Institutions and Comparative Advantage in Services Trade

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Abstract

Studies have highlighted the role of human capital and good economic institutions in establishing comparative advantage in trade in complex institutions-intensive goods. We show that the effect of institutions on comparative advantage in services trade is quite different: in fact, countries with bad institutions rely significantly more on services export. More specifically, as quality of institutions deteriorates, the share of information technology sector (ICT) services export in total ICT export increases significantly and countries with worse institutions get a substantial comparative advantage in the provision of ICT services.

(JEL: F10, F14)

1. Introduction

Human capital and economic institutions play a crucial role in the determination of comparative advantage in complex, institutions-intensive goods.[1] However as the role of services increases the question rises whether weak institutions have similarly dampening impact on comparative advantage in high-value complex services and,

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1. See the comprehensive review of the literature and discussion in Nunn and Trefler (2014).

relatedly, growth and development.[2] This paper studies the importance of institutions in determination of comparative advantage in services production relative to goods.

Although many determinants of trade patterns, including institutions, may be similar for goods and services,[3] it is the relative importance that determines the comparative advantage patterns. We hypothesize that the causal relationship between institutions and comparative advantage in services exports can starkly differ from goods. Indeed, this would be the case if services provision relies less on physical infrastructure, capital investments, physical inputs availability that are highly affected by institutional quality.

In order to isolate the relative importance of institutions on services versus goods we focus on one industry that is comparably important, innovative, human capital intensive and high-value in both goods and services provision. Comparison of total goods and services across all sectors would conflate too many differences that exist between goods and services, including human capital intensity, geographical constraints and composition in terms of complexity of provision. Thus we analyze the determination of comparative advantage in services relative to goods by focusing on the information and communications technology (ICT) sector. Both ICT goods and services are intensive in human capital and thus present a good comparison to study differences between goods and services provision.

ICT services are significantly less intensive in physical capital and demands for infrastructure than ICT goods. A number of statistical works demonstrated that capital intensity of services production is significantly lower than that of goods, and in particular, in the ICT sector. For example, Office of National Statistics in UK estimated that capital intensity, measured by net capital stock to output ratio, in Scientific and Technical Services is about 0.5, while in manufacturing it is much

2. See, for example, Francois and Hoekman (2010) on the linkages between services trade and potential for growth and development.

3. See literature review in section 2 for a discussion on the determinants of foreign direct investment and trade patterns goods and services.

higher - 1.5.[4] Within ICT, capital expenditures to sales is lowest in IT services and highest in semiconductors (GMT Research, 2020). Sales to capital ratio is among the highest in "Computer Service" industry and much higher than in any manufacturing industry (Damodaran, 2020). The effects of variables related to physical geography (distance, contiguity and being landlocked) are also significantly lower for services trade than for goods (Lennon, 2009).

We test our hypothesis by estimating the role of institutions on comparative advantage in ICT goods and ICT services. Our panel data on sectoral exports of goods and services, institutional indicators and human capital covers the period between 2000 and 2016. Controlling for year and country fixed effects, we estimate the impact of human capital and average institutional quality on revealed comparative advantage in goods and services.

We find that countries with weak institutions are more likely to have a revealed comparative advantage (RCA) in ICT services exports relative to ICT goods exports. Specifically, standard deviation improvement in institutional quality reduces the probability of having revealed comparative advantage in ICT services by around $0.24 - 0.26$. In addition, standard deviation improvement in institutions also reduces the value of RCA index by $40 - 64\%$.

Our findings provide a novel view on the opportunities for trade and growth of countries with weak institutions. High-technology services provision can provide opportunities for individuals with high human capital in developing countries, reduce incentives for brain-drain and increase return to education in countries with scarce human capital. Moreover, institutional barriers can drive the available human capital from high-technology manufacturing to the provision of human capital-intensive services exports as these are likely to be less intensive in institutions.

The paper continues as follows. Section 2 presents literature review, followed by data description in Section 3. Section 4 presents our empirical strategy. Our main

4. Figure 9 from bulletin "Capital stocks and fixed capital consumption, UK: 2016". Statistical bulletin. Office of National Statistics, UK.

results are discussed in Section 5, extensions and robustness tests - in Section 6. Finally, Section 7 concludes.

