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International service transactions: Is time a trade barrier in a connected world?

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Abstract

The firms' international fragmentation of production has recently widened its focus from outsourcing of intermediates to off-shoring of business services such as software program development and international call centre networks. Although a large number of business services are intangible and non-storable, gravity model estimates show that geographical distance between business partners is still relevant even when information and communication technologies (ICT) provide alternatives for face-to-face interaction. It has recently been argued that time zones can be a driving force of international service transactions by allowing for continuously operating over a 24 hours business day. In this paper, we find empirical evidence for the continuity effect in trade of business and commercial services which is even higher for trade with Non-OECD countries and robust to measurement and sample size. We show that the time zone effect in trading business services is dependent on the level of ICT infrastructure.

JEL Classification: F10, F14, F20

Keywords: international trade, business services, gravity model, distance, time zones, digital divide

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1 Introduction

The debate on the firms' international fragmentation of the production chain has recently widened its focus from outsourcing of intermediates to off-shoring of business services. This is evident in international trade flows which show that service trade has recently grown faster than merchandise trade. Especially, producer and business services have been among the fastest growing sub-sectors. The service sector has been regarded as the non-tradable sector of the economy as a large number of services are intangible and non-storable, and thus, require that production and consumption often need to appear simultaneously (e.g. in management consulting or tax advisory). However, innovations in information and communication technology (ICT) seem to render the proximity requirement for face-to-face interaction between business partners useless. Thus, software program development occurs with colleagues located in India and call center networks around the world provide customer support 24 hours seven days a week. An emerging body of literature focuses on international service transactions (e.g. Grünfeld and Moxnes, 2003; Kimura and Lee, 2006) and applies the gravity model which has been found useful to explain the location of manufacturing production and FDI. The gravity model considers two types of transaction costs which are shown to be relevant: geographical distance between countries account for transportation costs and historical ties capture the cultural costs of doing business. While in manufacturing trade the distance effect is found to overestimate the true cost of transportation (in times where transport costs such as air freight rates are rather decreasing), the question emerges whether geographical distance can correctly account for transportation costs of service delivery. It has recently been argued that time is a determinant in the location of production, especially, when just-in-time technology is introduced (Evans and Harrigan, 2005; Harrigan and Venables, 2006). The role time plays for international transactions is found to be ambiguous: for the location choice of multinational enterprises it is shown that time zones have a negative impact on productivity, as air-traveling in East-west direction is associated with a jet lag effect (Stein and Daude, 2007). Time zones act as a barrier even when electronic communication is an excellent substitute for face-to-face interaction, as coordination problems with sleeping business partners occur. Contrarily, Marjit (2007) and Kikuchi and Iwasa (2010) model time zones as a driving force of service trade and argue that, with little interruptions, business operations can continue when countries are connected via ICT. Head et al. (2009) find empirical evidence for the continuity effect in cross-border trade of business services.

This paper aims to evaluate time zones as a trade barrier when countries are connected to an ICT network. The research question is relevant for two reasons: first, time zones may determine how business service firms choose their mode of market entry (via FDI and cross-border export), and second, further liberalization of entry barriers in the business service sector can be effectively centered when time zones represent a relevant determinant for mode of supply. We estimate two gravity models (including market size and bilateral ICT-networks)

and compare intra OECD business- and commercial services trade to a sample of trade with Non-OECD countries.

The paper is organized as follows. The next section provides a literature review on transaction cost in the delivery of business services which are distinct when comparing to manufacturing products. Section 3 presents methodology and data sources. Empirical evidence is discussed in section 4. The last section concludes the paper.

2 Literature Review

Due to technological developments in telecommunication and information technologies international trade in services expanded faster than merchandise trade. Especially, producer services have been among the fastest growing sub-sectors. Thus, an emerging body of literature focuses on determinants of international service transactions. As most common in empirical studies on goods trade, it has been argued that the gravity model fits best to estimate determinants of service trade flows. The literature related to the gravity model distinguishes between two types of transaction costs: geographical characteristics of trading countries (such as distance, common border or remoteness, landlocked- and island status) account mainly for transportation costs. Variables related to cultural and historical ties between countries (such as common language, cultural similarities or past colonial linkages) capture transaction costs associated with the cultural costs of doing business. Grünfeld and Moxnes (2003), Mirza and Nicoletti (2004), Ceglowski (2006) and Kimura and Lee (2006) use the OECD data set on bilateral service trade and report a significantly negative distance effect which is previously found in goods trade as well. Moreover, Kimura and Lee (2006) find that geographical distance seems to be more relevant for services than for goods. In a long-standing debate centered on the coefficients of the distance variables in merchandise trade, it is argued that the magnitude of the distance effect is still higher than transportation costs would suggest (Grossman, 1998).¹

In contrast to the delivery of physical goods, services are mostly intangible and non-storable such that consumption and production of services often appears simultaneously, and thus, requires that supplier and consumer are physically located in the same place. When telephone, email and virtual conferences become close substitutes for face-to-face interaction between business partners, geographical distance should not represent a barrier for international service transactions any more. Recent empirical research on single service sectors shows that this is the case for international transactions in commercial services (Walsh, 2006)² and

¹ See Loungani et al. (2002) for a review of the debate.

² The same result holds for travel and government services. In transportation services the distance coefficient is significantly positive (Walsh, 2006). According to the OECD (2008), commercial services is a broad categorization of producer services and include communication services, construction services, insurance services, financial services, computer and information services, royalties and license fees, personal, cultural and recreational services, and business services. Moreover, business services are highly

software services (Tharakan and van Beveren, 2003; and Tharakan et al., 2005). Comparing with merchandise trade, Lennon (2009) finds that variables related to physical distance (these include border- and landlocked status) yield significantly smaller coefficients for commercial services trade.³ This is in contrast to higher transaction costs (distance) found for total services (Kimura and Lee, 2006).

A most recent example for transaction costs in trading consumer related services (digital goods) via internet is presented in Blum and Goldfarb (2006) who evaluate the web-surfing behavior of US internet users. They show that even when transportation and distribution costs are near zero, distance is relevant when products and services are taste-dependent (e.g. music, gambling, games, and pornography). For non-taste-dependent services or categories (e.g. general information, software, technology and financial information) distance represents no more a barrier. Thus, the service sector is very heterogeneous and transaction costs for trade in commercial services need not to be relevant for transportation, travel and tourism services.⁴ Accordingly, software, commercial and business services are heterogeneous but not necessarily taste-dependent when expressed in Blum and Goldfarb's (2006) terminology. So, an insignificant distance effect found for commercial services trade is consistent with the argument that geographical distance also proxies for taste and preferences.

Instead of estimating transportation costs in a single distance variable, the literature on merchandise trade distinguishes trade costs into a *financial* and a *time* dimension. While transportation costs such as air freight rates decrease (Hummels, 1999; and Duranton and Storper, 2005), delivery time has become increasingly important. Especially in fragmented production chains, time is a determinant in the location of manufacturing production when just-in-time technology is introduced.⁵ Time to deliver to the market (e.g. intermediates to assembly line, or fast fashion to retailers) has two effects on trade: first, time can be an entry barrier, and second, time can be considered as trade costs.⁶ A frequently cited paper in this field is Hummels (2001). He finds that *time* costs associated with the net shipping time between trading countries' ports reduces the probability that a country will export time-sensitive manufactures. Djankov et al. (2006) argue that a significant part of time costs stem from moving goods from the factory to the ship which involves time delays due to administrative procedures (e.g. customs and tax procedures, cargo inspection) at the port (see also Hausman et al., 2005), in addition to the quality of physical infrastructure in the country (Limao and Venables, 2001). Thus, when time for export is considered in gravity models,

specialized producer services and include: leasing, legal, accounting, auditing, book-keeping, tax consulting, business and management consulting, advertising, and research.

³ In a sample of Canadian inter-provincial trade, Lejour and De Paiva-Verheijden (2007) find that distance is relatively unimportant in communication and financial service sectors.

⁴ See Freytag and Vietze (2009) and Vietze (2009) for determinants of tourism services.

⁵ See Evans and Harrigan (2005) and Harrigan and Venables (2006) for theoretical models on just-in-time production and agglomeration.

⁶ A high variability in delivery time will prevent firms from entering the market as they will not be shortlisted for contracts that require just-in-time delivery (Nordas et al., 2006).

geographical transaction costs (distance, island- and landlocked status) matter less (Nordas et al., 2006). This is in line with the argument on overestimating geographical distance.

Although the physical transportation of goods requires time, some services exhibit characteristics that render the time costs associated with delays in transportation useless. Instead, Portes and Rey (2005) argue that a negative distance effect found in international equity flows can be interpreted as a kind of information cost.⁷ Applying the same logic as before, information costs can be split into a *financial* and a *time* element.

