Does Gravity Matter for Trade in Intermediate Services?

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Abstract

This paper makes a twofold contribution to the literature on trade in services. First, I construct a novel bilateral dataset of trade in services differentiating between final consumption and intermediate consumption following the most recent classification of UN's Broad Economic Categories (BEC Rev. 5). Second, I use this dataset to estimate a gravity model of trade in intermediate and final services for a sample of 48 economies for the time period 2010-2019. Using a robust model specification consistent with the recent advancements in the gravity literature, I find that trade in services exhibits a sensitivity to bilateral distance between trading partners, similar to trade in goods. Intermediate services tend to be more sensitive to distance relative to final services due to the distinct nature of these services (B2B versus B2C). Common language and common borders are important determinants of both trade in intermediate and final services. I also find evidence of non-linear effects of time zone differences on trade in services.

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1 Introduction

This paper aims to study the determinants of trade in final and intermediate services using the gravity model framework. In particular, I compare how standard gravity variables affect trade in final and intermediate services, relative to trade in goods. To do so, I construct a novel bilateral dataset of trade in services differentiating between final and intermediate services following the most recent classification of UN's Broad Economic Categories (BEC Rev. 5). Then, I use this dataset to estimate a gravity model of trade in intermediate and final services for a sample of 48 reporting economies for the time period 2010-2019.

This paper's focus on trade in intermediate services is motivated by the increasing fragmentation of supply chains and outsourcing of tasks across borders. While trade in intermediate inputs (both in goods and services) has been steadily growing, the literature on intermediate inputs, however, has predominantly focused on trade in intermediate goods. This is largely due to limitations of the available data on services trade. Compared to data for trade in goods, services trade data generally is of a lower level of quality and disaggregation (Baldwin 2022). Moreover, until recently, there did not exist a clear-cut approach to classify services by end-use i.e. final versus intermediate services. Unlike the UN's Broad Economic Categories (BEC) Classification which classifies trade in goods by end-use, no such classification was available for trade in services due to the high level of aggregation in services trade data (Miroudot et al. 2009). However, in 2016, the 5th revision of the BEC released a classification of services by end-use, allowing for the differentiation between final services and intermediate services.

With the new BEC classification available, it is now possible to look closely at how trade in intermediate services may vary from trade in final services. Intermediate services are those that serve as inputs in the production process of goods or other services. Examples of intermediate services include freight transport, logistics, consulting and legal services, research and development, and maintenance and repair services. Final services, on the other hand, are services delivered for final consumption. These include passenger transport, travel, insurance, healthcare and education services. An important distinction between these two types of services is that intermediate services tend to be Business-to-Business (B2B) transactions while final services are typically Business-to-Consumer (B2C) transactions.

In 2021, intermediate services made up 75 percent of total services extra-EU exports and 81 percent of total services extra-EU imports. On the other

hand, intermediate goods made up 48 percent of total goods extra-EU exports and 56 percent of total goods extra-EU imports (Eurostat 2023a). In 2020, while supply chain disruptions and lockdowns around the world resulted in goods trade sharply declining, the fall in intermediate services trade was much lower (ibid.). Excluding travel and transport-related services, trade in other commercial services has continued to increase even as trade in goods stagnated between 2010 and 2021 (Baldwin 2022). This services-driven transformation has occurred in part due to the recent developments in technology and automation, making previously non-tradable services now tradable across borders.

Given the increasing role of intermediate services in global trade, it is important to investigate how trade in intermediate services may vary from trade in final services (as well as from trade in goods, in general). In particular, do trade costs in terms of distance matter the same way for intermediate services as they do for final services? Understanding these differences will provide valuable insights for policymakers to formulate nuanced policies best suited to facilitate trade in both intermediate and final services.

However, due to the lack of services trade data distinguished by end-use, the literature so far has predominantly focused on gravity model estimation of either trade in intermediate goods (Conconi et al. 2020; Greaney and Kiyota 2020) or trade in services as a whole (Anderson, Borchert, et al. 2018; Ceglowski 2006; Kimura and Lee 2006). This paper aims to fill this crucial gap in the literature by distinguishing between intermediate services and final services to show how well the gravity framework explains trade in both types of services.

This paper makes a twofold contribution to the literature on trade in services. First, I construct a novel bilateral dataset of trade in services differentiating between final services and intermediate services following the most recent classification of UN's Broad Economic Categories (BEC Rev. 5). This dataset now makes it possible to measure and study trade in intermediate services for over 240 reporting economies (including regions and groups of economies) over a time period of 2005-2021.

Second, I use this dataset to estimate a gravity model of trade in intermediate and final services for a sample of 48 economies for the time period

2010-2019[3]. I use a robust model specification consistent with the recent advancements in the gravity model literature. In particular, I include a rich set of fixed effects to alleviate concerns regarding potential endogeneity between service imports and the explanatory variables in my gravity equation. The main results of my gravity model estimation are as follows. I find that trade in services tends to be sensitive to the bilateral distance between trading partners, with a magnitude similar to trade in goods. In particular, intermediate services tend to be more sensitive to distance relative to final services due to the distinct nature of these services (B2B versus B2C). Common language and common borders are important determinants of both trade in intermediate and final services. I also find evidence of non-linear effects of time zone differences on trade in services. Finally, I carry out a number of sensitivity analyses to ensure the robustness of my results.

The rest of the paper is organised as follows. Section 2 discusses the relevant literature and the contribution of this paper. The gravity model estimation strategy is outlined in Section 3. Section 4 describes the construction of the trade in services dataset, and data sources of the other gravity variables. Section 5 explains the main empirical findings. Section 6 describes the robustness analysis and Section 7 concludes.

2 Literature review

This paper contributes to the ever-growing literature on gravity models of trade. The gravity model framework is a popular and robust framework in international trade with strong theoretical foundations (Anderson and Van Wincoop 2003) and unprecedented predictive power[4]. In particular, this paper contributes to two strands of literature in this field. The first strand includes papers that estimate gravity models of trade in services (Anderson, Borchert, et al. 2018; Ceglowski 2006; Kimura and Lee 2006; Walsh 2006). Given the lack of a suitable approach to classify services by end-use, these papers studied trade in services without distinguishing between final and intermediate services. The second strand of literature includes papers that estimate gravity models of trade in intermediate inputs, predominantly focusing on trade in intermediate goods (Conconi et al. 2020; Greaney and Kiyota 2020). One of the earliest attempts at studying trade in intermediate services was undertaken by Miroudot et al. (2009) who combined trade data with Input-Output tables to compare trade in intermediate services

[3]Out of the 240 reporting economies in my dataset, only 48 economies have reported services trade data disaggregated by trading partners; for the rest, the only trading partner listed is the "world". Since the gravity model is a bilateral framework of trade, my empirical analysis is limited to these 48 economies. See section 4 for further details.

