance between capitals (in natural log form), time zone difference (in hours), the bilateral stock of migrants (in natural log form), dummy variables for common border, common legal origin and EU membership and similarity indices for religion and languages. The estimation uses exporter- and importer fixed effects. Robust standard errors in brackets. * significant at 10% level; ** significant at 5% level, *** significant at 1% level.

Table 3: Services, imports, 2009

VARIABLES	(1) Total	(2) Transp.	(3) Travel	(4) Commun.	(5) Constr.	(6) Insur.	(7) Fin.	(8) Comp.	(9) Royal.	(10) Oth. bus.	(11) Pers.	(12) Audio.	(13) Gov.
Distance (ln)	-0.78***	-0.96***	-0.87***	-0.71***	-1.20***	-0.84***	-0.85***	-0.82***	-0.87***	-0.80***	-0.92***	-0.70***	-0.32***
	(0.07)	(0.09)	(0.09)	(0.10)	(0.17)	(0.13)	(0.14)	(0.11)	(0.13)	(0.09)	(0.15)	(0.16)	(0.11)
Common border	-0.03	-0.24	0.15	-0.25	-0.28	0.27	-0.06	-0.37**	-0.25	-0.40***	0.03	-0.16	-0.01
	(0.14)	(0.17)	(0.16)	(0.15)	(0.23)	(0.18)	(0.20)	(0.17)	(0.19)	(0.14)	(0.20)	(0.22)	(0.19)
Time zone difference	-0.02	-0.02	-0.07***	-0.09***	0.07	-0.03	-0.06*	-0.03	-0.00	-0.02	-0.01	-0.10**	-0.07***
	(0.02)	(0.02)	(0.02)	(0.02)	(0.05)	(0.03)	(0.03)	(0.03)	(0.03)	(0.02)	(0.04)	(0.05)	(0.03)
Common legal origin	0.58***	0.46***	0.36***	0.35***	0.32*	0.33***	0.53***	0.35***	0.15	0.37***	0.38***	0.24	0.40***
	(0.06)	(0.08)	(0.07)	(0.10)	(0.18)	(0.11)	(0.12)	(0.12)	(0.12)	(0.09)	(0.13)	(0.18)	(0.09)
Common religion index	-0.27*	-0.10	0.20	0.26	0.56*	0.19	0.08	0.24	0.50*	0.02	0.20	-0.07	-0.73***
	(0.14)	(0.18)	(0.17)	(0.20)	(0.33)	(0.21)	(0.26)	(0.25)	(0.27)	(0.17)	(0.27)	(0.37)	(0.22)
Common language index	0.54***	0.48*	0.75***	0.27	0.16	0.24	-0.21	0.07	0.48	0.59**	-0.39	0.60	-0.44
	(0.19)	(0.26)	(0.22)	(0.29)	(0.48)	(0.34)	(0.36)	(0.34)	(0.44)	(0.26)	(0.38)	(0.49)	(0.33)
EU	0.38***	0.08	0.33*	-0.17	0.35	-0.30	0.20	-0.15	-0.09	0.09	-0.59**	-0.27	0.29
	(0.13)	(0.21)	(0.18)	(0.18)	(0.41)	(0.27)	(0.26)	(0.26)	(0.25)	(0.16)	(0.27)	(0.36)	(0.23)
Migrants (ln)	0.14***	0.12***	0.13***	0.19***	0.18***	0.09***	0.13***	0.13***	0.11***	0.17***	0.12***	0.07*	0.18***
	(0.02)	(0.02)	(0.02)	(0.02)	(0.04)	(0.03)	(0.03)	(0.03)	(0.04)	(0.02)	(0.03)	(0.04)	(0.03)
Bilateral hyperlinks (ln)	0.14***	0.18***	0.27***	0.33***	0.21	0.37***	0.54***	0.27***	0.23*	0.15**	0.32***	0.39***	0.02
	(0.05)	(0.06)	(0.08)	(0.08)	(0.14)	(0.09)	(0.10)	(0.10)	(0.12)	(0.07)	(0.10)	(0.13)	(0.10)
Observations	2,703	1,599	1,464	1,363	1,018	1,271	1,191	1,296	1,223	1,558	1,129	867	1,221
R-squared	0.87	0.82	0.86	0.84	0.65	0.79	0.82	0.82	0.81	0.86	0.77	0.73	0.75
Exporter fixed effects	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
Importer fixed effects	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes

Notes: The dependent variable is services imports (in natural log form); the explanatory variables are distance between capitals (in natural log form), time zone difference (in hours), the bilateral stock of migrants (in natural log form), bilateral hyperlinks for 2009 (com-cracked, in natural log form), dummy variables for common border, common legal origin and EU membership and similarity indices for religion and languages. The estimation uses exporter- and importer fixed effects. Robust standard errors in brackets. * significant at 10% level; ** significant at 5% level, *** significant at 1% level.

Table 4: Services, imports, 2012

VARIABLES	(1) Total	(2) Transp.	(3) Travel	(4) Commun.	(5) Constr.	(6) Insur.	(7) Fin.	(8) Comp.	(9) Royal.	(10) Oth. bus.	(11) Pers.	(12) Audio.	(13) Gov.
Distance (ln)	-0.71***	-0.96***	-0.79***	-0.70***	-1.06***	-0.88***	-0.84***	-0.83***	-0.88***	-0.82***	-0.77***	-0.75***	-0.14
	(0.07)	(0.10)	(0.09)	(0.10)	(0.16)	(0.11)	(0.17)	(0.11)	(0.15)	(0.09)	(0.14)	(0.19)	(0.10)
Common border	0.01	-0.21	0.37**	-0.38**	-0.18	-0.13	-0.03	-0.30	-0.36*	-0.25*	0.02	0.04	0.04
	(0.14)	(0.18)	(0.14)	(0.16)	(0.25)	(0.18)	(0.21)	(0.19)	(0.20)	(0.14)	(0.19)	(0.27)	(0.17)
Time zone difference	-0.03*	-0.01	-0.06***	-0.08***	0.03	-0.03	-0.04	-0.00	0.00	-0.02	-0.02	0.02	-0.12***
	(0.02)	(0.03)	(0.02)	(0.02)	(0.06)	(0.03)	(0.04)	(0.03)	(0.04)	(0.02)	(0.03)	(0.05)	(0.03)
Common legal origin	0.55***	0.45***	0.29***	0.56***	0.16	0.56***	0.56***	0.43***	0.28**	0.40***	0.16	0.03	0.25***
	(0.06)	(0.08)	(0.07)	(0.10)	(0.19)	(0.12)	(0.13)	(0.12)	(0.13)	(0.08)	(0.13)	(0.20)	(0.09)
Common religion index	-0.27**	0.01	0.19	0.15	0.30	0.24	-0.21	0.01	0.39	-0.00	0.20	0.09	-0.69***
	(0.13)	(0.18)	(0.17)	(0.20)	(0.35)	(0.21)	(0.30)	(0.25)	(0.28)	(0.16)	(0.24)	(0.39)	(0.20)
Common language index	0.51***	0.56**	0.85***	0.29	0.82*	0.27	-0.10	-0.29	0.93**	0.67***	0.56	0.57	-0.50
	(0.19)	(0.26)	(0.22)	(0.32)	(0.49)	(0.32)	(0.41)	(0.36)	(0.38)	(0.25)	(0.39)	(0.63)	(0.33)
EU	0.47***	0.02	0.72***	-0.43**	0.24	0.04	0.21	-0.08	-0.28	-0.04	0.03	-0.16	0.32
	(0.12)	(0.22)	(0.17)	(0.20)	(0.49)	(0.28)	(0.35)	(0.28)	(0.33)	(0.18)	(0.28)	(0.51)	(0.25)
Migrants (ln)	0.15***	0.15***	0.14***	0.18***	0.17***	0.09***	0.16***	0.12***	0.13***	0.14***	0.13***	0.08*	0.17***
	(0.01)	(0.02)	(0.02)	(0.02)	(0.04)	(0.03)	(0.04)	(0.03)	(0.04)	(0.02)	(0.03)	(0.05)	(0.02)
Bilateral hyperlinks (ln)	0.15***	0.12*	0.23***	0.30***	0.28**	0.35***	0.47***	0.31***	0.17	0.08	0.29***	0.44***	0.15*
	(0.04)	(0.06)	(0.06)	(0.09)	(0.12)	(0.09)	(0.10)	(0.10)	(0.11)	(0.07)	(0.10)	(0.17)	(0.08)
Observations	2,804	1,583	1,480	1,293	1,019	1,297	1,241	1,319	1,217	1,510	1,197	809	1,192
R-squared	0.87	0.83	0.86	0.83	0.64	0.81	0.80	0.82	0.81	0.86	0.78	0.71	0.76
Exporter fixed effects	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
Importer fixed effects	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes

Notes: The dependent variable is services imports (in natural log form); the explanatory variables are distance between capitals (in natural log form), time zone difference (in hours), the bilateral stock of migrants (in natural log form), bilateral hyperlinks for 2009 (com-cracked, in natural log form), dummy variables for common border, common legal origin and EU membership and similarity indices for religion and languages. The estimation uses exporter- and importer fixed effects. Robust standard errors in brackets. * significant at 10% level; ** significant at 5% level, *** significant at 1% level.

Table 5: Services, imports, 2009, IV

VARIABLES	(1) Total	(2) Transp.	(3) Travel	(4) Commun.	(5) Constr.	(6) Insur.	(7) Fin.	(8) Comp.	(9) Royal.	(10) Oth. bus.	(11) Pers.	(12) Audio.	(13) Gov.
Distance (ln)	-0.64***	-0.88***	-0.72***	-0.62***	-1.30***	-0.84***	-0.76***	-0.76***	-0.78***	-0.78***	-0.91***	-0.55***	-0.25**
	(0.07)	(0.10)	(0.08)	(0.10)	(0.17)	(0.13)	(0.16)	(0.12)	(0.14)	(0.09)	(0.15)	(0.16)	(0.12)
Common border	-0.13	-0.30*	0.02	-0.38**	-0.27	0.26	-0.10	-0.40**	-0.09	-0.42***	0.22	-0.00	-0.03
	(0.12)	(0.17)	(0.13)	(0.16)	(0.27)	(0.19)	(0.22)	(0.17)	(0.20)	(0.14)	(0.22)	(0.24)	(0.21)
Time zone difference	-0.03**	-0.00	-0.09***	-0.09***	0.11**	-0.01	-0.07*	-0.04	-0.01	-0.02	-0.00	-0.10**	-0.06**
	(0.02)	(0.02)	(0.02)	(0.02)	(0.05)	(0.03)	(0.04)	(0.04)	(0.03)	(0.02)	(0.04)	(0.05)	(0.03)
Common legal origin	0.26***	0.32***	0.27***	0.20*	0.43**	0.30**	0.39***	0.37***	0.09	0.30***	0.41***	0.40**	0.26**
	(0.06)	(0.09)	(0.08)	(0.11)	(0.21)	(0.12)	(0.14)	(0.12)	(0.13)	(0.08)	(0.13)	(0.19)	(0.10)
Common religion index	0.12	0.03	0.23	0.38*	0.55	0.23	0.08	0.08	0.45	0.08	0.24	0.19	-0.82***
	(0.14)	(0.20)	(0.17)	(0.22)	(0.38)	(0.22)	(0.27)	(0.26)	(0.29)	(0.17)	(0.31)	(0.38)	(0.26)
Common language index	0.52**	0.41	0.25	-0.10	0.23	0.07	-0.91**	0.01	-0.09	0.15	-0.40	0.28	-0.81**
	(0.20)	(0.29)	(0.22)	(0.32)	(0.57)	(0.39)	(0.42)	(0.38)	(0.48)	(0.26)	(0.44)	(0.55)	(0.37)
EU	0.29**	0.23	0.12	-0.24	0.81*	-0.07	0.07	-0.06	-0.11	-0.06	-0.48*	-0.22	0.29
	(0.13)	(0.21)	(0.18)	(0.20)	(0.44)	(0.27)	(0.29)	(0.27)	(0.25)	(0.16)	(0.28)	(0.38)	(0.23)
Migrants (ln)	0.15***	0.15***	0.15***	0.21***	0.18***	0.15***	0.15***	0.12***	0.14***	0.13***	0.16***	0.06	0.18***
	(0.02)	(0.03)	(0.03)	(0.03)	(0.05)	(0.03)	(0.04)	(0.03)	(0.04)	(0.02)	(0.04)	(0.04)	(0.03)
Bilateral hyperlinks (ln)	0.19**	0.13	0.48***	0.58***	-0.05	0.24	0.77***	0.34**	0.21	0.25**	0.19	0.51***	0.32**
	(0.07)	(0.12)	(0.09)	(0.12)	(0.20)	(0.15)	(0.18)	(0.16)	(0.17)	(0.11)	(0.17)	(0.17)	(0.14)
Observations	1,336	1,200	1,125	1,037	798	994	902	1,015	975	1,149	895	709	943
R-squared	0.88	0.80	0.86	0.83	0.64	0.77	0.80	0.80	0.81	0.86	0.75	0.72	0.75
Exporter fixed effects	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
Importer fixed effects	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes

Notes: The dependent variable is services imports (in natural log form); the explanatory variables are distance between capitals (in natural log form), time zone difference (in hours), the bilateral stock of migrants (in natural log form), dummy variables for common border, common legal origin and EU membership and similarity indices for religion and languages. The estimation uses exporter- and importer fixed effects. Instrumental variables estimation (2SLS). Bilateral hyperlinks for 2009 (com-cracked) are instrumented by bilateral hyperlinks for 2003. Robust standard errors in brackets. * significant at 10% level; ** significant at 5% level, *** significant at 1% level.

Table 6: Imports, 2009, PPML estimations

VARIABLES	(1) Total	(2) Transp.	(3) Travel	(4) Commun.	(5) Constr.	(6) Insur.	(7) Fin.	(8) Comp.	(9) Royal.	(10) Oth. bus.	(11) Pers.	(12) Audio.	(13) Gov.
Distance (ln)	-0.29***	-0.37***	-0.41***	-0.41***	-0.77***	-0.34***	-0.04	-0.40***	-0.29**	-0.27***	-0.71***	-0.74***	0.07
	(0.04)	(0.06)	(0.06)	(0.07)	(0.12)	(0.12)	(0.11)	(0.10)	(0.14)	(0.07)	(0.13)	(0.14)	(0.16)
Common border	0.17**	0.13	0.42***	0.01	-0.24	0.24	0.39**	0.03	-0.39**	0.10	0.27	-0.26	0.02
	(0.07)	(0.08)	(0.09)	(0.11)	(0.15)	(0.18)	(0.17)	(0.16)	(0.18)	(0.11)	(0.20)	(0.22)	(0.28)
Time zone difference	-0.03***	-0.00	-0.06***	-0.09***	0.07	0.05	-0.11***	-0.01	-0.03	-0.06***	0.03	-0.07	-0.15***
	(0.01)	(0.02)	(0.02)	(0.02)	(0.06)	(0.04)	(0.03)	(0.03)	(0.03)	(0.02)	(0.04)	(0.04)	(0.04)
Common legal origin	0.07	0.02	-0.04	0.11	-0.22	-0.15	0.14	0.32**	-0.34***	0.17**	0.34**	0.11	-0.08
	(0.05)	(0.06)	(0.08)	(0.08)	(0.16)	(0.15)	(0.10)	(0.14)	(0.13)	(0.08)	(0.14)	(0.14)	(0.19)
Common religion index	0.26**	0.34**	-0.01	0.52**	0.84***	1.63***	0.55**	0.49**	0.09	0.43***	0.58*	0.26	-0.55
	(0.13)	(0.14)	(0.17)	(0.25)	(0.30)	(0.30)	(0.27)	(0.22)	(0.39)	(0.15)	(0.31)	(0.38)	(0.39)
Common language index	0.48**	0.14	0.43**	0.42	1.21***	0.75	-1.13***	-1.24**	1.65***	-0.10	0.58	2.34***	-1.18**
	(0.19)	(0.18)	(0.21)	(0.30)	(0.37)	(0.57)	(0.36)	(0.57)	(0.42)	(0.33)	(0.54)	(0.62)	(0.55)
EU	0.45***	0.16	0.38**	-0.23	0.07	1.04***	0.25	0.60**	0.96***	-0.04	-0.01	-0.35	-0.58
	(0.10)	(0.14)	(0.16)	(0.22)	(0.45)	(0.33)	(0.22)	(0.25)	(0.21)	(0.18)	(0.29)	(0.30)	(0.37)
Migrants (ln)	0.12***	0.12***	0.17***	0.15***	0.04	0.12***	0.10***	0.04	0.12***	0.09***	0.07	-0.02	0.30***
	(0.01)	(0.02)	(0.02)	(0.02)	(0.03)	(0.04)	(0.03)	(0.04)	(0.04)	(0.02)	(0.05)	(0.06)	(0.05)
Bilateral hyperlinks (ln)	0.17***	0.19***	0.41***	0.29***	0.28**	0.29**	0.61***	0.37***	-0.20	0.23***	0.09	0.43***	0.45***
	(0.04)	(0.06)	(0.06)	(0.08)	(0.13)	(0.13)	(0.11)	(0.10)	(0.15)	(0.07)	(0.12)	(0.14)	(0.16)
Observations	2,773	1,670	1,702	1,541	1,517	1,598	1,546	1,513	1,605	1,609	1,524	1,525	1,596
R-squared	0.92	0.82	0.88	0.83	0.67	0.91	0.95	0.83	0.87	0.89	0.89	0.96	0.96
Exporter fixed effects	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
Importer fixed effects	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes

Notes: The dependent variable is services imports; the explanatory variables are distance between capitals (in natural log form), time zone difference (in hours), the bilateral stock of migrants (in natural log form), bilateral hyperlinks for 2009 (com-cracked, in natural log form), dummy variables for common border, common legal origin and EU membership and similarity indices for religion and languages. The estimation uses exporter- and importer fixed effects. Estimation by PPML. Robust standard errors in brackets. * significant at 10% level; ** significant at 5% level, *** significant at 1% level.

Table 7: Services, imports, 2009, incl. internet penetration of importing country

