

Information and Communication Technology (ICT) and Trade in Services: A Disaggregated Analysis

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Abstract: Previous studies have shown that the unprecedented advances in information and communications technology (ICT) have had positive and significant impact on trade, particularly on trade in services. However, this impact may vary across various service categories, depending on the extent to which ICT is used by a particular service. This paper empirically examines the impact of ICT on exports and imports of ten service categories using panel data from 49 countries including both advanced and emerging market economies for the period between 2000 and 2010. We combine seven different ICT variables to construct a comprehensive ICT development indicator (IDI) that captures the access, use, and capability aspects of the technology. Our results indicate that ICT development has significant positive impact on both exports and imports of transportation, travel and other business services. Furthermore, it has significant positive effects on the exports of ‘financial services’ and ‘royalties and license fees’ as well as the imports of construction, insurance and telecommunication services. When we estimate the model separately for advanced (AEs) and emerging market economies (EMEs), most of the significant impact are found among the EMEs. In addition, the significant positive effects of ICT development on the exports of ‘royalty and license fees’ and ‘transportation’, and on the imports of construction, telecommunication, transportation and travel are robust across a number of different model specifications and estimation methods.

Keywords: Information and Communication Technology (ICT); Advanced Economy (AE); Emerging Market Economy (EME); Services Exports; Services Imports; ICT Development Indicator (IDI).

JEL Classification: F12; F14; F15

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1. Introduction

There has been a growing literature that examines the effects of information and communication technology (ICT) on trade. In general, this literature finds evidence of a positive impact of ICT on international trade.¹ The role of this technology in services trade has assumed special significance primarily because of two reasons. *First*, the significant increases of world trade in services have coincided with the unprecedented advances in ICT. *Second*, many of the services have become tradable because of the ICT advances. This is particularly true for information-intensive services (IISs).² These services involve creating, processing, and communicating information. As ICT advances lower the costs of these processes, information-intensive services can be produced and delivered anywhere around the world. On the other hand, ICT may have an impact on trade in non-IISs as well. For example, the use of ICT may reduce the fixed entry cost into a market and thus stimulates exports. As Freund and Weinhold (2004) discuss, these fixed costs include the costs of finding out information about the market (search cost), advertising, and establishing a distribution network. Also, the use of ICT reduces delays in acquiring and transmitting information and makes planning more efficient and accurate.

¹ For example, using U.S. exports and imports data for 14 service items and 31 countries between 1995 and 1999, Freund and Weinhold (2002) find that Internet development in those countries has significant positive impact on bilateral trade with the U.S. They further extend this analysis to cover merchandise trade and to include 56 countries in a subsequent study (Freund and Weinhold 2004). Fink et al (2005) find evidence of significant influence of communication costs on bilateral trade in the data for 107 countries in 1999. Using data for 98 countries, Clarke and Wallsten (2006) further show that access to the Internet results in developing countries exporting more to developed countries. Vemuri and Siddiqi (2009) analyze panel data for 64 countries for the period 1985 -2005 and conclude that ICT infrastructure and the availability of Internet for commercial transactions have a positive and significant impact on the volume of international trade. Using data for 175 countries, Demirkan et al (2009) also find evidence of bilateral trade enhancing effects of ICT use. Choi (2010) provides further evidence of Internet usage raising services trade for 151 countries for a period from 1990 to 2006. More recently, Mattes et al (2012) examine the effects of availability and use of ICT on trade using data on the European Union (EU) countries. Although they do not find any significant impact of ICT on EU trade, their results suggest that trade is enhanced if both trading partners are advanced users of ICT. In contrast, Liu and Nath (2013) finds evidence of a positive impact of ICT use on trade in 40 emerging market economies.

² Examples of such services include various customer services, education, medical transcriptions, tax returns, web design, etc.

Consequently, the volume of trade between countries is expected to go up. Because of the multiplicity of channels and the fact that the extent to which ICT is used varies across industries, we can expect differential effects of ICT on various service items.

Most previous studies (Freund and Weinhold 2002 & 2004; Clarke and Wallsten 2006; Choi 2010) have focused on aggregate exports and imports. In contrast, we focus on ten disaggregate service items to examine if ICT has differential effects on different services. The services trade among AEs has undoubtedly increased over the last decade or so. This trend has been visible even among the EMEs. Therefore we consider a sample of 49 countries that include 21 advanced economies (AEs) and 28 emerging market economies (EMEs) during the period 2000-2010.

Previous literature uses the number of Internet hosts (Freund and Weinhold 2002 & 2004; Clarke and Wallsten 2006; Choi 2010) or/and the number of telephone lines, personal computers, and Internet users (Vemuri and Siddiqi 2009) as the measurement of ICT. Yet these measures can only reflect one aspect of ICT advances. In a recent study, Liu and Nath (2013) use four alternative variables that capture different aspects of ICT: total annual investment in telecom, international Internet bandwidth (Mega Bits per second), total fixed (wired) broadband Internet subscriptions per 100 people, and the number of Internet hosts per 100 people. In this paper we use an aggregate measure of ICT development that combines three aspects of the technology, namely access, use, and skills.