[4]See Yotov (2022) for the most recent survey of the gravity literature.

with final services. My paper contributes to the existing literature in two ways. First, in contrast with the Input-Output methodology of Miroudot et al. (2009), my approach to classifying trade in services by end-use relies on UN's most recent BEC classification which allows the direct breakdown of services into final and intermediate at the EBOPS sector level. Second, in my gravity model analysis, I use a 2-stage estimation strategy including pairwise country fixed effects, making my estimates consistent with a structural gravity model and robust to potential endogeneity concerns.

3 Empirical methodology

My empirical analysis of trade in intermediate and final services is based on the estimation of a standard gravity model. The gravity model framework is a popular and robust framework in international trade with strong theoretical foundations (Anderson and Van Wincoop 2003) and unprecedented predictive power (Yotov 2022). Consistent with the recent advancements in the empirical gravity literature, I estimate the following gravity equation:

$$\begin{aligned} Y_{ijt} = \exp(&\beta_0 + \beta_1 \text{log distance}_{ij} + \beta_2 \text{common language}_{ij} + \beta_3 \text{common border}_{ij} \\ &+ \beta_4 \text{time difference}_{ij} + \beta_5 \text{RTA coverage}_{ijt} + \beta_6 \text{EU pair}_{ijt} \\ &+ \sum_{k=7}^{12} \beta_k (D_{ijt} * X_{ijt}) + \beta_{13} D_{ijt} + \alpha_{it} + \alpha_{jt}) + \epsilon_{ijt} \end{aligned} \tag{3.1}$$

where the dependent variable Y_{ijt} denotes the imports of services from country i to country j at time t. The coefficients β_0 through β_6 represent the impact of standard gravity variables on the dependent variable. Specifically, β_1 is the effect of logarithm of the distance between countries i and j, while β_2 and β_3 represent the effect of a common language and a common border between the two countries, respectively. The coefficient β_4 captures the effect of the time difference between countries i and j. β_5 accounts for the impact of a categorical variable denoting the type of Regional Trade Agreement between countries i and j at time t. β_6 represents the effect of an indicator variable denoting EU membership of both trading partners i and j at time t.
To distinguish between intermediate and final services in this gravity equation, I include a dummy variable denoted as D_{ijt} which takes the value 1 for intermediate service imports and 0 for final service imports. An additional set of interaction terms between the D_{ijt} dummy and the 6 other explanatory variables X_{ijt} with coefficients denoted by β_k are included to measure the marginal difference in the impact of gravity variables on intermediate services imports and final services imports.

To mitigate potential endogeneity between service imports and the explanatory variables, I include a rich set of fixed effects in my model. Exporter-year fixed effects α_{it} and importer-year fixed effects α_{jt} control for outward and inward multilateral resistance respectively (Anderson and Van Wincoop 2003). They also control for all time-varying unobservable country-specific factors that may affect trade flows. Additionally, endogeneity related to bilateral time-varying trade policy variables is mitigated with the use of pairwise country fixed effects[5] α_{ij} (Baier and Bergstrand 2007). These pairwise country fixed effects also absorb all time-invariant bilateral trade costs (Egger and Nigai 2015). Finally, the equation includes an error term denoted as ϵ_{ijt}, representing the unobservable stochastic component of the model. Note that standard gravity variables such as population and gross domestic product which are country-specific and time-varying variables are omitted from this estimation and their marginal effects are captured by the exporter-year and importer-year fixed effects. Likewise, the inclusion of pairwise country fixed effects means that all time-invariant bilateral variables (such as distance, common language, common border and time difference) are also omitted from the estimation, and their effects are captured by the pairwise country fixed effects. In order to recover the marginal effects of the time-invariant bilateral variables that were omitted, I use a 2-stage estimation strategy which is described below.

Following Santos Silva and Tenreyro (2006), I use the Poisson Pseudo Maximum Likelihood (PPML) estimator to estimate the gravity equation in this study. The choice of this estimator is driven by its ability to overcome two key empirical challenges. First, in the presence of heteroskedastic errors, which are common in real-world trade data, estimating the log-linear form of the gravity equation using Ordinary Least Squares (OLS) results in biased as well as inconsistent estimates (ibid.). Second, OLS estimation entails dropping all observations with zero trade flows when transforming the trade values into logarithmic form. Yotov et al. (2016) note that the problem of zero trade flows is especially severe for sectoral data for trade in services "due to the highly localized consumption and highly specialized production patterns of services". To address these challenges, Santos Silva and Tenreyro (2006) propose the PPML estimator as a solution. In addition to its ability to address heteroskedasticity and account for zero trade flows, the PPML estimator offers two more advantages. First, the additive prop-

[5]Pairwise country fixed effects α_{ij} are not explicitly indicated in Equation 3.1 since they are perfectly collinear with the time-invariant bilateral regressors i.e. distance, common language and common border. As outlined in the 2-step estimation strategy in Section 3, the pairwise fixed effects α_{ij} are estimated in the first stage while the time-invariant bilateral regressors are estimated in the second stage.

erty of the PPML estimator allows the direct recovery of structural multilateral terms from the estimated exporter-time and importer-time fixed effects in the gravity equation (Arvis and Shepherd 2013; Fally 2015). This feature makes the PPML estimator consistent with a "structural" gravity model estimation, as the exporter-time and importer-time fixed effects precisely capture the corresponding multilateral resistance terms from the theoretical model (Yotov 2022). Second, PPML demonstrates robustness against the incidental parameter problem, even when using multi-way fixed effects, under fairly general conditions (Weidner and Zylkin 2021). Given these advantages, PPML has become the leading estimator of choice in the gravity literature. Nonetheless, for thoroughness, in my empirical analysis, I conduct a preliminary comparison between OLS estimates and PPML estimates and perform tests for model misspecification before selecting the baseline estimator for this study.

As noted earlier, the use of pairwise country-fixed effects in the gravity equation entails omitting all time-invariant bilateral variables of interest such as distance, common language, common border and time difference. A number of previous studies have dismissed the inclusion of pairwise country fixed effects arguing that it prevents the estimation of the effects of time-invariant bilateral variables (Greaney and Kiyota 2020; Kimura and Lee 2006; Wei and Frankel 1997). However, these concerns can be addressed by using a 2-stage estimation strategy which makes it possible to recover the estimates of time-invariant bilateral variables, as shown by Head and Mayer (2014).

Following Anderson and Yotov (2016) and Cheng and Wall (2005), I implement the following 2-stage estimation of the gravity equation. In the first stage, I estimate equation (3.1) using PPML including the full set of exporter-year, importer-year and pairwise country fixed effects[6]. This first stage provides estimates of all time-varying gravity variables namely the type of RTA coverage and EU membership of trading partners. In the second stage, the estimates of pairwise country fixed effects from the first stage are regressed on the standard set of time-invariant gravity variables (i.e. distance, common language, common border, and time difference) using OLS. In order to distinguish between intermediate and final services in this gravity estimation, I include in both stages the interaction terms between the gravity variables and the dummy variable D_{ijt}. This 2-step strategy allows me to obtain estimates of both time-varying and time-invariant bilateral variables while using a rich set of fixed effects to alleviate concerns regarding potential endogeneity between service imports and the explana-

[6]Since my unit of analysis is country pair-year, I do not include pairwise country-year fixed effects because that would perfectly predict trade flows.

tory variables in my gravity equation.