On the one hand, communication costs - measured by e.g. a standard residential rate for international calls - have decreased substantially (Tang, 2006) and allow for extending the volume of bilateral telephone traffic. Fink et al. (2005) find that trade in differentiated goods for which significant buyer-seller interaction is necessary is more sensitive to telecommunication prices. Similar results are obtained by Portes et al. (2001) and Portes and Rey (2005) for financial flows: By including the volume of bilateral telephone traffic, distance drops and does not matter for transactions of homogenous treasury bonds but remains relevant for transactions in heterogeneous financial assets (corporate bonds and equities). Loungani et al. (2002) extend the analysis by adding telephone traffic to bilateral FDI flows. However, as bilateral telephone traffic does not reflect the countries' capacities to communicate, the focus of analysis shifted to the (quality of) telecommunications infrastructure as a condition for international transactions.⁸ There has been much discussion that with emerging ICT a technology capacity gap is arising - the *digital divide* - between information-rich and information-poor countries. Further digitalization within the country increases the network capacity by lowering the marginal costs of additional users connected to the network and hence will increase the benefits from services trade. Information-poor countries in turn face the threat of being left further behind (Hanafizadeh et al., 2009 and references therein).

On the other hand, the proximity requirement for the delivery of services rather suggests that information costs may stem from *time zone* differences between business partners, as one way to provide service and communicate face-to-face is to travel abroad. Thus, traveling in East-West direction exhibits a jet lag effect and requires time to adjust to time differences.⁹ To the extent that electronic communication is a substitute for face-to-face interaction, the need to

⁷ See also Buch (2005) for international banking.

⁸ Freund and Weinhold (2002) find a significant positive effect of internet adoption abroad on US service trade growth which is somewhat stronger in a subsample of business, professional and technical services. Choi (2010) confirms the result. With a higher level of ICT infrastructure, service trade increases in OECD countries as well (Mirza and Nicoletti, 2004). See also Lennon (2009) for commercial services, Tang (2006) for merchandise trade and Loungani et al. (2002) for FDI.

⁹ According to Paulson (1996), the symptoms of a jet lag become important with time zone changes of 5 hours or more. Traveling in both directions cause time to re-establish a circadian equilibrium: Traveling from east to west stretches the traveler's day while travel from west to east compresses it. However, the time to re-establish is greater with flights eastward than westward. In a similar manner, Kamstra et al. (2000) find that sleeping disorders due to daylight saving time changes affects response time and problem solving ability of stock market participants.

travel (and therefore geographic distance) should become less relevant. Nevertheless, when being located in distant time zones, coordination problems with sleeping business partners occur. In a recent study on the location of FDI, Stein and Daude (2007) show that time zones act as a barrier when frequent real-time communications between headquarters and their foreign affiliates is important (see also Hattari and Rajan, 2008).

In trade theory, only a few attempts have been made to consider the role of time zones for trade.¹⁰ Marjit (2007) models time zones as a driving force for international services trade. When production of a service is fragmented and takes two days to be finished, time can be saved if countries located in separate time zones engage in production each performing one step. Thus, advances in ICT enables the delivery of services and allow that with little interruptions, business operations can continue if the office locations are in significantly distant time zones (e.g. one office is located in the US and the second in India). Assuming positive time costs for the delivery of services in their model, Kikuchi and Iwasa (2010) argue that a country's consumer, which would like to get the service rather sooner than later, can import the service cheaper, if there is a significant time zone difference between both countries. Kikuchi (2003, 2009) finds that time zones affect the structure of comparative advantages when services are used as an intermediate good.

The first empirical study which considers the role of time zones in the delivery of cross border services is Head et al. (2009). They find evidence for the "continuity effect" in business services trade but not in the broader categorization of commercial services trade. Thus, the ability to operate around the clock (continuity effect) offsets the need to communicate during business hours (synchronization effect).

In this paper, we evaluate the time zone effect for business and commercial services trade with respect to the ICT network condition. Accordingly, to make use of time zone differences, communication networks in both countries are required to transfer business services.

3 Model specification and variables

3.1 Hypotheses

Before introducing the empirical strategy our main hypotheses to be tested need to be summarized. As argued in the literature review, the relevant "transportation" costs associated with cross-border delivery of business services have a *time* and a *financial* element. Based on the data set we use to evaluate the *time* effect, we are not able to split cross-border business services trade according to the degree of buyer-seller interaction (simultaneous or sequential). The analysis allows rather a conclusion with respect to transactions which dominate in cross-border business service trade.

¹⁰ Evidence for importance of latitude is already considered in literature on geography and economic development (Acemoglu et al., 2001; Gallup et al., 1999; Hall and Jones, 1999). The comparative advantage effect of latitude is shown in Melitz (2004).

When *simultaneous* buyer-seller interactions dominate cross-border business service trade, *time zones* will represent a barrier. We will find a *negative* effect of time zones on bilateral business service trade. In contrast, a *positive* time zone effect can be interpreted as evidence for the continuity effect. Thus, service providers will rather profit from time zones in the sense that outsourcing of service production steps allow operating over a 24 hours business day. As a consequence, *time* represents a barrier to trade especially with countries located in the same time zone because they cannot continue to work until half a day later when abstracting from shift work. According to theory, the time zone effect in cross-border business services trade is valid only if the country is connected to an ICT network. Thus, the *financial* element of the constraints in trading business services is the presence of ICT infrastructure which in turn reflects the countries' capacity to communicate internationally. Thus, we expect that a bilateral ICT infrastructure network enhances business services trade.

Moreover, as both the *time* and *financial* dimension matter for business services trade, it becomes obviously necessary to estimate an interaction term of time zones and ICT network because the *time zone* effect materializes only if countries have a significant access to ICT infrastructure to transfer business services cross-border. The presence of a significant interaction term indicates that the time zone effect in trading business services is different with respect to the level of ICT network. However, the interpretation of the interaction term in turn depends on the buyer-seller relationship which dominates cross-border business services. Thus, *time costs* (as a consequence of a positive time zone effect) or *time zone costs* (in the case we obtain a negative time zone effect) may be more or less relevant when countries have adopted a significant ICT infrastructure network.

3.2 Model Specification

The gravity model has been widely used for explaining bilateral trade flows between countries since Tinbergen (1962). The log-linear specification of the gravity equation relates nominal bilateral trade flows from exporting country i to importing country j to the economic masses (GDP) of the trading partners and to the distance between them, whereas distance proxies for transportation costs. Even though, the gravity model first emerged as an empirical relationship, theoretical underpinning appears (Anderson, 1979; Bergstrand, 1985, 1989). Recently, there have been various attempts to develop structural gravity equations. The theoretical foundation can be distinguished in three broad approaches. The first models derive the gravity equation based on product differentiation by the country of origin (Anderson and van Wincoop, 2003). Thus, countries produce a differentiated bundle of products in the country of origin and send them across borders where it enters the utility of a consumer. The second strand of theoretical foundation, which considers product differentiation and monopolistic competition, builds on a similar argument (Krugman, 1980). The third approach builds the gravity equation on models with homogeneous products and heterogeneity in productivity (Eaton and Kortum, 2002). In contrast to the transaction costs associated with the shipment of goods, services can also be

traded electronically due to their intangible nature. When including transaction costs that are relevant for services trade, the structural gravity equation derived from models explaining merchandise trade, appears to be applicable to trade in services. The following gravity model specifications are used to evaluate time as a trade barrier for exporting business and commercial services:

$$\ln(\text{EXP}_{ijt}) = \beta_0 + \beta_1 \ln(\text{Dist}_{ij}) + \beta_2 \text{TIME}_{ij} + \beta_k \sum_{k=i,j} \ln(\text{GDP}_{kt-1}) + \beta_m \sum_m \text{X}_{ijm} + \gamma_i + \gamma_j + \gamma_t + \varepsilon_{ijt}$$

where EXP_{ijt} is the export of (business and commercial) services from home country i to host country j at time t . Market size of home and host country is measured by the nominal GDP in current USD at time $t-1$ with a one-year lag to proxy for services demand. By controlling for distance between countries in the regression, we add TIME_{ij} to the equation which is measured by the differences in hours between the countries' capitals. The determinants of bilateral business service trade flows can be separated into home-country specific effects γ_i , host-country specific effects γ_j and bilateral specific effects X_{ijm} . To control for home and host country effects, a set of country dummy variables is included in the regression. The bilateral control variables in X_{ijm} include a dummy for colonial relationships, English language, and cultural similarity respectively. In addition, we add a dummy which covers the presence of a free trade agreement in a bilateral trading pair when services trade according to GATS Article V is explicitly considered. In the merchandise estimation, we use a dummy for free trade agreements in merchandise trade according to GATT Article XXIV respectively.¹¹ The mean of the error term is expected to change over time due to advances in technology. Thus, to allow for time-varying means of the error term, we use a set of year dummies γ_t in an OLS model.