We estimate fixed effects models of exports and imports to examine the effects of ICT on trade in various services. We use the natural logarithm of exports and of imports for each service item as the dependent variables. The main variable of interest is the aggregate ICT index. Other control variables include the natural logarithm of GDP per capita, of population, and country and year fixed effects. Our results indicate that ICT development has significant positive impact on

the exports and imports of transportation, travel and other business services. Furthermore, it has significant positive effects on the exports of ‘financial services’ and ‘royalties and license fees’ as well as the imports of construction, insurance and telecommunication services. When we estimate the model separately for advanced economies (AEs) and emerging market economies (EMEs), the coefficient estimates are more significant for the EMEs. In addition, the significant positive effects of ICT development on the exports of ‘royalty and license fees’ and ‘transportation’ and on the imports of construction, telecommunication, transportation and travel are robust across a number of different model specifications and estimation methods.

The rest of the paper is organized as follows. Section 2 includes a detailed discussion of the data and methodology used for the empirical analysis. In section 3, we present and discuss the empirical results for our baseline model. Section 4 presents the sensitivity analysis results. In the last section, we summarize and include a few concluding remarks.

2. Data and Methodology

2.1 Data

We obtain data on the relevant variables for 49 countries between 2000 and 2010 from three major sources: (i) The World Trade Organization (WTO) - Trade in Commercial Services Dataset; (ii) The World Bank - World Development Indicators (WDI) database; and (iii) The International Telecommunication Union (ITU) - World Telecommunication ICT Indicator database. The choices of the countries and sample period are dictated by the availability of data. Annual data on exports and imports of ten major service items are available in current USD from WTO. The ten major service items include audio-visual and related services, computer services, construction, financial services, insurance services, other business services, royalty and license

fees, telecommunication services, transportation, and travel.³ In order to convert the current USD export and import values into constant USD, we first construct weighted price index for each service item using data obtained from the U.S. Bureau of Economic Analysis. In the absence of separate price deflator for each country, we use U.S. price deflator under the implicit assumption that relative price movements for these various services items are similar across countries. Given that these items are traded, this may not be an unrealistic assumption. We then apply equation (1) to obtain services exports and imports in 2000 constant USD.

$$X_{j,t,constant} = \frac{X_{j,t}}{P_{j,t}^{US} * E_t} * P_{j,2000}^{US} * E_{2000}, \quad (1)$$

where $X_{j,t,constant}$ is export or import of service item j in year t in 2000 constant USD, $X_{j,t}$ is export or import of service item j in year t in current USD, $P_{j,t}^{US}$ is the US price index for service item j in year t , $P_{j,2000}^{US}$ is the US price index for service item j in 2000, E_t is the exchange rate in year t and E_{2000} is the exchange rate in 2000; i indexes country with $i = 1, 2, \dots, N$; j indexes service item; and t indexes year with $t = 1, 2, \dots, T$. We obtain data on official exchange rates from WDI.

It is almost impossible to find a single measure of ICT that reflects all different aspects of this general-purpose technology.⁴ We follow ITU and combine seven variables into an ICT development index that reflects the access, use and skills of ICT.^{5,6} These variables are:

ICT Access: (1) fixed-telephone lines per 100 inhabitants;

³ Appendix Table A.1 provides a list of the ten items with their corresponding definitions according to WTO.

⁴ Because of its broader application across different sectors, ICT is referred to as a general-purpose technology. For example, see Basu and Fernald (2007).

⁵ ITU started constructing IDI in recent years and thus their data are available for 2007, 2009, 2010, and 2011 only.

⁶ Although ITU uses ten variables, we use only seven variables as data on the rest three variables are not consistently available for the countries in our sample for the entire period that we consider here. Appendix Table A.2 outlines the construction of our IDI index. In a recent study, Mattes et al (2012) use a similar index that was appropriately modified according to data availability.

- (2) mobile-cellular telephone subscriptions per 100 inhabitants;
- ICT Use: (3) international Internet bandwidth (bit/s) per Internet user;
- (4) percentage of individuals using the Internet;
- (5) fixed (wired)-broadband Internet subscriptions per 100 inhabitants;
- ICT Skills: (6) secondary gross enrollment ratio;
- (7) tertiary gross enrollment ratio.

The index takes a value between 0 and 10, with 0 representing the lowest level of ICT development and 10 representing the highest level of ICT development.

Besides IDI, we use per capita GDP and population as control variables, data on which are obtained from WDI. For our sensitivity analysis, we use two additional variables: the rest of the world (ROW) GDP and the average tariff rates. We obtain data on these variables from WDI.

[Insert Table 1]

Table 1 provides the summary statistics of the dependent variables, the ICT variable, and the control variables for the baseline specification. We use the natural logarithm of exports and imports for each service as the dependent variable in our empirical model specifications.⁷ Table 1 indicates that there are wide variations in average value of exports and imports of the service items across the countries. Bangladesh has the lowest mean values for 14 categories and the USA has the highest mean values for 8 categories. Furthermore, the year-to-year volatility of export and import is relatively low for more traditional services such as transportation and travel. The IDI summary statistics indicate that Denmark has the highest level of average ICT development over the sample period and Bangladesh has the lowest. Furthermore, there are significant cross-country variations in the average per capita GDP and the average population, the two major

⁷ Choi (2010) also uses natural logarithm of exports and imports as the dependent variable.

control variables in our model. China has the highest average population and Brazil has the lowest. For per capita GDP, Norway ranks the first while Bangladesh shows the lowest average.