VARIABLES	(1) Total	(2) Transp.	(3) Travel	(4) Commun.	(5) Constr.	(6) Insur.	(7) Fin.	(8) Comp.	(9) Royal.	(10) Oth. bus.	(11) Pers.	(12) Audio.	(13) Gov.
Distance (ln)	-0.61***	-0.71***	-0.66***	-0.85***	-0.89***	-0.51***	-0.71***	-0.57***	-0.55***	-0.77***	-0.84***	-0.67***	-0.48***
	(0.06)	(0.08)	(0.08)	(0.08)	(0.14)	(0.11)	(0.11)	(0.10)	(0.10)	(0.07)	(0.11)	(0.14)	(0.09)
Common border	0.11	-0.08	0.23	-0.25	0.02	0.26	-0.07	-0.18	-0.03	-0.29**	0.06	-0.10	-0.14
	(0.13)	(0.15)	(0.16)	(0.15)	(0.25)	(0.18)	(0.19)	(0.16)	(0.19)	(0.14)	(0.21)	(0.23)	(0.19)
Time zone difference	-0.06***	-0.06***	-0.08***	-0.08***	-0.03	-0.07**	-0.03	-0.04	-0.01	-0.04*	-0.00	-0.06	-0.04
	(0.02)	(0.02)	(0.02)	(0.02)	(0.05)	(0.03)	(0.03)	(0.03)	(0.03)	(0.02)	(0.03)	(0.04)	(0.02)
Common legal origin	0.72***	0.55***	0.38***	0.40***	0.24	0.35***	0.46***	0.23**	0.11	0.39***	0.32**	0.22	0.48***
	(0.06)	(0.09)	(0.08)	(0.10)	(0.17)	(0.12)	(0.13)	(0.11)	(0.13)	(0.09)	(0.13)	(0.17)	(0.10)
Common religion index	-0.57***	-0.50***	-0.22	-0.09	0.12	0.17	0.17	-0.09	0.40	-0.19	0.26	-0.58*	-1.19***
	(0.14)	(0.18)	(0.16)	(0.19)	(0.31)	(0.23)	(0.25)	(0.23)	(0.26)	(0.17)	(0.24)	(0.34)	(0.22)
Common language index	0.27	0.12	0.51**	0.41*	0.26	0.28	0.65**	0.31	0.36	0.36	-0.45	0.13	-0.36
	(0.18)	(0.24)	(0.21)	(0.25)	(0.47)	(0.35)	(0.32)	(0.30)	(0.41)	(0.26)	(0.34)	(0.48)	(0.33)
Population(ln)	0.71***	0.58***	0.53***	0.42***	0.59***	0.37***	0.53***	0.43***	0.61***	0.60***	0.27***	0.44***	0.64***
	(0.04)	(0.06)	(0.07)	(0.07)	(0.13)	(0.09)	(0.09)	(0.08)	(0.09)	(0.06)	(0.09)	(0.12)	(0.08)
GDP per capita(ln)	0.83***	0.76***	0.53***	0.55***	0.06	1.19***	0.62***	0.23**	0.46***	0.67***	0.66***	0.44***	0.27***
	(0.05)	(0.08)	(0.09)	(0.09)	(0.18)	(0.12)	(0.12)	(0.10)	(0.12)	(0.09)	(0.12)	(0.16)	(0.10)
EU	0.03	-0.06	0.25**	0.03	-0.24	0.14	0.18	0.21	-0.01	-0.02	-0.16	-0.10	0.08
	(0.10)	(0.13)	(0.11)	(0.14)	(0.24)	(0.18)	(0.19)	(0.16)	(0.18)	(0.13)	(0.18)	(0.24)	(0.15)
Migrants (ln)	0.17***	0.16***	0.16***	0.16***	0.13***	0.09***	0.16***	0.18***	0.12***	0.14***	0.13***	0.12***	0.15***
	(0.01)	(0.02)	(0.02)	(0.02)	(0.03)	(0.02)	(0.03)	(0.02)	(0.03)	(0.02)	(0.03)	(0.03)	(0.02)
Bilateral hyperlinks (ln)	0.09***	0.19***	0.38***	0.34***	0.30**	0.35***	0.35***	0.34***	0.40***	0.21***	0.45***	0.45***	0.04
	(0.03)	(0.06)	(0.07)	(0.07)	(0.14)	(0.09)	(0.08)	(0.09)	(0.09)	(0.07)	(0.10)	(0.11)	(0.08)
Internet penetration	0.01***	0.01***	0.01***	0.00	0.02***	-0.02***	0.01	0.02***	0.01***	0.01***	-0.00	0.01*	0.02***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.01)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.01)	(0.00)
Observations	2,658	1,584	1,451	1,352	1,013	1,261	1,184	1,287	1,212	1,546	1,122	864	1,215
R-squared	0.83	0.76	0.81	0.77	0.52	0.70	0.75	0.76	0.77	0.80	0.71	0.65	0.70
Exporter fixed effects	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
Importer fixed effects	no	no	no	no	no	no	no	no	no	no	no	no	no