4 Data

4.1 Trade in services data (classified by end-use)

For the empirical analysis of the gravity model of trade in intermediate and final services, I construct a novel dataset of trade in intermediate services ("TIMS"). Building upon the WTO's statistics on annual trade in commercial services, the TIMS dataset offers the added advantage of differentiating services trade flows by end-use, classifying them as either final services or intermediate services. Unlike the UN's Broad Economic Categories Classification (BEC) which classifies trade in goods by end-use, no such classification was available for trade in services due to the high level of aggregation in services trade data (Miroudot et al. 2009). However, in 2016, the 5th revision of the BEC introduced a classification of services by end-use, allowing the differentiation between final services and intermediate services.

Following the BEC Revision 5 classification, I have allocated services trade flows to either final consumption or intermediate consumption based on Eurostat's correlation table between the Extended Balance of Payments Services (EBOPS) classification and the BEC services classification.[7]. The resulting dataset covers both exports and imports of services for more than 240 reporting economies (including regions and groups of economies) disaggregated by over 50 service sectors for the time period 2005-2021. Of these 240 reporting economies, only 48 economies have reported services trade data disaggregated by trading partners; for the rest, the only trading partner listed is the "world". Since the gravity model is a bilateral framework of trade, my empirical analysis is limited to these 48 economies, over 70 percent of which are advanced economies[8] (Table A.2). Given the representation of advanced economies (including the 27 EU members) in my sample, I believe Eurostat's methodology (which is based on a sample of 21 EU economies) is also applicable to my sample[9].

The dependent variable in my gravity equation (3.1) is imports of final and

[7]see Appendix for details on the Eurostat methodology of classifying services trade flows by end-use.

[8]See here for IMF's latest classification of economies.

[9]A drawback of this methodology is that the shares of services allocated to final and intermediate consumption are assumed to be the same across all countries. However, in the absence of more disaggregated data on services trade, the TIMS dataset offers the most viable approximation currently available.

intermediate services, the data for which comes from the TIMS dataset described above. Specifically, I use a panel dataset of 48 reporting economies[10] spanning 10 years from 2010-2019[11].

4.2 Gravity variables

Standard bilateral gravity variables such as *distance, common language* and *common border* are taken directly from CEPII's Gravity database (Conte et al. 2022). *Distance* is measured as the log of distance (in kilometers) between the most populous cities of the two trading partners. *Common language* and *common border* variables are both indicator variables that take the value 1 if the trading partners have a common language and a common border respectively; and 0 otherwise. The additional variables namely *RTA coverage type, EU pair*, and *time difference* are also constructed using CEPII gravity data. *RTA coverage* is a categorical variable takes the value 0 if there is no RTA in place, 1 if the RTA covers only trade in goods, and 2 if the RTA covers trade in both goods and services. *EU pair* is an indicator variable that takes the value 1 if both trading partners are EU members and 0 otherwise. *Time difference* is a continuous variable that measures the difference in time zones (in hours) between the trading partners. The summary statistics of all variables are presented in Table 4.1.

Table 4.1: Summary statistics

Variable	Obs	Mean	Std. Dev.	Min	Max
Imports (thousand USD)	36529	435838.7	1760922	0	64386000
Log distance (km)	36529	8.079	1.109	4.007	9.884
Common language	36529	.079	.27	0	1
Contiguity	36529	.054	.226	0	1
RTA coverage	36529	1.039	.918	0	2
EU pair	36529	.343	.475	0	1
Time difference (hours)	36529	3.306	3.567	0	12

[10]The panel dataset covers bilateral trade flows between 48 reporting economies and a total of 106 partner economies. Note that reporting economies do not all have the same number of partner economies.

[11]I use consecutive-year panel data to estimate equation (3.1) for two reasons. First, the use of consecutive-year panel data avoids the potential downward bias of estimates obtained with interval or averaged data (Egger, Larch, et al. 2022). Second, it also improves the efficiency of estimates due to the use of all available data.

5 Results

5.1 Preliminary comparison: OLS versus PPML

As outlined in the methodology, I begin with a comparison of OLS estimates and PPML estimates in Table A.7. Both specifications include a rich set of exporter-year, importer-year and pairwise country fixed effects. Note that all time-varying country-specific variables such as population and gross domestic product are omitted from the regression and their marginal effects are captured by the exporter-year and importer-year fixed effects. Likewise, the inclusion of pairwise country fixed effects means that all time-invariant bilateral variables (such as distance, common language, common border and time difference) are also omitted from the estimation, and their effects are captured by the pairwise country fixed effects. Since most of the variables of my interest are omitted from this estimation, the focus is not on the interpretation of the estimated marginal effects presented in Table A.7. In the next subsection, I use a 2-stage estimation strategy to obtain the marginal effects of the time-invariant bilateral variables that were omitted in this preliminary comparison. In any case, the focus of Table A.7 is to test for model misspecification, so the statistic of interest here is the Ramsey RESET test p-value presented in the last row. With a p-value of 0.233 for the PPML specification, I fail to reject the null of no misspecification. This comparison favours the PPML estimator over OLS.

Following Head and Mayer (2014), I also perform a diagnosis of the error term which supports the use of the PPML estimator over OLS using the "MaMu" test statistic[12]. Based on the results of the Ramsey RESET test and MaMu test, I use PPML as the preferred estimator throughout the rest of my empirical analysis.

5.2 2-stage PPML estimation: Final versus Intermediate services

Following Anderson and Yotov (2016) & Cheng and Wall (2005), I adopt a 2-stage strategy to obtain the estimated marginal effects of time-invariant bilateral variables in the presence of pairwise country fixed effects. The first-stage PPML estimation results are presented in column (1) of Table

[12]Head and Mayer (2014) show that PPML is efficient when the data generating process (DGP) is characterized by a Constant Variance to Mean Ratio (CVMR). The MaMu test statistic (Manning and Mullahy 2001) assumes a value of $\lambda = 1$ if the DGP is characterized by CVMR and a value of $\lambda = 2$ if the DGP is characterized by a Constant Coefficient of Variation (CCV). In my sample using the PPML specification, I reject the null of $\lambda = 2$ in favour of CVMR error, making PPML my preferred estimator.

5.1. For final services, having an RTA covering goods only has no statistically significant effect on imports of final services, relative to not having an RTA at all. On the other hand, having an RTA covering goods and services reduces final services imports by 28 percent[13]. The negative marginal effect of RTAs on final services imports may be attributed to persistent non-tariff barriers such as differences in regulatory frameworks, licensing requirements and certification standards. These factors are particularly important for final services, such as healthcare, which are typically subject to strict country-specific regulations.

For intermediate services, having an RTA covering goods only has no statistically significant effect on imports of intermediate services, relative to not having an RTA at all. Conversely, having an RTA covering both goods and services increases imports of intermediate services by 33 percent, relative to having no RTA at all. RTAs' positive impact on intermediate services imports may be attributed to supply chain integration by reducing trade costs and enhancing compliance and coordination between trading partners. RTAs may be particularly important for facilitating imports of intermediate services because these services typically require higher levels of coordination than final services.