In a second model, we check whether the impact of time as a trade barrier changes when adding countries' bilateral interconnectivity to the gravity equation. Thus, we include information- and communications infrastructure variables (ICT) in the following model:

$$\ln(\text{EXP}_{ijt}) = \beta_0 + \beta_1 \ln(\text{Dist}_{ij}) + \beta_2 \text{TIME}_{ij} + \beta_3 \ln(\text{ICT}_{it-1} * \text{ICT}_{jt-1}) + \beta_4 \text{TIME}_{ij} * \ln(\text{ICT}_{it-1} * \text{ICT}_{jt-1}) + \beta_m \sum_m \text{X}_{ijm} + \gamma_i + \gamma_j + \gamma_t + \varepsilon_{ijt}$$

Accordingly, we exclude the reporter and partner countries' GDP for multicollinearity concerns. While previous studies use telecommunications prices and telephone traffic to estimate the effect of information costs on international flows, we focus on the countries' bilateral ICT infrastructure network present in the previous period. Telecommunication costs and bilateral telephone traffic can be a consequence of increasing international transactions and, thus, may be endogenous to international trade. In contrast, the presence of ICT infrastructure in the

¹¹ Grünfeld and Moxnes (2003) argue that the presence of a free trade agreement (FTA) for goods is insignificant in services trade, as mostly FTAs do not include trade in services explicitly.

country does better reflect the countries' capacities to be involved in international transactions. In contrast to business services transactions which cannot be split according to buyer-seller interactions, communications infrastructure can be distinguished into equipment used for simultaneous interaction (e.g. mobile and fixed line telephone) and equipment necessary for sequential interaction (personal computers, emailing via internet) between business services provider and consumer.

In addition, *time zones* matter for business services only if countries have an *ICT infrastructure*. Thus, a country pair with a better bilateral infrastructure network will trade more over longer (or shorter) time zone distance than a country pair with a worse ICT network. In the model, time zones are interacted with bilateral ICT infrastructure network. The interpretation of the interaction effect depends on the degree of buyer-seller interaction dominant in cross-border trade.

3.3 Variables and Data sources

Our main interest is the time zone effect on business services trade. We use bilateral services trade data from the *OECD Statistics on International Trade in Services*. The statistic covers the period from 1999 to 2006 (OECD, 2008). Total services trade data are reported by 27 OECD countries with their respective 226 partner countries.¹² The database allows the distinction between several service sectors. Regressions for trade in business services (which include leasing, legal, accounting, auditing, book-keeping, tax consulting, business and management consulting, advertising, and research) are compared to trade in commercial services which is a broader categorization of business services (as it additionally considers communication, construction, insurance and financial services, computer and information services, royalties and licenses fees). This is most interesting, as the recent debate on off-shoring of service transactions focuses on business and commercial services rather than on travel, transportation and government services. In sum, these service sectors add up to total service transactions between countries in the statistics. In addition, we provide estimations for the time zone effect on merchandise trade based on the *OECD International trade by commodity statistics* (OECD, 2010) for which we select the same sample period.

The services trade data in the OECD statistic is on balance-of-payments basis and, thus, covers most of GATS mode 1 trade (cross-border) and mode 2 transactions (consumption abroad). In contrast, they include only a small part of GATS mode 3 (commercial presence) and mode 4 (movement of natural persons) transactions. This classification has been adopted as a framework for current multilateral negotiations under the GATS. All four modes of service transactions considered in the GATS classification reflect the suppliers' choice of services

¹² Our dataset includes 25 reporter countries for commercial services trade and 23 reporter countries for business services trade for the time period 1999 to 2006 (see appendix table A1.1 for country and year coverage). Due to missing bilateral data, the number of observations varies with respect to the service sector: the number of commercial services export observations reduces to 5,681; the number of observations for business services reduces to 4,396 respectively. However, goods trade data are largely reported with 43,680 observations in the sample.

delivery. When *time* plays a role in the cross-border delivery of business services - as in the case of time-sensitive intermediates to the assembly line, *time zones* can affect the suppliers' market entry strategy (either FDI or export), and hence, the choice of location.¹³ In this regard, the concept of (horizontal and vertical) FDI and its relation to trade flows which has been developed for the manufacturing sector become blurred in the business services sector. More precisely, the firms' choice to outsource production steps to low-labor cost countries will not depend on the trade-off between *distance* (transportation costs) and fixed plant costs anymore. Instead, vertical FDI in the service sector - as a complement to cross-border service trade - will depend on the trade-off between *time zone* costs and the degree of buyer-seller *interaction* (simultaneous or sequential).

For the time zone measure we calculate the shortest time zone difference between the countries' capitals in hours (*TIMEcap*) based on time zone data provided by the *Physikalisch-Technische Bundesanstalt* (PTB, 2010). The variable varies between 0 and 12 hours when we abstract from daylight saving time. The full sample (henceforth Panel A) also includes (reporter and partner) countries with multiple time zones (e.g. Australia with UTC+8 hours in the west and UTC+10 hours in the east, or the Russian Federation with UTC+3 hours in the European zone and UTC+12 hours in Vladivostok which is also the largest intra-country time zone distance).¹⁴ However, it can be argued that in some countries the capital city is the centre of economic activity (e.g. Australia, Indonesia, and the Russian Federation) where most of the (internationalized) business service firms locate. In this respect, using *TIMEcap* as (our main) measure to capture a time zone effect seems to be valuable. Nevertheless, in some countries the (internationalized) business service sector is rather distributed within the country with service firms located in regional metropolises (e.g. in Canada and at the US East and West coast). Hence, time zone difference based on the countries' geographical centre (here calculated as *TIMEmean*) or based on the minimum geographical distance between the country and their respective trading partner (*TIMEmin*) would be a better approximation to cover such examples. Thus, for a robustness check we report results on *TIMEmean* and *TIMEmin* as well. Moreover, we calculate the number of overlapping office hours between the trading countries' capitals based on either a normal 8 hours working day (from 9 am to 5 pm) or an intensive 10 hours working day (from 9 am to 7 pm) which is mostly common in business consulting firms and R&D departments. The variables (*Office8*, *Office10*) vary between zero (with no hours overlap: these include trading pairs with time zone difference from 9 (11 respectively) to 12 hours) and 8 hours overlap (10 respectively) when countries are located in the same time zone. In addition to variation in the measurement of time zones, we estimate the time zone effect in

¹³ The WTO estimates that 50 per cent of service transactions is allocated to mode 3 transactions while mode 1 and mode 2 transactions account for 35 per cent and 10-15 per cent respectively (see Maurer et al., 2006).

¹⁴ See appendix table A1.1 for reporter countries included in Panel A and table A1.2 for countries with multiple time zones excluded from the analysis (Panel B).

a restricted sample (henceforth Panel B) which excludes (reporter and partner) countries with multiple time zones. In this sample, the US, Canada, and Australia which are known as major services exporters with respect to the UK, are excluded. The results present further robustness checks for the validity of the time zone variables.¹⁵

We want to compare estimations for business and commercial services trade to manufacturing trade to highlight differences in the distance and time zone effects. In many studies on manufacturing trade the distance effect largely depends on the data sample used for estimation and is highly sensible with respect to the magnitude of the coefficient (see e.g. Loungani et al., 2002). In contrast to manufacturing trade data which is comprehensively available for many industries and years, bilateral service trade data is rather recently recorded and published for only a few countries which do report regularly services transaction with partner countries. In order to make the comparison between manufacturing trade and (limited) service trade work, we present results for a restricted goods sample (Panel C) which includes observations on manufacturing trade when business services trade is reported and non-missing between trading countries.¹⁶

Data on standard gravity variables (distance and colonial ties) are taken from the CEP-II-Database (CEPII, 2010). We use *distw* as the geographical distance between countries to account for internal distance.¹⁷ We account for language barriers which are relevant in trading business services face-to-face. Officially spoken languages may not capture the effective language barriers.¹⁸ Thus, we construct a bilateral dummy which is equal to one when English is a widely spoken language in both countries. Due to the fact that most business services belong to a value added process where the quality cannot be evaluated in advance, asymmetric information between business partners (or services providers and consumers) lead to the fact that trust is a necessary condition to build up relationships across borders. Culture and religion are often associated with trust and play a prominent role for the ability to build networks.¹⁹ Similar to Vietze (2009), we use a dummy which is equal to one if more than 60 per cent of the countries' population belong to the Catholic (or Protestant, Orthodox, Muslim, and Others, respectively) religion. Instead, we build bilateral dummies for cultural similarity between trading partners. In all estimations we include a dummy for regional trade

¹⁵ Moreover, business- and commercial services trade data in the year 2006 are only reported by Australia and the US which reduces observations in sample B to the time period 1999 to 2005 instead.

¹⁶ As a consequence, the number of manufacturing export observations drops from 37,058 in estimations of Panel A (30,942 in Panel B respectively) to 4,192 observations in Panel C which is a bit more than ten per cent of the entire manufacturing trade sample. In this respect, the results on this sample can only be served for a robustness of the time zone effect in manufacturing trade.

¹⁷ The measure expresses a population-weighted average of the great-circle distance between the 20 highest populated cities (regional metropolises) within the (reporter- and partner-) countries.

¹⁸ Tharakan and van Beveren (2003) and Tharakan et al. (2005) find that India's endowment of a large stock of IT professionals proficient in English language seems to be an important determinant of India's successful software export.

¹⁹ See Glaeser et al. (2002) on determinants of social capital and Knack and Keefer (1997) on its' effects on economic outcomes. Guiso et al. (2009) show that religious similarity has a positive impact on trust. Tharakan and van Beveren (2003) stress the role of co-ethnic networks in bilateral services trade (see also Gould, 1994; Rauch and Casella, 1998; Rauch and Trindade, 2002).

agreements in force between countries to account for trade barriers when agreements are not signed for GATS Article V (for the services trade regression), and GATT Article XXIV (for the goods regression) respectively (WTO, 2010).