[Insert Table 2]

In order to get a sense of how IDI may be correlated with the trade variables, we calculate correlation coefficients for each country and for each item. Table 2 presents the average correlation coefficients (averaged across countries) along with the minimum and maximum. The average correlations are all positive. However, they are relatively stronger (the correlation coefficient being greater than 0.70) for computer services, other business services, royalties and license fees, telecommunication services, transportation services, and travel.

2.2 Methodology

We estimate fixed effects panel data models for our empirical analysis. We estimate two sets of equations: the first set for export of 10 service items and the second for import of the same service items. On the right-hand side of these models, we include IDI together with other control variables, country fixed effects, and year fixed effects. We use the natural logarithm of exports, imports, per capita GDP, and population.⁸ However, we use the level of IDI for two reasons. First, since IDI takes a value between 0 and 10, it is easy to interpret the results if we use it in level. Second, with other variables in logarithmic scale, the IDI values in level are comparable. Overall, our model takes the following form:

$$LT_{it}^j = \alpha_i + \delta Y_t + \beta' IDI_{it} + \gamma' Z_{it} + \varepsilon_{it} \quad (2)$$

⁸ These specifications are similar to Choi (2010)

where LT_{it}^j is the logarithm of exports (or imports) of service j for country i in year t ; α_i is the country fixed effect; Y_t is the year (time) fixed effect; IDI_{it} is the ICT variable of interest; Z_{it} is the vector of control variables; i indexes country with $i = 1, 2, \dots, N$; j indexes service item; and t indexes time with $t = 1, 2, \dots, T$.

In the baseline specification, we choose per capita GDP and population along with country and year fixed effects as the control variables. This is the most parsimonious specification that can be estimated with the most available data. This is also consistent with the gravity model that has been the workhorse of most empirical trade models.⁹ We do not explicitly include distance in our model. Since we use total exports of a service item from one country to all its trading partners and total imports into one country from all its trading partners, we may include an average distance between the country and all its trading partners. However, in our model specification, country fixed effects will capture the effect of this time-invariant average distance and therefore we do not include it separately.

The per capita GDP measures a country's standard of living. As a country grows, the import is expected to go up due to greater consumption and investment demand. The effect on exports is not clear a-priori. As growth takes place, the economy may increase its exports due to increased production. An increase in domestic demand may, however, compete with external demand and thereby lower exports. Moreover, higher per capita GDP also captures better infrastructural capacity which is crucial for international trade. In that case, we would expect it to have a positive impact on both exports and imports.

Like per capita GDP, the effect of population on exports is ambiguous a-priori. While a larger population may increase domestic production and exports by increasing labor supply, it

⁹ See, for example, Kimura and Lee 2006.

can also reduce exports by creating more domestic demand. On the other hand, a larger population is likely to increase the demand for imports. While the country fixed effects would capture the effects of time-invariant country-specific factors, the year fixed effects are expected to capture the effects of global events that may affect trade in all countries in the sample.

We use panel least square (PLS) method to estimate the baseline model.¹⁰ The country fixed effects are expected to capture much of the heteroskedasticity among the countries while the year fixed effects are expected to control for cross-correlations across countries. Since in our models the treatment takes place at the country level, the reported standard errors are clustered at that level.

3. Empirical Results

Our empirical results are presented in Tables 3 and 4. We first report the estimation results for the exports equations and then for imports for all countries in Table 3. For each service item, the availability of data for the countries in our sample varies, so the number of countries included in the estimation ranges from 37 for audio-visual and related services to 49 for insurance services, transportation, and travel. Next we separate the 49 countries into two groups: the AEs and the EMEs. The corresponding results are reported in Table 4.

3.1 Baseline Model

Table 3 shows the estimation results for the baseline model for exports and imports of the ten service items. Panel A presents the coefficient estimates for regression equations with natural logarithm of exports for each service item as the dependent variable. The estimated coefficients

¹⁰ Choi (2010) uses this method.

are positive for seven items and statistically significant at the conventional levels of significance for five of them. These five significant items include financial services, other business services, royalty and license fees, transportation, and travel. The first three of them are information-intensive services and ICT may have been the vehicle of trade for these items. In case of transportation and travel, the ICT development may have enhanced market accessibility and made the logistics more efficient. In terms of magnitude, the effects seem substantial. For example, the average effect of an increase of 1 point in IDI on exports for items with statistically significant impact ranges from 22.2% (travel) to 40.2% (royalties and license fees). Among the control variables, per capita GDP has a positive effect on exports of all items and the effect is statistically significant for eight items. The effects of population on exports of most items are negative and the effects are significant for two items.