Both trading partners being EU members has no statistically significant effect on the import of final services; however, it reduces intermediate services imports by 24 percent, relative to the partners not being EU members. To further investigate this, I exclude the EU's biggest extra-EU trading partner i.e. United States of America from the sample and redo the PPML estimation (Table A.8). I find that upon excluding the US from the sample, both trading partners being EU members increases final services imports by 57 percent and reduces intermediate services imports by 28 percent. The negative marginal effect on intermediate services might reflect the greater role of extra-EU imports of intermediate services from partners such as India, China, Singapore & Switzerland (Eurostat 2023b).

The second-stage gravity estimation results are presented in column (2) of Table 5.1. A 10 percent increase in bilateral distance between trading partners decreases imports of final services by 4.4 percent and imports of intermediate services by 5.15 percent. These results are consistent with the findings of Miroudot et al. (2009), Kimura and Lee (2006) and Ceglowski

[13]The marginal effects of indicator variables in the PPML estimation are calculated as $(e^{\beta} - 1)$ x 100 percent change in trade flows where β is the estimated coefficient of any indicator variable in the model (Yotov et al. 2016).

(2006) who all find that distance still matters for trade in services[14]. Intermediate services tend to be more sensitive to distance due to their predominantly Business-to-Business (B2B) nature. Intermediate services such as business consulting, accounting, and copy-editing often require greater personal interaction and collaboration, making them more synchronous. In contrast, final services such as audio-visual and telecommunication services are typically Business-to-Consumer (B2C) in nature and thus, more asynchronous and requiring less personal interaction.

Having a common border between trading partners has a strong positive effect on both final and intermediate services imports highlighting that even though services don't need to be physically transported like goods, their delivery often requires a certain degree of proximity to customers and clients. In particular, many final services such as healthcare, hospitality, and tourism rely on physical presence and face-to-face interaction, necessitating geographical proximity.

In a similar vein, minimizing the difference in time zones between trading partners is crucial to ensure coordination and real-time interaction to facilitate the imports of services. An increase in the time difference by 1 hour decreases imports of final services by 7 percent. There seems to be no additional statistically significant impact of time difference on imports of intermediate services, relative to final services. Having a common language between trading partners increases imports of final services by 90 percent. Again, there seems to be no additional statistically significant impact of common language on imports of intermediate services, relative to final services.

To further investigate the impact of bilateral time-invariant variables on service imports, I differentiate between 4 types of services: goods-related services, transport services, travel services and other commercial services. Including dummy variables to distinguish services by type (and their interactions with standard gravity variables), I repeat the 2-stage estimation strategy separately for final services and intermediate services. The results are presented in Tables 5.2 & 5.3.

Starting with the results for intermediate services, column (1) of Table 5.2 shows that having an RTA covering goods only has no statistically sig-

[14]The magnitude of my estimated distance coefficient is also within the range of previous estimates of [-0.44, -0.9], although my specification is not directly comparable to previous studies due to different samples and the use of a 2-stage PPML estimator in the presence of pairwise country fixed effects (as opposed to simple OLS and/or PPML without pairwise country fixed effects).

nificant impact on the intermediate services imports in any of the 3 types: transport services (i.e. the reference category in this model), goods-related services and other commercial services[15]. For transport services and other commercial services, having an RTA covering both goods and services has a negative impact on intermediate imports (47.5 percent and 1.9 percent respectively) whereas the same has a positive impact of 67 percent on intermediate imports of goods-related services. Both trading partners being EU members has no statistically significant impact on the intermediate imports of transport services or other commercial services. However, both trading partners being EU members decreases imports of goods-related intermediate services by 64.5 percent.

The second-stage estimation results in column (2) of Table 5.2 show that a 10 percent increase in bilateral distance decreases imports of intermediate transport services and other commercial services by 5.9 percent and 5.1 percent respectively. Intermediate transport services refer to freight services that are inherently more sensitive to distances over which the services are delivered. Longer distances mean higher transportation costs and potentially longer transit times, making imports of freight services more sensitive to distances.

Relative to transport services, goods-related services and other commercial services are both more sensitive to having a common border between trading partners. This may be attributed to the need for building and maintaining business relationships which are often more important for goods-related services and other commercial services that rely more on face-to-face interactions and collaboration, as compared to freight transportation services. Neighboring countries often share similar cultures and business practices. This cultural proximity may facilitate better communication and stronger business relationships, making it easier for businesses to deliver goods-related services or other commercial services in a familiar environment.

Relative to transport services, goods-related services seem to be less sensitive to a common language while other commercial services tend to be more sensitive (negatively) to a common language between trading partners. An extra hour of time difference between trading partners increases imports of intermediate transport services by 6.44 percent and decreases imports of other commercial intermediate services by 1.77 percent.

Looking at the results for final services, column (1) of Table 5.3 shows that neither the kind of RTA nor EU membership of trading partners has a statistically significant effect on the imports of final services, across all

[15]Note that there are no travel services in the intermediate services category.

three types: transport services, travel services and other commercial services[16]. Turning to the second-stage estimates for final services, I find that a 10 percent increase in bilateral distance decreases imports of final transport services, travel services and other commercial services by 6.35 percent, 4.76 percent and 5.34 percent respectively. Having a common border between trading partners increases imports of final transport services by 129 percent but has no additional statistically significant effect on the imports of final travel services or other commercial services.

Having a common language between trading partners increases imports of final transport services, travel services and other commercial services by 50.2 percent, 101.1 percent and 68.5 percent respectively. An extra hour of time difference between trading partners reduces imports of final travel services by 1.23 percent and increases other commercial services by 0.52 percent respectively. Overall, it seems that time difference is not such an important factor in the case of final service imports, perhaps because of the asynchronous nature of B2C final services, compared to B2B intermediate services.

[16]Note that there are no goods-related services in the final services category.

Table 5.1: 2-stage gravity (PPML) estimation with pairwise country fixed effects

	1st stage	2nd stage
	(1) PPML, FE	(2) OLS
Log distance		-0.441***
		(0.0171)
Common language		0.644***
		(0.0409)
Common border		1.300***
		(0.0329)
Time difference		-0.0700***
		(0.00628)
Goods only RTA	0.0971	
	(0.130)	
Goods & services RTA	-0.332**	
	(0.113)	
Intermediate services × Goods only RTA	0.0547	
	(0.203)	
Intermediate services × Goods & services RTA	0.623***	
	(0.158)	
EU pair	0.288	
	(0.191)	
Intermediate services × EU pair	-0.564*	
	(0.223)	
Intermediate services × Log distance		-0.0745***
		(0.0219)
Intermediate services × Common language		-0.0148
		(0.0587)
Intermediate services × Common border		-0.0999*
		(0.0501)
Intermediate services × Time difference		0.0130
		(0.00688)
Intermediate services		0.615***
		(0.162)
Constant	14.97***	2.107***
	(0.347)	(0.122)
Observations	36529	36529
R^2		0.259