In our second model estimation, we link the time zone effect to the interconnectivity of countries. Especially for transactions without movement of supplier or consumer, countries need to be connected to ICT to transfer business services. The World Bank (2010) reports ICT variables (mobile phones, telephones, personal computer, and internet access) which are expressed in relative terms to the country's population (except for the registered air transport carriers). These reflect the distribution of communications infrastructure within the country. Instead of country observations, we build bilateral interconnectivity variables. For each trading pair the product of both countries population weighted infrastructure variable is calculated and yield the size of the bilateral communications network. Another way to deliver business services requires traveling. Thus, the product of both country's domestic takeoffs and takeoffs abroad of air carriers registered in the country is used to proxy for the ability to get good flight connections. Due to limited availability of data on infrastructure at the country-level, the bilateral interconnectivity variable mostly restricts our sample to a lower number of observations in the regressions. Thus, the number of observations in these estimations varies with respect to the ICT-variable used.²⁰ In a second step, the time zone variable is interacted with each ICT network variable to estimate the marginal impact of time zones on business services trade. Thus, with a better bilateral infrastructure network a country pair will trade more over longer (or shorter) time zone distance than a country pair with a worse network.

4 Results

4.1 Time as a trade barrier

Estimations for the time zone effect are presented in table 1 for the broader categorization of commercial services and table 2 for specialized business services. In panel A we use all bilateral business services trade flows to estimate various measures of the time zone effect. All estimates on control variables are statistically significant and show the expected sign.²¹

We find a negative distance effect which is slightly higher for business services than for commercial services trade. In contrast, the time zone effect is significantly *positive* for trade in business and commercial services. This indicates that the continuity effect offsets the

²⁰ See descriptive statistics and correlation matrix in appendix table A3 and A4 respectively.

²¹ Colonial ties and language barriers are important for exporting business services. Moreover, we find strong explanatory power of both countries lagged GDP which indicates that firms export business services to countries with high demand for heterogeneous products. The coefficients for cultural similarity are in most cases positive significant for Orthodox religion and negative significant for other religion (which include Hindu, Buddhist and other religion). In the commercial services estimations, the impact of Protestant and Catholic religion is insignificant in all cases. Catholic religion is positively significant for business services. As we do not have a reporter country with more than 60 per cent Muslim religion, the bilateral dummy for Muslim drops from the estimation. For commercial services, dummies for the GATS agreement and for EU27 are insignificant. For business services, the GATS dummy is significantly positive, while the EU-27 dummy is significantly negative.

synchronization effect and, hence, service firms profit from time zone differences by being able to operate over a 24 hours business day. Thus, service providers trade more with business partners located in a distant time zone. The significance of the continuity effect holds for time zones measured in hours between the countries capitals (*TIMEcap*) and for alternative measures of time zone distance based on countries geographical centre (*TIMEmean*) and the minimum time distance (*TIMEmin*). Further robustness checks on time zone measures show that business service transactions decrease with the number of overlapping office hours in both business partners' countries. However, this is not as strong for trading commercial services; the coefficients on overlapping office hours are not significant.

Table 1: The time zone effect in trading commercial services

	A1	A2	A3	A4	A5	A6	B1	B2	B3
<i>Ln Dist</i>	-1.415*** (.040)	-1.487*** (.057)	-1.544*** (.058)	-1.498*** (.058)	-1.430*** (.059)	-1.467*** (.058)	-1.401*** (.071)	-1.387*** (.071)	-1.379*** (.071)
<i>TIMEcap</i>		.024** (.011)					.012 (.019)		
<i>TIMEmean</i>			.045*** (.012)						
<i>TIMEmin</i>				.030** (.012)					
<i>Office 8</i>					-.006 (.014)			-.005 (.023)	
<i>Office 10</i>						-.018 (.012)			.001 (.020)
<i>Ln GDPit-1</i>	1.310*** (.245)	1.309*** (.245)	1.306*** (.244)	1.307*** (.245)	1.310*** (.245)	1.310*** (.245)	1.201*** (.318)	1.202*** (.318)	1.203*** (.318)
<i>Ln GDPjt-1</i>	.712*** (.134)	.709*** (.134)	.705*** (.134)	.708*** (.134)	.711*** (.134)	.710*** (.134)	.862*** (.168)	.863*** (.168)	.863*** (.168)
<i>Colony</i>	.758*** (.078)	.746*** (.078)	.734*** (.078)	.743*** (.078)	.756*** (.078)	.750*** (.078)	.740*** (.103)	.745*** (.103)	.748*** (.103)
<i>English</i>	.440*** (.064)	.418*** (.065)	.403*** (.065)	.419*** (.065)	.436*** (.065)	.425*** (.065)	.659*** (.092)	.661*** (.092)	.662*** (.092)
<i>Catholic</i>	-.010 (.077)	-.019 (.078)	-.021 (.077)	-.016 (.077)	-.012 (.078)	-.017 (.078)	.055 (.088)	.055 (.089)	.056 (.089)
<i>Protestant</i>	.172* (.103)	.161 (.102)	.135 (.102)	.149 (.103)	.168 (.103)	.163 (.102)	.497*** (.144)	.504*** (.144)	.508*** (.144)
<i>Orthodox</i>	1.128*** (.275)	1.133*** (.271)	1.125*** (.269)	1.132*** (.271)	1.131*** (.274)	1.134*** (.272)	1.531*** (.357)	1.531*** (.358)	1.529*** (.358)
<i>Other Religion</i>	-.724*** (.201)	-.663*** (.202)	-.675*** (.201)	-.675*** (.202)	-.709*** (.202)	-.677*** (.202)	-.430* (.239)	-.443* (.250)	-.467** (.243)
<i>FTA GATS V</i>	.031 (.127)	.062 (.127)	.086 (.126)	.055 (.127)	.038 (.127)	.053 (.127)	-.260 (.230)	-.274 (.229)	-.281 (.230)
<i>EU27</i>	.058 (.154)	.043 (.154)	.086 (.151)	.085 (.153)	.060 (.154)	.052 (.154)	.409 (.298)	.389 (.297)	.379 (.296)
<i>const</i>	-23.87*** (7.521)	-23.23*** (7.533)	-22.62*** (7.522)	-22.99*** (7.535)	-23.70*** (7.546)	-23.25*** (7.546)	-25.22** (9.922)	-25.29** (9.928)	-25.38** (9.933)
N	5462	5462	5462	5462	5462	5462	3836	3836	3836
Rsquared	.8724	.8726	.8728	.8726	.8725	.8725	.8604	.8604	.8604

Note: See appendix table A2 for commercial services included and appendix table A1.2 for countries excluded from the regression in panel B. All regressions are OLS estimations and include year fixed effects and home and host country dummies. Robust standard errors reported in parentheses. ***denote significance at 1 per cent level, **5 per cent level, *10 per cent level respectively.

Although in business services trade the continuity effect is stable to variations in time measures, the robustness can be misleading when countries with multiple time zones bias the estimations. We exclude those (reporter and partner) countries from the sample and provide further robustness checks in column B1 to B3 in table 1 and 2 respectively. As previously found, distance effects and controls remain significant in panel B. The continuity effect is significant in specialized business services trade. However, time zones are not a driving force for trade of commercial services as previously testified.