[Insert Table 3]

In Panel B, we present the results for the models with logarithm of imports for various service items as the dependent variable. The estimated coefficients are positive for nine items and statistically significant at the conventional levels of significance for six of them. These items include construction, other business services, telecommunication services, transportation, and travel. The average effect of a 1 point increase in IDI on imports for items with statistically significant impact ranges from 14.7% (transportation) to 76.2% (construction). Among the control variables, per capita GDP has a positive effect on imports of all items and the effect is statistically significant for seven items. Population has largely a negative effect on the imports of most items.

Overall, the results suggest that ICT development has contributed positively to the exports and imports of transportation and travel and other business services. It also has a positive impact

on the exports of ‘financial services’ and ‘royalties and license fees’ as well as the imports of construction and telecommunication services. In comparing results across service items, it is important to recognize that the number of countries and the sample period for each country are not the same for different service items.

3.2 Advanced Economies (AEs) versus Emerging Market Economies (EMEs)

Since our sample includes both advanced economies (AEs) and emerging market economies (EMEs), it would be interesting to examine if ICT development affects international trade differently in these two sets of countries. As we can see from Appendix Table A.2, there are 21 AEs and 28 EMEs in our sample.

[Insert Table 4]

Table 4 presents the results for AEs and EMEs separately. According to Panel A, ICT development has a significant positive impact only on the exports of construction for AEs. Furthermore, the estimated coefficients are negative for exports of computer services and travel, and for imports of four items. But all of these negative coefficients are statistically insignificant. Our finding of insignificant impact of ICT on services trade in AEs is consistent with the results reported in Clarke and Wallsten (2006).

Panel B reports the results for EMEs. ICT development has significant positive effect on exports of three items and imports of six items in EMEs. The significant positive impact of IDI on imports of most service items seems to suggest that ICT development has significantly improved the access to the EMEs market for foreign companies, which has contributed to the increase in imports. ICT development has also been a significant determinant of exports of other business services – an IIS item – and travel for EMEs. Interestingly, IDI has a negative and statistically significant impact on the exports of construction.

In summary, ICT development seems to have a much stronger effect on service trade, particularly imports, in EMEs. In contrast, it does not seem to play an important role in the AEs. It is likely that the most of the ICT induced trade growth in the AEs occurred before the sample period we consider here. Major advances in ICT took place in the 1990s and the AEs were the first to introduce and benefit from these advances. Thus, the growth of exports and imports in the post 1990s in those countries was primarily due to factors other than ICT advances in those countries. However, for EMEs, their services trade may just started to benefit more from ICT as the technology becomes widespread in these countries in the post 1990s. As the trading partners of AEs, the trade between most AEs and EMEs increased significantly during the first decade of the 21st century and we have just seen that ICT played an important role in promoting trade in EMEs.

4. Sensitivity Analysis

In order to examine if the results with regard to the effects of ICT on exports and imports are robust, we estimate several alternative specifications of our regression models. Our empirical model is based on the assumption that the causality runs from ICT to exports and imports of various service items. However, it is possible that exports and imports may also contribute to ICT advances.¹¹ Similarly, the causality may run from trade to other control variables like GDP and population. Furthermore, both IDI (and other right-hand side variables) and exports/imports may be caused by a third factor that is not observable. These possibilities give rise to the endogeneity problem that has been widely recognized in the literature. Clarke and Wallsten

¹¹ However, although the reverse causality could be an important issue when we use total exports and total imports, it is intuitively less of an issue when we consider exports and imports of individual items.

(2006) and Vemuri and Siddiqi (2009) extensively discuss this issue in the context of ICT and trade.¹²

To deal with the potential endogeneity, we first include 1-year lagged ICT variables (rather than including them contemporaneously) on the right-hand side.¹³ The coefficient estimates for the lagged ICT variable are presented in Table 5.¹⁴ In most cases, they are qualitatively similar to the coefficient estimates in our baseline model. All coefficients that are significant in the baseline model remain significant except for that of export of other business services. The sign of the estimated coefficient changed for exports of ‘audio-visual and related services’ and ‘construction’ and imports of computer services. However, these coefficients are all statistically insignificant.

[Insert Table 5]

The second strategy that we adopt is to use the instrumental variable (IV) method. Although it is intuitively appealing, the most challenging issue is to find the appropriate instrument. However, following Hausman and Taylor (1981), we can use lagged values of potentially endogenous variables as instruments.¹⁵ We then use a panel GMM estimation method, as in Choi (2010). We use the ICT variables, per capita GDP and population, all lagged by one period, as the instruments. As shown in Table 5, the estimated coefficients for IDI are positive and statistically significant for exports of three items and imports of five items. Like the baseline case, the coefficient estimates are positive and significant for both exports and imports of transportation, exports of royalty and license fees, and imports of construction,

¹² Clarke and Wallsten (2006) use a country’s regulation of data services as an instrument for Internet hosts in order to control for endogeneity. In contrast, Vemuri and Siddiqi (2009) use instrumental variable approach of Hausman and Taylor (2009). We also use a similar approach.

¹³ Freund and Weinhold (2004) use 1-year lag in one of their specifications.

¹⁴ For comparison, we reproduce the coefficient estimates of the baseline model in the first row.