Dependent variable in column (1) is imports (in thousand USD). Column (1) includes pairwise country fixed effects as well as fixed effects at the exporter-year and importer-year level separately for intermediate services and final services. Standard errors (in parentheses) in column (1) are clustered at the country-pair level. Column (2) reports results from the second-stage estimation where the country-pair fixed effects from the first-stage specification are regressed on the standard set of (time-invariant) gravity variables. Bootstrapped standard errors are reported in column (2).* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 5.2: 2-stage gravity estimation: Intermediate services

	1st stage	2nd stage
	(1)	(2)
	PPML, FE	OLS
Log distance		-0.586***
		(0.0187)
Common language		0.294***
		(0.0545)
Common border		1.005***
		(0.0295)
Time difference		0.0644***
		(0.00675)
Goods only RTA	-0.312	
	(0.192)	
Goods & services RTA	-0.643***	
	(0.162)	
GRS × Goods only RTA	0.657	
	(0.362)	
GRS × Goods & services RTA	1.156***	
	(0.312)	
OCS × Goods only RTA	0.351	
	(0.201)	
OCS × Goods & services RTA	0.624***	
	(0.178)	
EU pair	0.163	
	(0.215)	
GRS × EU pair	-1.200**	
	(0.371)	
OCS × EU pair	-0.142	
	(0.242)	
GRS × Log distance		0.0486
		(0.0278)
OCS × Log distance		0.0795**
		(0.0289)
GRS × Common language		-0.294***
		(0.0867)
OCS × Common language		-0.411***
		(0.0897)
GRS × Common border		0.114*
		(0.0475)
OCS × Common border		0.180***
		(0.0426)
GRS × Time difference		-0.0653***
		(0.00973)
OCS × Time difference		-0.0821***
		(0.0116)
Observations	42358	42358
R^2		0.198

Dependent variable in column (1) is imports (in thousand USD). Column (1) includes pairwise country fixed effects as well as fixed effects at the exporter-year and importer-year level separately for intermediate services and final services. Standard errors (in parentheses) in column (1) are clustered at the country-pair level. Column (2) reports results from the second-stage estimation where the country-pair fixed effects from the first-stage specification are regressed on the standard set of (time-invariant) gravity variables. Bootstrapped standard errors are reported in column (2). * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

GRS denotes goods-related services. OCS denotes other commercial services. The reference category is TRPT i.e. transport services. The constant term and dummies for OCS & GRS are omitted for brevity.

Table 5.3: 2-stage gravity estimation: Final services

	1st stage	2nd stage
	(1)	(2)
	PPML, FE	OLS
Log distance		-0.635***
		(0.0219)
Common language		0.407***
		(0.0616)
Common border		0.830***
		(0.0430)
Time difference		0.0398***
		(0.00718)
Goods only RTA	0.233	
	(0.251)	
Goods & services RTA	0.151	
	(0.265)	
TRVL × Goods only RTA	-0.0236	
	(0.235)	
TRVL × Goods & services RTA	-0.0710	
	(0.266)	
OCS × Goods only RTA	0.249	
	(0.284)	
OCS × Goods & services RTA	0.195	
	(0.271)	
EU pair	0.0790	
	(0.383)	
TRVL × EU pair	0.182	
	(0.293)	
OCS × EU pair	0.477	
	(0.351)	
TRVL × Log distance		0.159***
		(0.0269)
OCS × Log distance		0.101***
		(0.0291)
TRVL × Common language		0.292***
		(0.0651)
OCS × Common language		0.115
		(0.0748)
TRVL × Common border		0.0250
		(0.0586)
OCS × Common border		0.0677
		(0.0538)
TRVL × Time difference		-0.0521***
		(0.00804)
OCS × Time difference		-0.0346***
		(0.00868)
Observations	44470	44470
R^2		0.241

Dependent variable in column (1) is imports (in thousand USD). Column (1) includes pairwise country fixed effects as well as fixed effects at the exporter-year and importer-year level separately for intermediate services and final services. Standard errors (in parentheses) in column (1) are clustered at the country-pair level. Column (2) reports results from the second-stage estimation where the country-pair fixed effects from the first-stage specification are regressed on the standard set of (time-invariant) gravity variables. Bootstrapped standard errors are reported in column (2). * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

TRVL denotes travel services. OCS denotes other commercial services. The reference category is TRPT i.e. transport services. The constant term and dummies for OCS & TRVL are omitted for brevity.

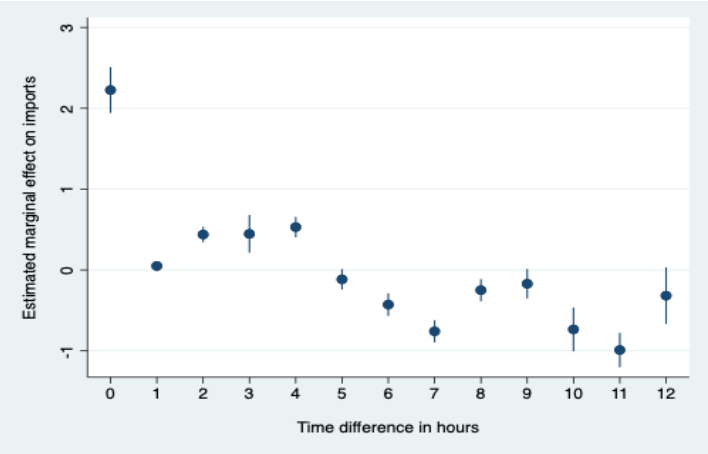
6 Robustness checks

6.1 Non-linear effects of time zone difference

The time difference between two trading partners may not have a linear effect on trade in services. Complementary time zones between India and the United States may in fact be advantageous if, for example, a software development company in India works on a project during their business hours and at the end of Indian business hours, hands it off to a company in the United States where the time zone is behind, allowing for continuous progress on the project. In order to more flexibly investigate the potential non-linearities in the effect of time difference on trade in services, I estimate the 2-stage PPML model with separate dummies for each hour of time difference (instead of a continuous variable). I also include the interaction between a dummy for "intermediate services" and the "time difference" dummies to check if the impact varies between final services and intermediate services. The results presented in Table 6.1 are consistent with my baseline results in Table 5.1 with one notable exception: upon allowing the effect of time difference on services imports to vary more flexibly, the marginal effect of distance on the imports of intermediate services becomes statistically insignificant. This may be attributed to the fact that intermediate services usually do not need to be physically transported and tend to be digitally delivered, so overlapping time zones may be more important in facilitating imports rather than the geographical distance between trading partners.

The estimated coefficients on the time dummies are omitted from the regression table for the sake of brevity and instead plotted in Figure 2. As shown in Figure 2, a time difference of up to 4 hours between trading partners has a positive marginal effect on imports of final services. A time difference of between 5-7 hours has a negative marginal impact on imports of final services. The plotted estimates of dummies for time difference greater than 7 hours indicate that there are indeed non-linear effects of time zone difference on final service imports. Note that none of the interaction terms between the "intermediate services" dummy and the "time difference" dummies were found to be statistically significant. This means that there is no evidence to suggest that intermediate services are marginally more sensitive to time difference, relative to final services, after accounting for non-linear effects.