Table 2: The time zone effect in trading Business Services

	A1	A2	A3	A4	A5	A6	B1	B2	B3
<i>Ln Dist</i>	-1.581*** (.052)	-1.649*** (.065)	-1.704*** (.065)	-1.672*** (.065)	-1.640*** (.065)	-1.644*** (.065)	-1.689*** (.076)	-1.691*** (.077)	-1.683*** (.076)
<i>TIMEcap</i>		.031** (.015)					.086*** (.025)		
<i>TIMEmean</i>			.061*** (.016)						
<i>TIMEmin</i>				.045*** (.016)					
<i>Office 8</i>					-.031* (.018)			-.095*** (.029)	
<i>Office 10</i>						-.029* (.015)			-.084*** (.026)
<i>Ln GDPit-1</i>	1.398*** (.307)	1.391*** (.306)	1.385*** (.304)	1.389*** (.305)	1.392*** (.306)	1.393*** (.306)	1.279*** (.358)	1.277*** (.358)	1.281*** (.358)
<i>Ln GDPjt-1</i>	.702*** (.147)	.700*** (.147)	.692*** (.146)	.697*** (.147)	.702*** (.147)	.700*** (.147)	.687*** (.166)	.689*** (.166)	.687*** (.166)
<i>Colony</i>	.657*** (.086)	.641*** (.086)	.627*** (.086)	.635*** (.086)	.647*** (.086)	.644*** (.086)	.583*** (.101)	.588*** (.100)	.591*** (.100)
<i>English</i>	.447*** (.079)	.437*** (.079)	.424*** (.079)	.433*** (.079)	.438*** (.079)	.438*** (.079)	.450*** (.095)	.449*** (.095)	.452*** (.095)
<i>Catholic</i>	.163* (.087)	.163* (.087)	.168** (.087)	.165* (.087)	.161* (.087)	.162* (.087)	.166* (.096)	.165* (.096)	.165* (.096)
<i>Protestant</i>	-.030 (.101)	-.051 (.101)	-.074 (.101)	-.064 (.101)	-.051 (.101)	-.049 (.101)	.193 (.121)	.188 (.122)	.195 (.121)
<i>Orthodox</i>	.918*** (.275)	.931*** (.271)	.931*** (.269)	.933*** (.270)	.936*** (.272)	.932*** (.272)	1.157*** (.359)	1.170*** (.358)	1.162*** (.359)
<i>Other Religion</i>	-.939*** (.214)	-.855*** (.212)	-.855*** (.210)	-.862*** (.212)	-.850*** (.213)	-.856*** (.212)	-.661*** (.252)	-.522** (.257)	-.628** (.253)
<i>FTA GATS V</i>	.481*** (.171)	.533*** (.174)	.574*** (.172)	.548*** (.173)	.514*** (.172)	.526*** (.173)	.520* (.283)	.506* (.282)	.511* (.283)
<i>EU27</i>	-1.227*** (.220)	-1.173*** (.220)	-1.022*** (.220)	-1.098*** (.221)	-1.156*** (.225)	-1.172*** (.221)	-.658* (.348)	-.691** (.350)	-.684** (.349)
<i>const</i>	-25.27*** (9.216)	-24.58*** (9.207)	-23.82*** (9.171)	-24.15*** (9.197)	-24.49*** (9.219)	-24.38*** (9.218)	-20.93** (10.734)	-20.25* (10.745)	-20.19* (10.743)
N	4207	4206	4206	4206	4206	4206	3292	3292	3292
Rquared	.8412	.8413	.8417	.8414	.8413	.8413	.8378	.8378	.8377

Note: See appendix table A2 for business services included and appendix table A1.2 for countries excluded from the regression in panel B. All regressions are OLS estimations and include year fixed effects and home and host country dummies. Robust standard errors reported in parentheses. ***denote significance at 1 per cent level, **5 per cent level, *10 per cent level respectively.

Two reasons may explain why this can be the case: first, the heterogeneity of services within the broad category of commercial services avoids justifying a significant positive or negative time zone effect. Hence, the time effect may vary with respect to the service transaction included in commercial services. Second, the continuity effect may depend on the countries considered in the sample. Thus, we split the entire sample into a subsample representing intra OECD trade and a sample on OECD countries' (business and commercial) service trade with Non-OECD countries.

Subsample estimates are reported in table 3 for commercial services trade and in table 4 for business service trade. We find mixed results: the time zone effect is positive in intra OECD business and commercial services trade. The coefficients on alternative measures of time zones are slightly significant in panel A and become insignificant in panel B. However, the continuity effect is significant for business and commercial services trade with Non-OECD countries and becomes even stronger when excluding multiple time zone countries in panel B.

Moreover, larger coefficients on time zones in trade with Non-OECD countries indicate that the continuity effect seems to be more important as in intra OECD trade. The same holds for distance. The coefficients are twice as high in trade with Non-OECD countries, although significantly negative.

In addition, we perform estimations for single service sectors and find that time zones play a significant role for financial services and royalties and licenses fees. In contrast, for communication services and computer- and information services the time zone measures do not yield any significant effects.²² Thus, the heterogeneity of single service transactions in the broad category of commercial services confirms the neutralization of the time zone effect.

The continuity effect present in trading business and commercial services is not valid for merchandise trade (see appendix A5). Rather, we find significantly negative time zone effects which validate simultaneous interactions as more relevant. Estimates on alternative definitions of time zones strengthen the results: merchandise trade significantly increases with the number of overlapping office hours between trading partners. Excluding reporter and partner countries with multiple time zones in sample B confirms the robustness of negative time zone effects (column B1 to B3). Thus, time zones seem to put additional transaction costs on the delivery of goods which are not captured by distance at all.

However, in previous merchandise trade studies it is argued that the magnitude of the distance effect depend on sample selection. Our estimates show that the distance effect drops only marginally from -1.65 to around -1.56 when adding the time zone variables to the model and it remains with a coefficient of -1.53 when turning to the restricted goods sample (in column C1 to C5 in appendix A5). Here, we account for observations on merchandise trade for which business services export data are non-missing. Although the distance effect remains, the time zone effect in merchandise trade reverses and becomes significantly positive. In this respect, trade in goods follows the same pattern as cross-border business service trade which is perhaps an indication for the fact that business services accompany manufacturing products. This is especially relevant for high-tech products such as machinery or ICT equipment which is bundled with (locally produced) services i.e. providing financing and installation services as well as customer support.

Moreover, a large part of intra OECD merchandise trade takes place in higher valued product categories where accompanying (locally produced) services represent a significant share of the product bundle.²³ Thus, we split the entire merchandise sample into intra

²² In addition, we find mixed results for other subsectors included in commercial services. For construction services, time zone effects are significantly positive in panel A but do not remain robust in panel B. For insurance and personal recreational services, insignificant time zone effects in panel A become significant in panel B. In all estimations distance is highly significant and negative.

²³ Appendix A3 shows that the mean value of merchandise trade is still higher in intra OECD trade than in trade with Non-OECD countries which indicate that on average higher valued products are traded.

OECD trade and trade with Non-OECD countries and present subsample estimates in appendix A6. Accordingly, we find negative time zone effects for intra OECD merchandise trade which we find in the full sample as well. Thus, a negative time zone effect is perhaps an indication for additional transaction costs in form of frequent communication between firms (and consumer) when in-house customer support is provided. In contrast, this is not the case for merchandise trade with Non-OECD countries: the continuity effect still holds. Instead, Non-OECD countries play an important part in firms' fragmentation of the production chain: as merchandise trade includes to a higher extend the delivery of intermediates, trade with Non-OECD countries is rather vertical intra-industry trade. Thus, transaction costs to connect production steps in distant locations seem to differ from transaction costs associated with horizontal intra-industry trade in higher valued products.

4.2 Interconnectivity and Time Zones

Especially (accompanying) cross-border business and commercial services transactions without movement of service supplier and consumer (as in the case of customer support services) require communications infrastructure to enable the interaction over long distances. Thus, the second model captures the idea that bilateral communications infrastructure enhance international service delivery. Moreover, the ability to make use of the time zone effect is higher with a better infrastructure network. The results are presented in table 5 for the broader category of commercial services and table 6 for specialized business services respectively.

Estimates on panel A indicate that an ICT infrastructure network is significantly relevant for commercial services trade. When excluding multiple time zone countries from the sample the result remains: positive coefficients on ICT indicate that connecting countries to an ICT network increase commercial services trade.²⁴ Accordingly, the time zone effect becomes insignificant which supports our results on panel B from table 1 with the GDP included instead.

In contrast, for business services the continuity effect remains significant when including ICT variables instead of the trading countries' GDP. Positive coefficients for bilateral ICT network can be obtained for business services trade in both panel A and B: but except for air transport connections, ICT network variables are insignificant in panel B. The bilateral communications network has a statistically significant effect on merchandise trade (see appendix A7) which remains robust to country exclusion in panel B.

²⁴ Estimates for each subsector of commercial services are mixed: the ICT infrastructure is significant for communication services (with mobile, fixed-line and pc significant in panel B as well) and personal and recreational services (mobile, fixed line and internet relevant). For all other subsectors, coefficients on ICT are in most cases insignificant.

Table 5: ICT network and Commercial Service exports

	A1	A2	A3	A4	A5	B1	B2	B3	B4	B5	A6	A7	A8	A9	A10
<i>Ln Dist</i>	-1.5*** (.057)	-1.5*** (.057)	-1.5*** (.059)	-1.5*** (.057)	-1.5*** (.060)	-1.4*** (.072)	-1.4*** (.072)	-1.4*** (.074)	-1.4*** (.072)	-1.5*** (.080)	-1.5*** (.057)	-1.5*** (.057)	-1.5*** (.058)	-1.5*** (.057)	-1.4*** (.058)
<i>TIMEcap</i>	.021** (.011)	.022** (.011)	.022** (.011)	.022** (.011)	.045*** (.012)	.006 (.019)	.007 (.019)	.007 (.020)	.007 (.019)	.121*** (.038)	-.028 (.027)	-.203*** (.050)	-.238*** (.029)	-.092*** (.023)	-1.06*** (.083)
<i>Mobile_{ijt-1}</i>	.171*** (.040)					.141*** (.051)					.161*** (.040)				
<i>Tele_{ijt-1}</i>		.206** (.083)					.127 (.115)					.120 (.085)			
<i>PC_{ijt-1}</i>			.288*** (.111)					.319** (.133)					.147 (.111)		
<i>Net_{ijt-1}</i>				.109*** (.041)					.060 (.052)					.065 (.042)	
<i>Air_{ijt-1}</i>					.036 (.052)					.076 (.087)					-.105** (.053)
<i>TIMEcap *ICT</i>	-	-	-	-	-	-	-	-	-	-	.007** (.004)	.026*** (.006)	.044*** (.005)	.019*** (.003)	.043*** (.003)
<i>const</i>	29.9*** (.544)	29.1*** (.860)	28.9*** (.918)	30.2*** (.559)	29.8*** (1.462)	30.0*** (.664)	29.8*** (1.138)	28.7*** (1.028)	30.6*** (.646)	28.9*** (2.284)	30.1*** (.553)	29.9*** (.881)	29.9*** (.918)	30.5*** (.564)	32.6*** (1.455)
N	5427	5431	5118	5418	4975	3815	3819	3705	3808	3465	5427	5431	5118	5418	4975
Rsq	.8726	.8725	.8678	.8718	.8638	.8607	.8608	.8613	.8597	.8492	.8727	.8730	.8703	.8727	.8686

Note: See appendix table A2 for Commercial services included and appendix table A1.2 for countries excluded from the regression in panel B. All regressions are OLS estimations and include year fixed effects and home and host country dummies. Robust standard errors reported in parentheses. ***denote significance at 1 per cent level, **5 per cent level,*10 per cent level respectively.