¹⁵ Vemuri and Siddiqi (2009) use this approach.

telecommunication services, and travel. We also conduct Hansen's J test for the validity of the instruments: the high p -values indicate that the instruments are valid. However, we do not report these test results.

Finally, there are additional variables may potentially affect trade. We consider two additional variables: the logarithmic value of the rest of the world (ROW) GDP and the logarithm of average tariff rates.¹⁶ An increase in the ROW GDP creates demand for exports from a country. The effect on imports is not quite clear. While economic growth in the rest of the world increases the supply of imports into a country, growth and higher standard of living in the rest of the world may crowd out some of these imports and the net effect is not clear. Lower tariff rates reflect trade openness and are expected to have a direct positive effect on imports and an indirect positive effect on exports. As imports become cheaper, a country may increase imports of capital goods that enhance its ability to export. The results reported in Table 4 indicate that all coefficients that are significant remain significant. In addition, the coefficient of important of financial services became significant, although it is statically insignificant in the baseline model.

Overall, the results from these sensitivity check indicate that the significant positive effects of ICT development on the exports of 'royalty and license fees' and 'transportation' as well as on the imports of construction, telecommunication, transportation, and travel are robust across a number of different model specifications and estimation methods.

5. Concluding Remarks

¹⁶ We considered some other control variables such as real exchange rate and foreign direct investment (FDI) but neither of those turned out to be significant determinants of exports and imports of these individual items. Therefore we do not include them.

Previous studies have shown that the unprecedented advances in information and communications technology (ICT) have had positive and significant impact on trade, particularly on trade in services. However, this impact may vary across various service categories, depending on the extent to which ICT is used by a particular service. This paper empirically examines the impact of ICT on exports and imports of ten service categories using panel data from 49 countries including both advanced and emerging market economies for the period between 2000 and 2010. We combine seven different ICT variables to construct a comprehensive ICT development indicator (IDI) that captures the access, use, and capability aspects of the technology. Our results indicate that ICT development has significant positive impact on both exports and imports of transportation, travel and other business services. Furthermore, it has significant positive effects on the exports of 'financial services' and 'royalties and license fees' as well as the imports of construction, insurance and telecommunication services. When we estimate the model separately for advanced (AEs) and emerging market economies (EMEs), most of the significant impact are found among the EMEs. In addition, the significant positive effects of ICT development on the exports of 'royalty and license fees' and 'transportation', and on the imports of construction, telecommunication, transportation, and travel are robust across a number of different model specifications and estimation methods.

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Table 1 Summary statistics of the major variables

Variables	Mean				Standard Deviation			
	Overall	Min		Max	Overall	Min		Max
<i>Export</i>								
Audio-Visual and related services	18.17	13.29 (BGD)		23.03 (USA)	0.63	0.14 (USA)		1.26 (GRC)
Computer services	20.21	16.35 (BGD)		24.15 (IND)	0.73	0.10 (GBR)		1.76 (PHL)
Construction	19.32	14.74 (BGD)		22.90 (DEU)	0.59	0.10 (IDN)		1.46 (BGD)
Financial services	19.47	14.19 (ARG)		24.45 (GBR)	0.59	0.13 (MAR)		1.16 (IND)
Insurance services	18.61	10.57 (COL)		22.75 (IRL)	0.64	0.24 (IRN)		2.07 (CZE)
Other business services export	21.96	18.36 (BGD)		24.71 (DEU)	0.39	0.07 (MYS)		0.66 (LVA)
Royalties and license fees	18.74	11.47 (BGD)		24.80 (USA)	0.75	0.24 (MEX)		1.80 (ROM)
Telecommunication services	19.91	17.73 (LVA)		22.79 (GBR)	0.54	0.05 (FRA)		1.73 (BRA)
Transportation	22.03	18.08 (BGD)		24.57 (USA)	0.40	0.11 (PAK)		0.84 (HUN)
Travel	22.19	17.68 (BGD)		25.27 (USA)	0.37	0.08 (BGD)		0.70 (LVA)
<i>Import</i>								
Audio-Visual and related services	18.45	11.48 (BGD)		22.02 (DEU)	0.62	0.10 (JPN)		1.54 (LTU)
Computer services	19.88	14.21 (BGD)		23.13 (DEU)	0.64	0.09 (SVN)		1.48 (ROM)
Construction	18.69	13.12 (COL)		22.65 (DEU)	0.79	0.19 (IDN)		2.60 (COL)
Financial services	19.57	16.42 (LTU)		23.18 (USA)	0.56	0.20 (USA)		1.19 (RUS)
Insurance services	19.76	14.35 (EST)		24.05 (USA)	0.51	0.10 (ISR)		1.06 (SVN)
Other business services	21.94	17.07 (IRN)		24.85 (USA)	0.49	0.06 (MAR)		1.28 (PHL)
Royalties and license fees	20.28	15.40 (BGD)		23.87 (IRL)	0.56	0.13 (IRN)		1.33 (RUS)
Telecommunication services	19.72	16.23 (BGD)		22.62 (GBR)	0.55	0.07 (KOR)		1.26 (CZE)
Transportation	22.29	19.85 (LVA)		24.84 (USA)	0.42	0.10 (USA)		0.86 (LTU)
Travel import	22.07	18.67 (BGD)		25.08 (DEU)	0.39	0.06 (USA)		0.75 (LTU)
<i>Independent variables</i>								
IDI index	4.66	1.27 (PAK)		7.38 (DNK)	0.82	0.26 (BGD)		1.23 (LTU)
Log population	17.13	14.12 (EST)		20.99 (CHN)	0.03	0.00 (JPN)		0.06 (MYS)
Log per capita GDP	8.86	6.09 (BGD)		10.59 (NOR)	0.10	0.01 (PRT)		0.32 (CHN)

Note: The code of the country that has the minimum or the maximum value of the relevant variable is in brackets.