Figure 2: Marginal effect of time difference on final services imports



This figure displays the point estimates and 95% confidence intervals for each of the dummy variables for 1 to 12 hours of time difference between trading partners. The reference (i.e. constant term) is indicated by zero hours of time difference.

6.2 Time-varying effects of distance

To mitigate potential endogeneity between trade flows and the explanatory variables, I include a rich set of fixed effects in my model. Exporter-year and importer-year fixed effects control for outward and inward multilateral resistance respectively (Anderson and Van Wincoop 2003). They also control for all time-varying unobservable country-specific factors that may affect trade flows. Endogeneity related to bilateral time-varying trade policy variables is mitigated with the use of pairwise country fixed effects (Baier and Bergstrand 2007). The pairwise country-fixed effects also absorb all time-invariant bilateral trade costs (Egger and Nigai 2015). However, there may be another source of potential endogeneity due to unobservable time-varying changes in bilateral trade costs. Following Bergstrand et al. (2015), I allow the effect of bilateral trade costs to vary over time by including interaction terms between distance and year dummies. The results are presented in Table 6.2. Upon allowing the effect of distance to vary over time, I find that the results in Table 6.2 are consistent with my baseline results in Table 5.1. A 10 percent increase in bilateral distance reduced final services imports and intermediate services imports (for the year 2010) by 4.6 percent and 4 percent respectively. None of the interaction terms between distance and the year dummies are found to be statistically significant, relative to the reference year 2010.

Table 6.1: Robustness check: Dummies for time difference

	1st stage	2nd stage
	(1)	(2)
	PPML, FE	OLS
Log distance		-0.461***
		(0.0216)
Common language		0.612***
		(0.0487)
Common border		1.341***
		(0.0379)
Goods only RTA	0.0477	
	(0.126)	
Goods & services RTA	-0.405***	
	(0.106)	
Intermediate services × Goods only RTA	0.0975	
	(0.199)	
Intermediate services × Goods & services RTA	0.757***	
	(0.129)	
EU pair	0.226	
	(0.200)	
Intermediate services × EU pair	-0.352	
	(0.243)	
Intermediate services × Log distance		-0.0574
		(0.0328)
Intermediate services × Common language		-0.0399
		(0.0761)
Intermediate services × Common border		-0.0905
		(0.0540)
Intermediate services		0.519*
		(0.232)
Constant	15.02***	2.151***
	(0.343)	(0.154)
Time difference dummies	Yes	Yes
Intermediate services x Time difference dummies	Yes	Yes
Observations	36519	36519
R^2		0.309

Dependent variable in column (1) is imports (in thousand USD). Column (1) includes pairwise country fixed effects as well as fixed effects at the exporter-year and importer-year level separately for intermediate services and final services. Standard errors (in parentheses) in column (1) are clustered at the country-pair level. Column (2) reports results from the second-stage estimation where the country-pair fixed effects from the first-stage specification are regressed on the standard set of (time-invariant) gravity variables. Bootstrapped standard errors are reported in column (2).* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Time difference dummies and their interactions with "Intermediate services" dummy not reported for brevity.

Table 6.2: Robustness check: Time-varying effects of distance

	1st stage	2nd stage
	(1)	(2)
	PPML, FE	OLS
Log distance		-0.459***
		(0.0177)
Common language		0.612***
		(0.0415)
Common border		1.341***
		(0.0364)
Goods only RTA	0.0497	
	(0.130)	
Goods & services RTA	-0.415***	
	(0.107)	
Intermediate services × Goods only RTA	0.0978	
	(0.200)	
Intermediate services × Goods & services RTA	0.757***	
	(0.129)	
EU pair	0.226	
	(0.200)	
Intermediate services × EU pair	-0.352	
	(0.243)	
Intermediate services × Log distance		-0.0577*
		(0.0259)
Intermediate services × Common language		-0.0390
		(0.0686)
Intermediate services × Common border		-0.0911
		(0.0607)
Year=2011 × Log distance		0.00165
		(0.00501)
Year=2012 × Log distance		-0.000315
		(0.00461)
Year=2013 × Log distance		-0.00269
		(0.00578)
Year=2014 × Log distance		-0.000421
		(0.00382)
Year=2015 × Log distance		0.0000212
		(0.00480)
Year=2016 × Log distance		-0.00127
		(0.00425)
Year=2017 × Log distance		-0.00652
		(0.00464)
Year=2018 × Log distance		-0.00562
		(0.00502)
Year=2019 × Log distance		-0.00322
		(0.00448)
Intermediate services		0.521**
		(0.179)
Constant	15.02***	2.151***
	(0.354)	(0.122)
Time difference dummies	Yes	Yes
Intermediate services x Time difference dummies	Yes	Yes
Observations	36519	36519
R^2		0.309

Dependent variable in column (1) is imports (in thousand USD). Column (1) includes pairwise country fixed effects as well as fixed effects at the exporter-year and importer-year level separately for intermediate services and final services. Standard errors (in parentheses) in column (1) are clustered at the country-pair level. Column (2) reports results from the second-stage estimation where the country-pair fixed effects from the first-stage specification are regressed on the standard set of (time-invariant) gravity variables. Bootstrapped standard errors are reported in column (2).* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

6.3 Comparison with trade in goods

Finally, I estimate a gravity model for trade in goods for the same sample and using the same empirical specification as my baseline results in Table 5.1. As a robustness check, I use three alternative sources of data for trade in goods: UN COMTRADE data, CEPII's BACI data and IMF's DOTS data. In estimating this gravity model of trade in goods, I interact all the standard explanatory variables with a dummy for "services" to directly compare how the estimated impact of gravity variables differs between trade in goods and trade in services. The results are presented in Table 7.1. First of all, I find that the standard gravity variables have the usual signs as expected and magnitudes comparable to previous research. The estimates most directly comparable to mine are those from Anderson and Yotov (2016) who use a 2-stage PPML strategy in the presence of pairwise country-fixed effects to estimate an industry-specific gravity model of trade in goods, albeit for a different sample of countries[17].