Table 6: ICT network and Business Service exports

	A1	A2	A3	A4	A5	B1	B2	B3	B4	B5	A6	A7	A8	A9	A10
<i>Ln Dist</i>	-1.6*** (.065)	-1.6*** (.066)	-1.6*** (.068)	-1.6*** (.066)	-1.6*** (.068)	-1.7*** (.076)	-1.7*** (.076)	-1.7*** (.078)	-1.7*** (.076)	-1.7*** (.080)	-1.6*** (.065)	-1.6*** (.064)	-1.6*** (.065)	-1.6*** (.064)	-1.5*** (.065)
<i>TIMEcap</i>	.029** (.015)	.029** (.015)	.029* (.016)	.029** (.015)	.034** (.016)	.081*** (.025)	.081*** (.025)	.082*** (.026)	.080*** (.025)	.129*** (.034)	-.13*** (.049)	-.39*** (.091)	-.35*** (.046)	-.16*** (.036)	-1.4*** (.126)
<i>Mobile_{ijt-1}</i>	.078* (.043)					.037 (.051)					.063 (.042)				
<i>Tele_{ijt-1}</i>		.115 (.099)					.060 (.119)					.010 (.098)			
<i>PC_{ijt-1}</i>			.095 (.126)					.127 (.137)					-.069 (.124)		
<i>Net_{ijt-1}</i>				.007 (.050)					-.034 (.057)					-.036 (.049)	
<i>Air_{ijt-1}</i>					.135* (.072)					.167* (.092)					-.001 (.073)
<i>TIMEcap *ICT</i>	-	-	-	-	-	-	-	-	-	-	.021*** (.006)	.046*** (.010)	.059*** (.006)	.028*** (.005)	.055*** (.005)
<i>const</i>	30.9** (.611)	30.4*** (1.006)	30.7*** (1.040)	31.3*** (.636)	27.9*** (1.978)	31.9*** (.691)	31.6*** (1.203)	31.3*** (1.065)	32.3*** (.671)	27.8*** (2.395)	31.2*** (.607)	31.4*** (.996)	31.5*** (1.014)	31.6*** (.626)	30.1*** (1.962)
N	4175	4174	3957	4168	4011	3275	3274	3166	3269	3128	4175	4174	3957	4168	4011
Rsq	.8406	.8405	.8367	.8403	.8380	.8374	.8374	.8375	.8373	.8352	.8412	.8415	.8405	.8419	.8435

Note: See appendix table A2 for business services included and appendix table A1.2 for countries excluded from the regression in panel B. All regressions are OLS estimations and include year fixed effects and home and host country dummies. Robust standard errors reported in parentheses. ***denote significance at 1 per cent level, **5 per cent level,*10 per cent level respectively.

We find a positive impact of ICT infrastructure which is significant for commercial services and merchandise trade, but not for business services. Nevertheless, we suggest that ICT is a necessary condition for (trade in) specialized business services. Rather the quality of the communications network seems to be more important than the access rates to ICT infrastructure in the country on average. Thus, (internationalized) services firms and their relevant business partners' cluster (to a higher extent) in capital cities and regional metropolises, which do have on average higher access rate to ICT than the whole country. In contrast, country wide access to ICT infrastructure seems to be more important for manufacturing firms as they do not necessarily cluster in large cities but are more equally distributed in the country.

When arguing that ICT infrastructure is a necessary condition for business service outsourcing to time distant countries, we need to add an interaction term to the model accordingly. The interaction effect is significant and increases the fit of the model marginally in all estimations A6 to A10 in table 5 and 6 respectively. This indicates that the time zone effect in business and commercial services trade is different for different levels of ICT networks. The coefficient on the interaction term is positive and shows that business and commercial services trade increases with *time zone* differences when a better *ICT infrastructure* network is available in countries. In this regard, service firms export business services to countries in significant distant time zones *to save time* when ICT infrastructure networks allow for doing so. By adding an interaction term to the model the coefficient on the single time zone effect becomes negative and can only be interpreted as single effect when no ICT infrastructure network is available in both countries.

When the need for *timely delivery* is an important determinant in cross-border trade of business services, *time zones* affect the business service providers' market entry strategy. The trade-off between *time zone costs* and degree of *buyer-seller interaction* becomes more relevant than the trade-off between transportation costs (distance) and fixed plant costs. In this regard, the concept of outsourcing production steps to low-labor cost countries which is driven by transportation costs (vertical manufacturing FDI) does not hold for the business services sector anymore. On the one hand, time distant countries will become more relevant for outsourcing by setting up a subsidiary (vertical FDI) when simultaneous interaction is low - as in the case of software service between the US and India. On the other hand, low-labor cost countries in the same time zone (not necessarily countries close to the market) will be chosen for vertical FDI when frequent interaction is necessary - as in the case of call centre service delivery between the EU and Turkey. When business services are transferable via ICT networks the digitalization becomes a serious task for countries to profit from outsourcing decisions of international services firms in general. Nevertheless, the framework for FDI and cross-border trade needs some modification to the business service sector.

5 Conclusion

Due to innovations in information and telecommunication technology (ICT) the proximity requirement for face-to-face interaction between business partners seem to become less important. Thus, producer services have been among the fastest growing sub-sectors in international trade. While geographical distance in gravity models on merchandise trade is found to overestimate the true cost of transportation, the firms' fragmentation of production renders time as an important determinant in the location of intermediate production. In this paper, we analyze whether time is a trade barrier for business and commercial services when countries become connected to ICT networks. We estimate gravity models which include various measures of time zones and a number of bilateral ICT infrastructure networks. We compare intra OECD business- and commercial services trade to a sample of trade with Non-OECD countries and find evidence for a positive time zone effect. Thus, services suppliers rather profit from time zone differences. When time zones allow saving time by operating over a 24 hours business day, *time* seems to be relevant for cross-border business services trade, as previously found for time sensitive intermediates. In this regard, *time* represents a barrier in trading with business partners located in the same time zone as they can continue to work half a day later when we abstract from shift work. Moreover, the continuity effect seems to be more important for business and commercial services trade with Non-OECD countries, and hence, may indicate here that production steps in business service provision are off-shored to Non-OECD countries in distant time zones. Has the firms' ability to profit from time zones emerged due to improved tradability of business services? We argue that a bilateral ICT network is relevant for business and commercial services trade. By including an interaction term into the model, we find that time zone costs for cross-border services trade are significantly dependent on the ICT network. In order *to save time* service firms export business services to countries in significant distant time zones when ICT infrastructure networks allow for doing so.

The classification adopted in the General Agreement on Trade in Services reflects the entry modes of the business services supplier (via FDI or cross-border export). When timely delivery plays a role in business services, time zones affect the market entry strategy of service providers. For transferable business services via ICT, the trade-off between *time zone costs* and degree of *buyer-seller interaction* becomes more relevant than the trade-off between transportation costs (distance) and fixed plant costs. Especially countries in *distant* time zones become relevant for business services outsourcing when simultaneous interaction is low. In turn, for countries to profit from business services outsourcing further digitalization is a serious task.