Table 2 Average correlations between trade variables and IDI index

Services trade	Correlation coefficients	Services trade	Correlation coefficients
Audio-Visual and related services export	0.54 (-1.00, 0.98)	Audio-Visual and related services import	0.53 (-1.00, 0.98)
Computer services export	0.72 (-0.92, 0.99)	Computer services import	0.74 (-0.97, 0.99)
Construction export	0.41 (-0.84, 0.96)	Construction import	0.49 (-0.88, 0.98)
Financial services export	0.58 (-0.62, 0.97)	Financial services import	0.66 (-0.72, 0.98)
Insurance services export	0.65 (-0.86, 0.99)	Insurance services import	0.63 (-0.97, 0.98)
Other business services import	0.75 (-0.94, 0.99)	Other business services export	0.78 (-0.98, 0.99)
Royalties and license fees export	0.82 (-0.33, 0.99)	Royalties and license fees import	0.74 (-0.69, 0.98)
Telecommunication services export	0.76 (-0.95, 1.00)	Telecommunication services import	0.64 (-0.92, 0.99)
Transportation export	0.79 (-0.17, 1.00)	Transportation import	0.76 (-0.53, 0.99)
Travel export	0.72 (-0.52, 0.98)	Travel import	0.71 (-0.51, 0.98)

Table 3. ICT and services trade: Fixed effects panel estimates for all countries**Panel A: Services export**

VARIABLES	Audio-visual and related services	Computer services	Construction	Financial services	Insurance services	Other business services	Royalty and license fees	Tele-communication services	Transportation	Travel
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
IDI index	-0.0931 (0.209)	-0.125 (0.187)	-0.0590 (0.272)	0.303* (0.176)	0.114 (0.156)	0.280** (0.112)	0.402** (0.182)	0.210 (0.165)	0.261** (0.102)	0.222** (0.0942)
Log of per capita GDP	1.475** (0.674)	1.949** (0.884)	1.615** (0.684)	1.439** (0.545)	1.124** (0.557)	1.232*** (0.386)	0.297 (0.500)	0.929 (0.718)	0.955** (0.378)	0.805*** (0.273)
Log of population	-4.948* (2.530)	-0.0149 (2.272)	-4.169* (2.106)	-1.463 (1.931)	0.295 (1.780)	1.899 (1.745)	-2.377 (2.041)	-2.783 (3.459)	-0.991 (1.115)	-0.555 (1.012)
Observations	359	317	432	487	489	380	493	385	530	532
R-squared	0.403	0.788	0.427	0.503	0.422	0.777	0.503	0.523	0.749	0.662
Number of countries	37	37	44	48	49	42	48	41	49	49

Panel B: Services import

VARIABLES	Audio-visual and related services	Computer services	Construction	Financial services	Insurance services	Other business services	Royalty and license fees	Tele-communication services	Transportation	Travel
	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)
IDI index	0.267 (0.240)	-0.00379 (0.196)	0.762* (0.435)	0.172 (0.172)	0.394* (0.223)	0.219*** (0.0738)	0.202 (0.123)	0.270* (0.138)	0.147** (0.0729)	0.348** (0.131)
Log of per capita GDP	1.707*** (0.584)	0.667 (0.662)	0.827 (0.952)	1.492** (0.563)	0.368 (0.650)	0.545* (0.274)	1.264*** (0.428)	1.245* (0.653)	1.211*** (0.280)	0.945*** (0.253)
Log of population	-1.451 (2.621)	-2.991* (1.502)	0.770 (5.463)	-0.311 (2.125)	0.949 (1.668)	-0.374 (1.558)	-3.324** (1.370)	-3.010** (1.487)	-1.455 (0.914)	1.082 (1.255)
Observations	366	318	425	476	517	393	511	384	532	532
R-squared	0.369	0.752	0.239	0.570	0.461	0.780	0.714	0.663	0.744	0.628
Number of countries	37	36	44	47	49	44	49	41	49	49

Note: ***Significant at 1% level; ** significant at 5% level; * significant at 10% level. Cluster-robust standard errors are reported in parentheses.