I also find no statistically significant evidence to suggest that imports of services are more sensitive to distance, relative to imports of goods. Similar to the findings of Section 6.2, I find evidence of non-linear effects of time difference on trade in goods. The estimates of time difference dummies are plotted in Figure A.1. For trade in services, however, there seems to be no additional marginal effect of time difference since all the interaction terms are found to be statistically insignificant. In fact, I don't find any of the interaction terms between the "services" dummy and the explanatory variables to be statistically significant in Table 7.1, across the three sources of data for trade in goods. This means that there are no statistically significant differences in the marginal effects of gravity variables on imports of services, relative to imports of goods. There are a number of reasons why this may be the case. First, trade in services often relies on trust and reputation between trading partners. The need for face-to-face interactions and proximity to clients (especially for services such as hospitality, healthcare and even legal or consulting services which require some level of in-person contact with the client) makes service trade also sensitive to distance, similar to trade in goods. Second, the variable *distance* in my analysis may capture more than just the geographical distance between trading partners. It may be interpreted as a proxy for differences in the regulatory frameworks as well as cultural and administrative barriers between the trading partners. Even though services don't require physical transportation the same way as goods do, services trade can be sensitive to

[17] Anderson and Yotov (2016) find the coefficient on distance to be in the range of [-0.399, -0.799] depending on the industry. My estimated coefficients of distance, common language and common border are comparable to theirs in sign as well as magnitude.

bilateral distance on account of these differences in business culture, local regulations, and legal frameworks. Third, trade in services is intrinsically tied to trade in goods. Often, trade in goods can serve as the basis of trade in services by fostering supply chain linkages and developing new business relationships (Ceglowski 2006). This means that factors affecting trade in goods may affect trade in services as well.

7 Conclusion

This paper makes a twofold contribution to the literature on trade in services. First, I construct a novel bilateral dataset of trade in services differentiating between final services and intermediate services following the most recent classification of UN's Broad Economic Categories (BEC Rev. 5). This dataset now makes it possible to measure and study trade in intermediate services for over 240 reporting economies (including regions and groups of economies) over a time period of 2005-2021.

Second, I use this dataset to estimate a gravity model of trade in intermediate and final services for a sample of 48 economies for the time period 2010-2019. I use a robust model specification consistent with the recent advancements in the gravity model literature. In particular, I include a rich set of fixed effects to alleviate concerns regarding potential endogeneity between service imports and the explanatory variables in my gravity equation. The main results of my gravity model estimation are as follows. I find that trade in services tends to be sensitive to the bilateral distance between trading partners, with a magnitude similar to trade in goods. In particular, intermediate services tend to be more sensitive to distance relative to final services due to the distinct nature of these services (B2B versus B2C). Common language and common borders are important determinants of both trade in intermediate and final services. I also find evidence of non-linear effects of time zone differences on trade in services. My results are found to be robust across a number of specifications.

The findings of this paper highlight the distinctive nature of trade in final and intermediate services, necessitating nuanced policy measures to facilitate trade in both types of services. As noted by Baldwin (2022), regulatory barriers to trade in services are typically applied to final services. For intermediate services, on the other hand, barriers to trade are typically technological constraints in facilitating coordination and delivery across borders. As such, policymakers aiming to facilitate trade in intermediate services may want to focus on lowering the technological barriers to trade by investing in digital infrastructure and digital skills development

and training of the workforce. Since intermediate services tend to be more sensitive to distance, special attention should be given to strengthening regional integration and promoting economic ties with neighboring countries to encourage cross-border business-to-business (B2B) interactions. On the other hand, for trade in final services, policymakers may want to focus on consumer protection measures and data privacy regulations to build consumer trust. Most importantly, given the vast potential of services-led growth in emerging economies, policymakers should prioritize the collection and reporting of disaggregated services trade data. Future research using more granular data and better coverage of emerging and developing economies can enhance our understanding of the specific challenges faced by these economies in participating in services trade.

Table 7.1: Trade in goods versus trade in services

	COMTRADE		IMF		BACI	
	(1) PPML, FE	(2) OLS	(3) PPML, FE	(4) OLS	(5) PPML, FE	(6) OLS
Log distance		-0.316***		-0.319***		-0.261***
		(0.0160)		(0.0178)		(0.0133)
Services × Log distance		-0.0109		-0.0127		-0.0135
		(0.0207)		(0.0224)		(0.0199)
Common language		0.362***		0.369***		0.397***
		(0.0349)		(0.0294)		(0.0311)
Services × Common language		0.0154		0.0135		0.0165
		(0.0443)		(0.0516)		(0.0489)
Common border		1.169***		1.216***		1.243***
		(0.0273)		(0.0315)		(0.0281)
Services × Common border		-0.0104		-0.0110		-0.0147
		(0.0328)		(0.0447)		(0.0445)
Goods only RTA	0.229		0.0900		0.127**	
	(0.119)		(0.0513)		(0.0423)	
Goods & services RTA	-0.00891		0.0348		0.0876*	
	(0.0446)		(0.0401)		(0.0347)	
EU pair	0.504**		0.521**		0.223**	
	(0.189)		(0.174)		(0.0799)	
Services × Goods only RTA	-0.148		0.0245		-0.121	
	(0.198)		(0.210)		(0.181)	
Services × Goods & services RTA	0.253		0.187		0.101	
	(0.181)		(0.189)		(0.158)	
Services × EU pair	-0.286		-0.362		-0.268	
	(0.243)		(0.262)		(0.218)	
Services		0.0730		0.0860		0.0923
		(0.143)		(0.160)		(0.142)
Constant	16.67***	1.476***	16.69***	1.445***	16.76***	1.079***
	(0.0902)	(0.113)	(0.0861)	(0.129)	(0.0673)	(0.0971)
Time difference dummies	Yes	Yes	Yes	Yes	Yes	Yes
Services x Time difference dummies	Yes	Yes	Yes	Yes	Yes	Yes
Observations	39556	39556	39677	39677	39855	39855
R^2		0.254		0.246		0.275

Odd numbered columns (1), (3) & (5) denote the first-stage PPML regression, while even numbered columns (2), (4) & (6) denote the second-stage OLS regression. In the first-stage regressions, the dependent variable is imports (in thousand USD). First-stage specifications include pairwise country fixed effects as well as fixed effects at the exporter-year and importer-year level separately for intermediate services and final services. In the second-stage regressions, the country-pair fixed effects from the first-stage specification are regressed on the standard set of (time-invariant) gravity variables. Standard errors (in parentheses) are clustered at the country-pair level in columns (1), (3) & (5). Bootstrapped standard errors are reported in columns (2), (4) & (6). * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

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Appendix

A.1 Additional tables and figures

Table A.1: Country coverage

(1) G7 economies	(2) Other advanced economies	(3) Emerging & developing economies
Canada	Australia	Albania
France	Austria	Bosnia and Herzegovina
Germany	Belgium	Bulgaria
Italy	Croatia	Chile
Japan	Cyprus	China
United Kingdom	Czech Republic	Hungary
United States of America	Denmark	Malaysia
	Estonia	Mexico
	Finland	Montenegro
	Greece	Poland
	Hong Kong, China	Romania
	Iceland	Russian Federation
	Ireland	Serbia
	Israel	Ukraine
	Korea, Republic of	
	Latvia	
	Lithuania	
	Luxembourg	
	Netherlands	
	New Zealand	
	Portugal	
	Singapore	
	Slovak Republic	
	Slovenia	
	Spain	
	Sweden	
	Switzerland	

Table A.2: Country groups coverage

Country groups	Obs.	Percent
G7	11,272	20.28
Other advanced economies	30,962	55.71
Emerging & developing economies	13,340	24.00
Total	55,574	100.00

Table A.3: Goods-related services

EBOPS 2010 Services Classification
Maintenance and repair services n.i.e. n.i.e denotes "not included elsewhere"
Manufacturing services on physical inputs owned by others