Appendices

Appendix A1.1: Reporter countries (Panel A)

Country	Business services	Commercial services	Merchandise
Australia	1999-2006	1999-2006	1999-2005
Austria	1999-2005	1999-2005	1999-2006
Belgium	2002-2005	2002-2005	1999-2006
Canada	-	1999-2005	1999-2006
Czech Republic	2000-2005	2000-2005	1999-2006
Denmark	1999-2005	1999-2003,2005	1999-2006
Spain	1999-2005	1999-2005	1999-2006
Finland	1999-2005	1999-2005	1999-2006
France	1999-2005	1999-2005	1999-2006
Germany	-	1999-2005	1999-2006
Greece	1999-2005	1999-2005	1999-2006
Hong Kong	-	-	1999-2004
Hungary	1999-2005	1999-2005	1999-2006
Ireland	1999-2005	1999-2005	1999-2006
Italy	1999-2005	1999-2005	1999-2006
Japan	1999-2005	1999-2005	1999-2006
Korea	1999-2005	1999-2005	1999-2006
Luxemburg	2002-2005	-	1999-2006
Netherland	1999-2005	1999-2005	1999-2006
Norway	1999-2005	1999-2001,2004-2005	1999-2006
New Zealand	2004-2005	1999-2005	1999-2006
Poland	2004-2005	2004-2005	1999-2006
Portugal	1999-2005	1999-2005	1999-2006
Slovak Republic	1999-2005	1999-2005	1999-2006
Sweden	1999-2005	1999-2005	1999-2006
United Kingdom	1999-2004	1999-2005	1999-2006
United States	-	1999-2006	1999-2006

Appendix A1.2: Reporter and partner countries excluded in Panel B

Australia	UTC+8 hours to UTC+10 hours
Brazil	UTC-3 hours to UTC-5 hours
Canada	UTC-3.5 hours to UTC-8 hours
Indonesia	UTC+7 hours to UTC+9 hours
Kazakhstan	UTC+5 hours to UTC+6 hours
DR Congo	UTC+1 hours to UTC+2 hours
Mexico	UTC-6 hours to UTC-8 hours
Mongolia	UTC+7 hours to UTC+8 hours
Russian Federation	UTC+3 hours to UTC+12 hours
United States	UTC-4 hours to UTC-10 hours

Appendix A2: Documentation of variables and data sources

Variable	Description	Source
Business Services Exports	Include leasing, legal, accounting, auditing, book-keeping, tax consulting, business and management consulting, advertising, and research	OECD (2008)
Commercial Services Exports	Include communication services, construction services, insurance services, financial services, computer and information services, royalties and license fees, other business services, personal, cultural and recreational services	OECD (2008)
Merchandise Exports	Includes total trade based on SITC Rev. 3.	OECD (2010)
Distance	The weighted distances (Indistw) are calculated following the great circle formula, which uses latitudes and longitudes of the most important city or of its official capital (incorporate internal distances).	CEPII (2010)
TIME capital	Shortest time zone difference between trading partners' capital city, daylight saving time is not included.	PTB (2010)
TIME mean	Time zone difference between trading partners' based on the mean time zone in the country for countries with multiple time zones. Daylight saving time is not included.	PTB (2010)
TIME min	Time zone difference between trading partners' based on the minimum time zone difference between the countries with multiple time zones and its trading partners. Daylight saving time is not included.	PTB (2010)
Office hours overlap	Number of overlapping office hours between trading partners based on the capital time zone difference. (ranges between zero and 8 hours or zero and 10 hours)	PTB (2010)
GDP	Nominal GDP in current USD	World Bank (2010)
Mobile telephone subscriptions (per 100 people)	Mobile cellular telephone subscriptions are subscriptions to a public mobile telephone service using cellular technology, which provide access to the public switched telephone network. Include post-paid and prepaid subscriptions.	World Bank (2010)
Telephone subscribers (per 100 people)	Total telephone subscribers are mobile and fixed-line subscribers	World Bank (2010)
Personal computers (per 100 people)	Personal computers are self-contained computers designed to be used by a single individual.	World Bank (2010)
Internet users (per 100 people)	Internet users are people with access to the worldwide network.	World Bank (2010)
Air transport, registered carrier departures worldwide	Registered carrier departures worldwide are domestic takeoffs and takeoffs abroad of air carriers registered in the country	World Bank (2010)
English language	English language is equal to one if the English language is spoken by at least 50 per cent of the population in both countries.	CIA (2010)
Colonial ties	Dummy if countries have colonial relationship	CEPII (2010)
Religion	Dummy if both countries have the same religion. A country is considered as a Muslim, Catholic, Protestant, Orthodox, or other religion if at least 60 per cent of population belongs to the	CIA (2010)
EU27	Dummy for countries in the European Union	WTO (2010)
GATS	Dummy if countries have a trade agreement including service trade considered in GATS Article V, into force until 2002	WTO (2010)
GATT	Dummy if countries have a trade agreement GATT Article XXIV, into force until 2002	WTO (2010)

Appendix A3: Summary statistics

Panel A	Obs.	Mean	Std.Dev.	Min	Max
Ln Business Service Export	4396	16.121	2.776	6.846	23.185
Ln Commercial Service Export	5681	17.063	3.067	3.912	24.214
Ln Merchandise Export	43680	16.267	3.536	.693	26.481
Ln Distance	5599	8.350	1.054	5.081	9.880
Time capital	5681	3.967	3.527	0	12
Time mean	5681	4.102	3.523	0	12
Time min	5681	3.536	3.188	0	12
Office 8	5681	4.297	3.088	0	8
Office 10	5681	6.096	3.404	0	10
LnGDP _{t-1}	5681	26.563	1.533	23.729	30.147
LnGDP _{j,t-1}	5462	25.813	1.708	19.252	30.147
LnMobile _{ijt-1}	5509	7.077	1.663	-1.081	9.477
LnTele _{ijt-1}	5513	8.666	1.081	3.347	10.609
LnPC _{ijt-1}	5119	5.780	1.504	.333	8.829
LnNet _{ijt-1}	5484	5.711	1.824	-1.673	8.815
LnAir _{ijt-1}	4975	24.092	2.225	16.066	30.230

Panel B	Obs.	Mean	Std.Dev.	Min	Max
Ln Business Service Export	3474	15.918	2.784	6.846	22.305
Ln Commercial Service Export	4032	16.579	3.071	3.912	23.007
Ln Merchandise Export	36713	15.918	2.784	6.846	22.305
Ln Distance	3950	8.083	1.104	5.081	9.880
Time capital	4032	3.185	3.363	0	12
Office 8	4032	4.982	3.035	0	8
Office 10	4032	6.859	3.265	0	10
LnGDP _{t-1}	4032	26.396	1.453	23.729	29.172
LnGDP _{j,t-1}	3836	25.488	1.584	19.252	29.172

OECD-sample (A)	Obs.	Mean	Std.Dev.	Min	Max
Ln Business Service Export	1934	16.977	2.774	6.846	23.185
Ln Commercial Service Export	2789	18.027	2.845	6.846	24.214
Ln Merchandise Export	6778	20.284	2.252	7.465	26.481
Ln Distance	2789	8.165	1.160	5.081	9.880
Time capital	2789	3.949	3.829	0	12
Time mean	2789	4.071	3.864	0	12
Time min	2789	3.451	3.464	0	12
Office 8	2789	4.369	3.351	0	8
Office 10	2789	6.110	3.723	0	10
LnGDP _{t-1}	2789	26.622	1.562	23.729	30.147
LnGDP _{j,t-1}	2789	26.526	1.570	22.793	30.147

Non-OECD-sample (A)	Obs.	Mean	Std.Dev.	Min	Max
Ln Business Service Export	2052	15.317	2.620	6.846	21.949
Ln Commercial Service Export	2892	16.134	2.986	3.912	22.398
Ln Merchandise Export	36902	15.529	3.218	.693	25.462
Ln Distance	2810	8.535	.900	5.563	9.867
Time capital	2892	3.985	3.210	0	12
Time mean	2892	4.132	3.161	0	12
Time min	2892	3.617	2.895	0	12
Office hours 8	2892	4.228	2.810	0	8
Office hours 10	2892	6.082	3.066	0	10
LnGDP _{t-1}	2892	26.505	1.503	23.729	30.147
LnGDP _{j,t-1}	2673	25.068	1.518	19.252	28.436

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Appendix A4: Correlation matrix (Panel A)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
(1) Dist	1												
(2) Time cap	.760	1											
(3) Time mean	.741	.964	1										
(4) Time min	.737	.970	.956	1									
(5) Overlap8	-.771	-.976	-.943	-.944	1								
(6) Overlap10	-.766	-.996	-.961	-.965	.988	1							
(7) GDP _{it-1}	.079	.085	.111	.042	-.096	-.089	1						
(8) GDP _{jt-1}	-.273	-.069	-.056	-.093	.047	.062	.011	1					
(9) Mobile _{ijt-1}	-.192	.004	-.017	.013	-.006	-.004	.075	.415	1				
(10) Tele _{ijt-1}	-.238	.048	.037	.049	-.050	-.048	.078	.466	.901	1			
(11) PC _{ijt-1}	-.197	.099	.083	.087	-.098	-.100	.108	.431	.770	.884	1		
(12) Net _{ijt-1}	-.140	.113	.092	.106	-.111	-.113	.121	.391	.890	.895	.876	1	
(13) Air _{ijt-1}	.002	.194	.092	.131	-.197	-.197	.547	.676	.370	.472	.508	.444	1

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Appendix A5: The time zone effect in merchandise trade