Table 4. ICT and services trade: Fixed effects panel estimates for advanced economies and emerging market economies**Panel A: advanced economies****Services Export**

Services Exports	Audio-visual and related services	Computer services	Construction	Financial services	Insurance services	Other business services	Royalty and license fees	Tele-communication services	Transportation	Travel
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
IDI index	0.192 (0.251)	-0.134 (0.252)	0.509** (0.209)	0.223 (0.259)	0.152 (0.199)	0.107 (0.142)	0.284 (0.201)	0.0769 (0.226)	0.138 (0.0882)	-0.0508 (0.0941)
Observations	180	161	195	206	213	188	221	164	229	229
R-squared	0.428	0.836	0.361	0.648	0.598	0.882	0.792	0.720	0.830	0.828
Number of countries	18	18	20	20	21	19	21	18	21	21

Services Import

Services Imports	Audio-visual and related services	Computer services	Construction	Financial services	Insurance services	Other business services	Royalty and license fees	Tele-communication services	Transportation	Travel
	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)
IDI index	-0.238 (0.245)	-0.198 (0.206)	0.160 (0.337)	0.0147 (0.164)	0.0296 (0.200)	0.0551 (0.0982)	0.113 (0.155)	0.265 (0.224)	-0.103 (0.0945)	-0.0159 (0.109)
Observations	184	156	182	206	219	182	221	164	229	229
R-squared	0.453	0.864	0.254	0.771	0.549	0.889	0.783	0.744	0.832	0.758
Number of countries	18	17	18	20	21	19	21	18	21	21

Table 5 (contd)**Panel B: Emerging market economies****Services Export**

Variables	Audio-visual and related services	Computer services	Construction	Financial services	Insurance services	Other business services	Royalty and license fees	Tele-communication services	Transportation	Travel
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
IDI index	-0.568 (0.402)	-0.0321 (0.285)	-0.848** (0.303)	0.0258 (0.257)	-0.179 (0.270)	0.340** (0.127)	0.554 (0.346)	0.605 (0.361)	0.311* (0.175)	0.316* (0.154)
Observations	179	156	237	281	276	192	272	221	301	303
R-squared	0.420	0.806	0.550	0.516	0.402	0.736	0.394	0.509	0.722	0.625
Number of countries	19	19	24	28	28	23	27	23	28	28

Services Import

Variables	Audio-visual and related services	Computer services	Construction	Financial services	Insurance services	Other business services	Royalty and license fees	Tele-communication services	Transportation	Travel
	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)
IDI index	0.336 (0.480)	-0.0714 (0.313)	1.191* (0.630)	-0.0496 (0.291)	0.689* (0.379)	0.274* (0.139)	0.0505 (0.196)	0.425* (0.213)	0.249** (0.0946)	0.472** (0.188)
Observations	182	162	243	270	298	211	290	220	303	303
R-squared	0.413	0.712	0.291	0.564	0.447	0.733	0.697	0.670	0.732	0.611
Number of countries	19	19	26	27	28	25	28	23	28	28

Note: ***Significant at 1% level; ** significant at 5% level; * significant at 10% level. Cluster-robust standard errors are reported in parentheses.

Table 5. Sensitivity analysis results**Panel A: Services export**

Model specification	Audio-visual and related services	Computer services	Construction	Financial services	Insurance services	Other business services	Royalty and license fees	Tele-communication services	Transportation	Travel
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Baseline Model	-0.0931 (0.209)	-0.125 (0.187)	-0.0590 (0.272)	0.303* (0.176)	0.114 (0.156)	0.280** (0.112)	0.402** (0.182)	0.210 (0.165)	0.261** (0.102)	0.222** (0.0942)
Lagged IDI variable	0.0912 (0.191)	-0.129 (0.193)	0.0912 (0.269)	0.352** (0.167)	0.176 (0.147)	0.208 (0.126)	0.456*** (0.154)	0.278 (0.197)	0.298*** (0.0955)	0.226** (0.0930)
IV GMM	-0.213 (0.302)	-0.254 (0.297)	0.589** (0.231)	0.136 (0.302)	-0.426 (0.315)	0.175 (0.328)	0.747** (0.306)	0.244 (0.227)	0.384* (0.224)	-0.0303 (0.242)
Additional variables	-0.226 (0.247)	-0.130 (0.181)	-0.120 (0.352)	0.434** (0.188)	0.195 (0.180)	0.198* (0.105)	0.476** (0.222)	0.183 (0.165)	0.281** (0.113)	0.233** (0.0954)

Panel B: Services import

Model specification	Audio-visual and related services	Computer services	Construction	Financial services	Insurance services	Other business services	Royalty and license fees	Tele-communication services	Transportation	Travel
	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)
Baseline Model	0.267 (0.240)	-0.00379 (0.196)	0.762* (0.435)	0.172 (0.172)	0.394* (0.223)	0.219*** (0.0738)	0.202 (0.123)	0.270* (0.138)	0.147** (0.0729)	0.348** (0.131)
Lagged IDI variable	0.366 (0.225)	0.0601 (0.197)	0.820** (0.396)	0.252 (0.158)	0.402* (0.223)	0.235*** (0.0734)	0.186 (0.127)	0.273* (0.158)	0.168** (0.0708)	0.373*** (0.117)
IV GMM	-0.203 (0.321)	0.141 (0.360)	1.288*** (0.281)	0.577 (0.379)	-0.280 (0.283)	0.413 (0.324)	0.285 (0.285)	0.461** (0.229)	0.372** (0.188)	0.357** (0.170)
Additional variables	0.277 (0.258)	0.00423 (0.220)	0.834* (0.472)	0.334* (0.171)	0.348* (0.190)	0.235*** (0.0856)	0.177 (0.122)	0.256* (0.140)	0.145* (0.0834)	0.420*** (0.137)

Note: ***Significant at 1% level; ** significant at 5% level; * significant at 10% level. Cluster-robust standard errors are reported in parentheses.