Notes: The dependent variable is services imports (in natural log form); the explanatory variables are distance between capitals (in natural log form), time zone difference (in hours), the bilateral stock of migrants (in natural log form), bilateral hyperlinks for 2009 (com-cracked, in natural log form), dummy variables for common border, common legal origin and EU membership and similarity indices for religion and languages as well as GDP per capita, population (both in natural log form) and the share of internet users in the total population (for the importing country). The estimation uses exporter-fixed effects. Robust standard errors in brackets. * significant at 10% level; ** significant at 5% level, *** significant at 1% level.

Table 8: Services, imports, 2009, incl. internet penetration of exporting country

VARIABLES	(1) Total	(2) Transp.	(3) Travel	(4) Commun.	(5) Constr.	(6) Insur.	(7) Fin.	(8) Comp.	(9) Royal.	(10) Oth. bus.	(11) Pers.	(12) Audio.	(13) Gov.
Distance (ln)	-0.41***	-0.61***	-0.49***	-0.78***	-0.78***	-0.52***	-0.59***	-0.45***	-0.69***	-0.45***	-0.63***	-0.33**	0.02
	(0.06)	(0.08)	(0.07)	(0.08)	(0.17)	(0.10)	(0.13)	(0.10)	(0.11)	(0.08)	(0.11)	(0.15)	(0.08)
Common border	0.20	-0.02	0.15	-0.28*	0.03	0.40**	0.00	-0.25	-0.19	-0.11	0.10	-0.09	0.07
	(0.13)	(0.15)	(0.16)	(0.15)	(0.27)	(0.18)	(0.22)	(0.18)	(0.19)	(0.15)	(0.20)	(0.25)	(0.18)
Time zone difference	-0.06***	-0.07***	-0.12***	-0.08***	-0.00	-0.08**	-0.07**	-0.06*	-0.04	-0.06***	-0.04	-0.08*	-0.15***
	(0.02)	(0.02)	(0.02)	(0.02)	(0.05)	(0.03)	(0.03)	(0.03)	(0.03)	(0.02)	(0.03)	(0.05)	(0.02)
Common legal origin	0.77***	0.70***	0.49***	0.34***	0.32*	0.24*	0.56***	0.22	0.21	0.37***	0.38***	0.07	0.48***
	(0.06)	(0.10)	(0.09)	(0.11)	(0.18)	(0.13)	(0.16)	(0.14)	(0.14)	(0.10)	(0.14)	(0.20)	(0.10)
Common religion index	-0.46***	-0.65***	-0.01	0.10	0.38	0.36	-0.27	-0.20	0.39	0.03	0.38	0.50	-1.05***