	A1	A2	A3	A4	A5	A6	B1	B2	B3	C1	C2	C3	C4	C5
<i>Ln Dist</i>	-1.65*** (.021)	-1.57*** (.030)	-1.56*** (.030)	-1.55*** (.031)	-1.54*** (.031)	-1.57*** (.030)	-1.63*** (.032)	-1.60*** (.032)	-1.62*** (.032)	-1.53*** (.044)	-1.55*** (.043)	-1.54*** (.044)	-1.51*** (.043)	-1.52*** (.044)
<i>TIMEcap</i>		-.016*** (.005)					-.014** (.007)			.031*** (.011)				
<i>TIMEmean</i>			-.018*** (.005)								.044*** (.012)			
<i>TIMEmin</i>				-.022*** (.005)								.039*** (.012)		
<i>Office 8</i>					.027*** (.006)			.029*** (.008)						-.024* (.013)
<i>Office 10</i>						.018*** (.006)			.017** (.008)					-.029** (.012)
<i>Colony</i>	1.150*** (.042)	1.135*** (.041)	1.136*** (.041)	1.137*** (.041)	1.136*** (.041)	1.135*** (.041)	1.175*** (.044)	1.178*** (.044)	1.176*** (.044)	.418*** (.047)	.413*** (.047)	.415*** (.047)	.427*** (.047)	.421*** (.047)
<i>English</i>	.562*** (.028)	.565*** (.028)	.565*** (.028)	.564*** (.028)	.565*** (.028)	.565*** (.028)	.548*** (.034)	.548*** (.034)	.548*** (.034)	.396*** (.045)	.390*** (.045)	.394*** (.045)	.398*** (.045)	.397*** (.045)
<i>Ln GDPit-1</i>	.411*** (.082)	.442*** (.082)	.442*** (.082)	.442*** (.082)	.441*** (.082)	.441*** (.082)	.480*** (.091)	.479*** (.091)	.479*** (.091)	.283* (.162)	.281* (.161)	.282* (.162)	.284* (.163)	.284* (.162)
<i>Ln GDPjt-1</i>	.512*** (.046)	.509*** (.046)	.509*** (.046)	.509*** (.046)	.509*** (.046)	.509*** (.046)	.495*** (.051)	.494*** (.051)	.494*** (.051)	.641*** (.077)	.636*** (.077)	.639*** (.077)	.644*** (.077)	.642*** (.077)
<i>const</i>	10.40*** (2.555)	9.04*** (2.565)	8.99*** (2.566)	8.83*** (2.569)	8.67*** (2.568)	8.84*** (2.569)	7.96*** (2.831)	7.59*** (2.835)	7.77*** (2.838)	9.58** (4.878)	9.88** (4.860)	9.83** (4.881)	9.50* (4.904)	9.77** (4.889)
N	37496	37058	37058	37058	37058	37058	30942	30942	30942	4192	4192	4192	4192	4192
Rsquared	.8702	.8705	.8705	.8705	.8705	.8705	.8666	.8666	.8666	.9248	.9251	.9249	.9247	.9248

Note: Dependent Variable: The log of merchandise exports. See table A1.2 for countries excluded from the regression in Panel B. Panel C restricts the merchandise trade sample to observations with positive non-missing business services trade observations. All regressions are OLS estimations and include year fixed effects and home and host country dummies. Regressions include dummy for same religion, GATT agreement, and EU27. Robust standard errors reported in parentheses. ***denote significance at 1 per cent level, **5 per cent level,*10 per cent level respectively.

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Appendix A6: Time zone effect in Merchandise trade: OECD versus NON-OECD Countries

	OECD					NON-OECD					NON-OECD					
	Panel A		Panel B			Panel A		Panel B			Panel A		Panel B			
<i>Ln Dist</i>	-1.11*** (.060)	-1.06*** (.068)	-1.07*** (.072)	-1.07*** (.062)	-1.10*** (.059)	-1.12*** (.056)	-1.11*** (.057)	-1.11*** (.056)	-2.01*** (.034)	-1.99*** (.033)	-1.98*** (.033)	-2.00*** (.035)	-2.02*** (.035)	-2.17*** (.042)	-2.13*** (.042)	-2.17*** (.043)
<i>TIMEcap</i>	-.019* (.011)					-.002 (.015)			.031*** (.006)					.043*** (.008)		
<i>TIMEmean</i>		-.037*** (.011)								.027*** (.006)						
<i>TIMEmin</i>			-.036*** (.012)								.024*** (.006)					
<i>Office 8</i>				.040*** (.013)			.006 (.018)					-.033*** (.007)			-.040*** (.010)	
<i>Office 10</i>					.022* (.012)			.005 (.016)					-.033*** (.006)			-.046*** (.009)
<i>Colony</i>	.435*** (.057)	.452*** (.059)	.447*** (.059)	.440*** (.057)	.435*** (.056)	.512*** (.074)	.513*** (.073)	.514*** (.073)	1.35*** (.046)	1.35*** (.046)	1.35*** (.046)	1.35*** (.046)	1.35*** (.046)	1.31*** (.048)	1.31*** (.048)	1.31*** (.048)
<i>English</i>	.382*** (.045)	.379*** (.045)	.379*** (.045)	.381*** (.045)	.382*** (.045)	.358*** (.056)	.359*** (.056)	.358*** (.056)	.515*** (.032)	.515*** (.032)	.518*** (.032)	.515*** (.032)	.514*** (.032)	.500*** (.039)	.502*** (.038)	.501*** (.038)
<i>Ln GDPit-1</i>	.596*** (.119)	.596*** (.120)	.596*** (.120)	.596*** (.119)	.596*** (.119)	.527*** (.131)	.527*** (.131)	.527*** (.131)	.403*** (.094)	.404*** (.094)	.404*** (.094)	.404*** (.094)	.404*** (.094)	.466*** (.103)	.468*** (.103)	.467*** (.103)
<i>Ln GDPjt-1</i>	.572*** (.118)	.571*** (.117)	.571*** (.117)	.571*** (.117)	.572*** (.118)	.622*** (.135)	.622*** (.135)	.622*** (.135)	.506*** (.048)	.506*** (.048)	.506*** (.048)	.507*** (.048)	.507*** (.048)	.487*** (.053)	.488*** (.053)	.487*** (.053)
<i>const</i>	-1.09 (5.228)	-1.36 (5.233)	-1.41 (5.246)	-1.60 (5.233)	-1.33 (5.229)	-1.47 (5.853)	-1.54 (5.867)	-1.55 (5.866)	11.6*** (2.801)	11.5*** (2.802)	11.4*** (2.804)	11.8*** (2.808)	11.9*** (2.808)	10.1*** (3.015)	10.0*** (3.026)	10.5*** (3.025)
N	6778	6778	6778	6778	6778	5259	5259	5259	30280	30280	30280	30280	30280	25683	25683	25683
Rsquared	.8943	.8947	.8946	.8946	.8944	.9086	.9086	.9086	.8272	.8272	.8272	.8272	.8273	.8206	.8204	.8206

Note: See table A1.2 for countries excluded from the regression in Panel B. Panel C restricts the merchandise trade sample to observations with non-missing business services trade observations. All regressions are OLS estimations and include year fixed effects and home and host country dummies. Regressions include dummy for same religion, GATT agreement, and EU27. Robust standard errors reported in parentheses. ***denote significance at 1 per cent level, **5 per cent level, *10 per cent level respectively.

Table A7: ICT network and Merchandise exports

	A1	A2	A3	A4	A5	A6	B1	B2	B3	B4	B5	B6
<i>Ln Dist</i>	-1.562*** (.030)	-1.546*** (.030)	-1.437*** (.033)	-1.559*** (.031)	-1.498*** (.035)	-1.602*** (.033)	-1.610*** (.033)	-1.596*** (.032)	-1.485*** (.033)	-1.606*** (.033)	-1.521*** (.036)	-1.679*** (.034)
<i>TIMEcap</i>	-.013** (.005)	-.017*** (.005)	-.036*** (.006)	-.014*** (.005)	-.022*** (.006)	.020*** (.006)	-.012* (.007)	-.019*** (.007)	-.039*** (.008)	-.012* (.007)	-.029*** (.008)	.052*** (.009)
<i>Ln Mobile_{ijt-1}</i>	.063*** (.011)						.044*** (.012)					
<i>Ln Tele_{ijt-1}</i>		.102*** (.021)						.085*** (.023)				
<i>Ln PC_{ijt-1}</i>			.084*** (.027)						.059** (.029)			
<i>Ln Net_{ijt-1}</i>				.053*** (.012)						.046*** (.013)		
<i>Ln IntCap_{ijt-1}</i>					.043*** (.010)						.044*** (.011)	
<i>Ln Air_{ijt-1}</i>						.131*** (.019)						.150*** (.021)
<i>const</i>	34.26*** (.279)	33.61*** (.319)	33.10*** (.352)	34.28*** (.281)	33.69*** (.341)	31.29*** (.562)	34.29*** (.281)	33.78*** (.331)	33.31*** (.337)	34.32*** (.279)	33.54*** (.336)	30.93*** (.607)
N	37043	38173	32578	37336	28289	29287	30951	32127	28010	31243	24058	24186
Rsquared	.8658	.8639	.8765	.8678	.8746	.8805	.8615	.8592	.8734	.8632	.8714	.8803

Note: All regressions are OLS estimations and include year fixed effects and home and host country dummies. Regressions include dummy for English language, colonial ties, same religion, GATT agreements and EU27. Robust standard errors reported in parentheses. ***denote significance at 1 per cent level, ** significance at 5 per cent level, * significance at 10 per cent level respectively.

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