Table A.1 Services trade items and WTO definitions

	Trade Items	WTO definition
1	Audio-visual and related services	Includes services and fees related to the production of motion pictures, radio and television programmes, and musical recordings.
2	Computer services	Includes hardware and software related services and data processing services.
3	Construction	Covers work performed on construction projects and installation by employees of an enterprise in locations outside the territory of the enterprise.
4	Financial services	Includes financial intermediation and auxiliary services provided by banks, stock exchanges, factoring enterprises, credit card enterprises, and other enterprises.
5	Insurance services	Covers the provision of various types of insurance to non-residents by resident insurance enterprises, and vice versa, for example, freight insurance, direct insurance (e.g. life) and reinsurance.
6	Other business services	Comprises trade-related services, operational leasing (rentals), and miscellaneous business, professional and technical services such as legal, accounting, management consulting, public relations services, advertising, market research and public opinion polling, research and development services, architectural, engineering, and other technical services, agricultural, mining and on-site processing.
7	Royalty and license fees	Covers payments and receipts for the use of intangible non-financial assets and proprietary rights, such as patents, copyrights, trademarks, industrial processes, and franchises.
8	Telecommunication services	Encompasses the transmission of sound, images or other information by telephone, telex, telegram, radio and television cable and broadcasting, satellite, electronic mail, facsimile services etc., including business network services, teleconferencing and support services. It does not include the value of the information transported. Also included are cellular telephone services, Internet backbone services and on-line access services, including provision of access to the Internet.
9	Transportation	Covers sea, air and other including land, internal waterway, space and pipeline transport services that are performed by residents of one economy for those of another, and that involve the carriage of passengers, the movement of goods (freight), rentals (charters) of carriers with crew, and related supporting and auxiliary services.
10	Travel	Includes goods and services acquired by personal travelers, for health, education or other purposes, and by business travelers.

Table A.2 Composition of IDI

Variables	Weight in sub-group	Weight of sub-group
<i>ICT Access</i>		
(1) fixed-telephone lines per 100 inhabitants	33%	40%
(2) mobile-cellular telephone subscriptions per 100 inhabitants	33%	
(3) international Internet bandwidth (bit/s) per Internet user	33%	
<i>ICT Use</i>		
(4) percentage of individuals using the Internet	50%	40%
(5) fixed (wired)-broadband Internet subscriptions per 100 inhabitants	50%	
<i>ICT Skills</i>		
(6) secondary gross enrollment ratio	50%	20%
(7) tertiary gross enrollment ratio	50%	

Table A.3 List of countries and country codes

Advanced economies		Emerging market economies			
Country	Country code	Country	Country code	Country	Country code
Australia	AUS	Argentina	ARG	Korea, Republic of	KOR
Belgium	BEL	Bangladesh	BGD	Latvia	LVA
Canada	CAN	Brazil	BRA	Lithuania	LTU
Denmark	DNK	Bulgaria	BGR	Malaysia	MYS
Finland	FIN	Chile	CHL	Mexico	MEX
France	FRA	China	CHN	Morocco	MAR
Germany	DEU	Colombia	COL	Pakistan	PAK
Greece	GRC	Czech Republic	CZE	Peru	PER
Ireland	IRL	Egypt	EGY	Philippines	PHL
Israel	ISR	Estonia	EST	Romania	ROM
Italy	ITA	Hungary	HUN	Russian Federation	RUS
Japan	JPN	India	IND	Slovenia	SVN
Netherlands	NLD	Indonesia	IDN	Thailand	THA
New Zealand	NZL	Iran, Islamic Rep. of	IRN	Turkey	TUR
Norway	NOR				
Portugal	PRT				
Spain	ESP				
Sweden	SWE				
Switzerland	CHE				
United Kingdom	GBR				
USA	USA				

Table A.4 Variables Description

Variable name	Variable description	Years available	Data source
Services trade	Export and import of services in ten categories, in current US\$	2000-2010	WTO database
IDI index	Information and Communication Technology (ICT) development Index	2000-2010	International Telecommunication Union
GDP per capita	GDP per capita in constant 2000 US\$	2000-2010	World Development Indicators (WDI)
Population	Total population	2000-2010	World Development Indicators (WDI)
Exchange rate	Nominal official exchange rate	2000-2010	World Development Indicators (WDI)
Services goods price index		2000-2010	U.S. Bureau of Economic Analysis
World GDP	World GDP in constant 2000 US\$	2000-2010	World Development Indicators (WDI)
Local GDP	Local GDP in constant 2000 US\$	2000-2010	World Development Indicators (WDI)
Tariffs	Weighted average of tariff rate in percentages, applied on all products	2000-2010	World Development Indicators (WDI)