	(0.14)	(0.18)	(0.16)	(0.19)	(0.31)	(0.25)	(0.29)	(0.27)	(0.27)	(0.19)	(0.25)	(0.35)	(0.24)
Common language index	0.28	-0.12	0.36	0.56**	0.21	0.66*	0.64	0.61*	0.53	0.19	0.01	1.37***	-0.13
	(0.19)	(0.26)	(0.26)	(0.27)	(0.48)	(0.38)	(0.41)	(0.36)	(0.40)	(0.25)	(0.36)	(0.47)	(0.30)
Population(ln)	0.73***	0.57***	0.47***	0.41***	0.59***	0.61***	0.58***	0.39***	1.08***	0.56***	0.44***	0.60***	0.77***
	(0.04)	(0.06)	(0.07)	(0.07)	(0.12)	(0.08)	(0.11)	(0.10)	(0.10)	(0.07)	(0.09)	(0.14)	(0.07)
GDP per capita(ln)	0.94***	0.82***	0.95***	0.81***	0.47***	1.48***	1.57***	0.84***	1.58***	0.87***	1.05***	0.84***	1.06***
	(0.06)	(0.08)	(0.09)	(0.09)	(0.15)	(0.11)	(0.14)	(0.13)	(0.13)	(0.09)	(0.12)	(0.16)	(0.10)
EU	0.20**	-0.16	0.15	-0.11	0.26	-0.32*	-0.25	0.34*	-0.21	0.22	-0.37**	-0.15	-0.19
	(0.10)	(0.13)	(0.12)	(0.13)	(0.21)	(0.17)	(0.20)	(0.17)	(0.21)	(0.14)	(0.18)	(0.25)	(0.15)
Migrants (ln)	0.19***	0.15***	0.18***	0.19***	0.19***	0.11***	0.16***	0.17***	0.16***	0.16***	0.14***	0.15***	0.21***
	(0.02)	(0.03)	(0.03)	(0.03)	(0.05)	(0.03)	(0.04)	(0.04)	(0.04)	(0.03)	(0.03)	(0.04)	(0.03)
Bilateral hyperlinks (ln)	0.05*	0.20***	0.36***	0.30***	0.15	0.27***	0.35***	0.27***	0.03	0.33***	0.25***	0.19	-0.04
	(0.03)	(0.06)	(0.06)	(0.06)	(0.11)	(0.08)	(0.10)	(0.10)	(0.10)	(0.07)	(0.09)	(0.12)	(0.07)
Internet penetration	0.02***	0.02***	-0.01***	0.00	0.02***	-0.01	0.00	0.03***	0.04***	0.02***	0.01***	0.02***	0.01**
	(0.00)	(0.00)	(0.00)	(0.00)	(0.01)	(0.00)	(0.01)	(0.01)	(0.01)	(0.00)	(0.00)	(0.01)	(0.00)
Observations	2,664	1,589	1,455	1,355	1,012	1,262	1,184	1,288	1,216	1,548	1,122	864	1,213
R-squared	0.79	0.72	0.76	0.74	0.55	0.68	0.67	0.65	0.73	0.76	0.67	0.58	0.63
Exporter fixed effects	no	no	no	no	no	no	no	no	no	no	no	no	no
Importer fixed effects	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes

Notes: The dependent variable is services imports (in natural log form); the explanatory variables are distance between capitals (in natural log form), time zone difference (in hours), the bilateral stock of migrants (in natural log form), bilateral hyperlinks for 2009 (com-cracked, in natural log form), dummy variables for common border, common legal origin and EU membership and similarity indices for religion and languages as well as GDP per capita, population (both in natural log form) and the share of internet users in the total population (for the exporting country). The estimation uses importer-fixed effects. Robust standard errors in brackets. * significant at 10% level; ** significant at 5% level, *** significant at 1% level.

Appendix

Table I: Country sample for 2009

Argentina	France	Luxembourg	Singapore
Australia	Germany	Malaysia	Slovakia
Austria	Greece	Malta	Slovenia
Belgium	Hong Kong	Mexico	South Africa
Brazil	Hungary	Moldova	South Korea
Bulgaria	Iceland	Netherlands	Spain
Canada	India	New Zealand	Sweden
China	Indonesia	Nigeria	Switzerland
Croatia	Iran	Norway	Taiwan
Cyprus	Ireland	Panama	Thailand
Czech Republic	Israel	Poland	Turkey
Denmark	Italy	Portugal	United Arab Emirates
Egypt	Japan	Romania	United Kingdom
Estonia	Latvia	Russia	United States
Finland	Lithuania	Serbia	

Table II: Top 10 bilateral hyperlinks

	Country	Partner	Bilateral hyperlinks 2009 (in millions, .com-cracked)
1	United States	United Kingdom	48.9
2	United States	Japan	43.9
3	United States	Germany	40.8
4	China	United States	34.9
5	Japan	United States	34.1
6	United States	China	32.5
7	United Kingdom	United States	31.3
8	United States	Italy	22.1
9	France	United States	21.0
10	Germany	United Kingdom	20.8