Table A.4: Transport services

EBOPS 2010 Services Classification
Freight (Air)
Freight (Other)
Freight (Sea)
Other (Air)
Other (Other)
Other (Sea)
Passenger (Air)
Passenger (Other)
Passenger (Sea)
Postal and courier services

Table A.5: Travel services

EBOPS 2010 Services Classification
Travel

Table A.6: Other commercial services

EBOPS 2010 Services Classification
Accounting, auditing, bookkeeping, and tax consulting services
Advertising, market research, and public opinion polling services
Architectural services
Artistic related services
Audio-visual services
Auxiliary insurance services
Business and management consulting and public relations services
Computer software
Construction abroad
Construction in the reporting economy
Education services
Engineering services
Financial intermediation services indirectly measured (FISIM)
Franchises and trademarks licensing fees
Freight insurance
Health services
Heritage and recreational services
Legal services
Licences for the use of outcomes of research and development
Licences to reproduce and/or distribute audio-visual products
Licences to reproduce and/or distribute computer software
Licences to reproduce and/or distribute other products
Life insurance
Memo item: Embassies and consulates
Memo item: Military units and agencies
Memo item: Other government goods and services n.i.e.
News agency services
Operating leasing services
Other business services n.i.e.
Other computer services
Other direct insurance
Other information services
Other personal services
Other research and development services
Pension services
Provision of customized and non-customized research and development services
Reinsurance
Sale of proprietary rights arising from research and development
Scientific and other technical services
Services incidental to agriculture, forestry and fishing
Services incidental to mining, and oil and gas extraction
Standardized guarantee services
Telecommunications services
Trade-related services
Waste treatment and de-pollution

Table A.7: Ramsey RESET test: OLS vs PPML

	OLS	PPML
	(1)	(2)
	Log imports	Imports
Goods only RTA	0.213	0.0971
	(0.151)	(0.130)
Goods & services RTA	-0.145	-0.332**
	(0.0906)	(0.113)
EU pair	0.317	0.288
	(0.162)	(0.191)
Intermediate services × Log distance	-0.131*	0.0198
	(0.0651)	(0.0781)
Intermediate services × Common language	0.0449	-0.172
	(0.124)	(0.104)
Intermediate services × Common border	-0.293*	-0.378***
	(0.115)	(0.107)
Intermediate services × Goods only RTA	-0.164	0.0547
	(0.166)	(0.203)
Intermediate services × Goods & services RTA	0.229	0.623***
	(0.135)	(0.158)
Intermediate services × EU pair	-0.484**	-0.564*
	(0.153)	(0.223)
Intermediate services × Time difference	0.0726***	-0.0384
	(0.0200)	(0.0228)
Constant	11.15***	14.97***
	(0.244)	(0.347)
Observations	30857	36529
R^2	0.922	
RESET test p-value	0.001	0.233

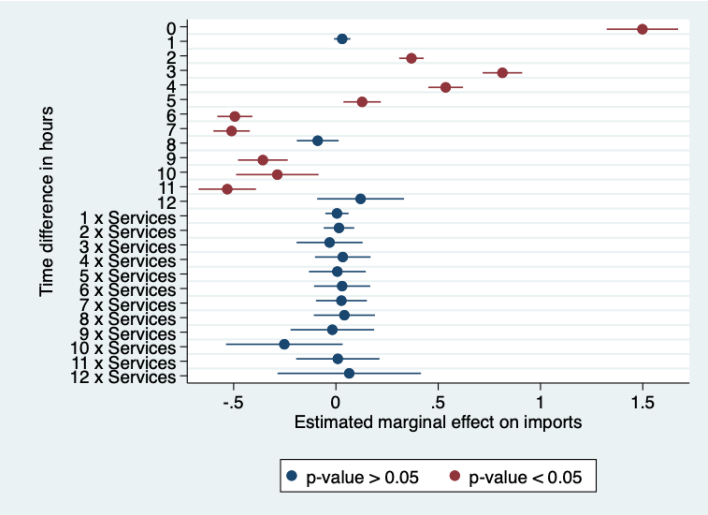
Standard errors (in parentheses) are clustered at the country-pair level. Both specifications include pairwise country fixed effects as well as fixed effects at the exporter-year and importer-year level separately for intermediate services and final services. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table A.8: 2-stage gravity (PPML) estimation: Excluding United States

	1st stage	2nd stage
	(1)	(2)
	PPML, FE	OLS
Log distance		-0.345***
		(0.0206)
Common language		1.068***
		(0.0480)
Common border		1.175***
		(0.0480)
Time difference		-0.0655***
		(0.00613)
Goods only RTA	-0.191	
	(0.162)	
Goods & services RTA	-0.423***	
	(0.118)	
Intermediate services × Goods only RTA	0.559*	
	(0.255)	
Intermediate services × Goods & services RTA	0.945***	
	(0.187)	
EU pair	0.452*	
	(0.223)	
Intermediate services × EU pair	-0.781*	
	(0.310)	
Intermediate services × Log distance		-0.0568*
		(0.0274)
Intermediate services × Common language		0.0502
	(0.0622)	
Intermediate services × Common border		-0.0814
		(0.0681)
Intermediate services × Time difference		0.00712
		(0.00931)
Intermediate services		0.494*
		(0.193)
Constant	14.23***	1.369***
	(0.336)	(0.147)
Observations	34225	34225
R^2		0.246

Dependent variable in column (1) is imports (in thousand USD). Column (1) includes pairwise country fixed effects as well as fixed effects at the exporter-year and importer-year level separately for intermediate services and final services. Standard errors (in parentheses) in column (1) are clustered at the country-pair level. Column (2) reports results from the second-stage estimation where the country-pair fixed effects from the first-stage specification are regressed on the standard set of (time-invariant) gravity variables. Bootstrapped standard errors are reported in column (2). This analysis excludes the United States of America. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Figure A.1: Estimated marginal effect of time difference on imports of goods versus services



This figure displays the point estimates and 95% confidence intervals for each of the dummy variables for 1 to 12 hours of time difference and their interactions with the dummy for imports of services. The reference (i.e. constant term) is indicated by zero hours of time difference.

A.2 Construction of TIMS dataset: Eurostat methodology

The allocation of trade flows to either intermediate or final consumption follows Eurostat's "fine-tuned" correlation table published here. This table is based on a correspondence table between the Classification by Broad Economic Categories revision 5 (BEC Rev. 5), the Central Product Classification, version 2.1 (CPC 2.1) and the Extended Balance of Payments Services Classification, version 2010 (EBOPS 2010), published by the UNSD. Building upon the EBOPS-CPC-BEC conversion table, Eurostat allocated modelled shares of the EBOPS items to the relevant BEC Rev.5 categories (based upon estimations applicable to the EU). Using the resulting "fine-tuned" table with allocation shares, Eurostat mapped the flow of EU services by EBOPS to BEC categories and calculated the final and intermediate consumption services trade. Further details of the methodology can be found here.