2. Literature Review

There is a substantive research on the relationship between institutions and the patterns of international trade in goods concluding that weak institutions have negative impact on the trade value and export complexity. Anderson and Marcouiller (2002) find that bad institutions significantly constrain import. They argue that imperfect contract enforcement, high level of corruption and in general bad qualities of institutions act as hidden tax on trade. They develop a structural model, and after fitting it to data, find that trade expands dramatically when it is supported by strong institutions – specifically, by a legal system capable of enforcing contracts. Berkowitz et al. (2006) complement this research and show empirically how good institutions located in the exporter's country enhance international trade. They are the first to argue that complex products whose characteristics are difficult to fully specify in a contract are likely to be exported from countries with better institutions. Francois and Manchin (2013) analyzes two sides of the market (exporter and importer). They show that low institutions and quality of infrastructure in the developing country may affect market access for export from the developed country. The conclusion is that policy emphasis on developing country market access that does not provide enough support for trade facilitation may be misplaced.

Levchenko (2007) takes a deeper look into the hold-up problem. He argues that the main implication of bad institutions is impossibility to enforce contracts. If the parties cannot enforce contracts, firm-specific relationships are subject to a hold-up problem, i.e., the party that had less relationship-specific investment can threaten to stop the project, and, therefore, obtains a dis-proportionally high bargaining power in renegotiations. This leads to lower than optimal investment in the creation of complex products. This results in comparative advantage of complex goods production in countries that have good institutions. The theory was confirmed by Nunn (2007) who created an index of contractual intensity of industries and

showed that countries with good contract enforcement specialize in the production of goods for which relationship-specific investments are most important. Moreover, the paper finds that contractual enforcement is more important than physical capital or skilled labor. Li et al. (2012) and Feenstra et al. (2012) confirm these findings for China using firm level data, while Ma et al. (2010) finds similar evidence on firm-level data for developing and transition countries. For more extensive review of comparative advantage provided by domestic institutions see Nunn and Trefler (2014).

Recent study by Araujo et al. (2016) suggests that the impact of institutions is more complex than just a drop in export value. The authors develop a model of institutions and export dynamics. The model's predictions are then taken to the firm-level data from Belgium. Key finding is that, although firms enter markets with better contracting institutions with larger volumes, conditional on continued exports, growth of exports is higher in markets with weaker institutions.

The literature says very little about determining comparative advantage in services trade however there are some studies discussing the complementarity between goods and services. Ariu (2016) compares trade in goods with trade in services. Using a dataset from the National Bank of Belgium on export and import transactions of Belgian firms, the paper's results suggest that trade in services and trade in goods are complementary. Firms that specialize on both trade in services and trade in goods represent 10% of all firms but more than 30% of total trade. Beverelli et al. (2017) find that liberalization of services trade restriction improves manufacturing productivity. However, notably, these productivity gains are larger for countries with high institutional quality. Ramasamy and Yeung (2010) study determinants that attract FDI in services into a country in panel settings for OECD countries. Their conclusion, however, is that determinants for trade in services are similar to determinants for trade in goods, and, therefore, no new theories are needed to explain trade pattern.

Few studies analyze the effect of institutions on the pattern of the service trade. Álvarez et al. (2018) look at the impact of institutions on bilateral trade. The paper finds that institutions are more important determinant for agricultural and raw goods trade than for manufacturing and services trade. Crozet et al. (2016) take firm-level

data to analyze the impact of domestic regulation on international trade in services. They take OECD measure of domestic regulation and detailed French firm-level data and find that the firms are less likely to export to highly regulated markets and that the value of export decreases with the level of regulation in the destination market. Comprehensive analysis of developing countries and service export is provided in Goswami et al. (2012). They analyze the complex nature of reforms and policy making in the service sector that has been recently done in a number of developing countries and how it affected the service trade industry.

De Jong and Bogmans (2011) studies how international trade is affected by inefficient customs and corruption. They find that while in general corruption hampers international trade, bribes at customs offices can enhance it especially with countries with inefficient customs. Another paper that analyses the effect of corruption international trade to FDI is Dutta et al. (2017). They specifically compare the effect of corruption and the effect of human capital. They find that improvement in corruption given much more of an advantage comparing to an equivalent improvement in human capital.

3. Data and Descriptive Statistics

Data description

Data for ICT goods exports, total goods exports, GDP, GDP per capita, and additional controls used robustness tests, come from the World Bank's World Development Indicators (WDI). Appendix section A1 presents descriptive statistics for our main variables and section A4 describes additional controls variables used in the robustness.

Institutional data is available at World Governance Indicators (WGI) dataset from World Bank. The indicators are provided along six dimensions of institutions: 1) Voice and Accountability, 2) Political Stability and Absence of Violence, 3) Government Effectiveness, 4) Regulatory Quality, 5) Rule of Law and 6) Control of Corruption. The indicators come from a large number of surveys of individuals and firms in developing and developed countries. According to WGI, institutional variables are

are based on over 30 individual data sources produced by a variety of survey institutes, think tanks, non-governmental organizations, international organizations, and private sector firms. They are scaled and transformed so that the values are approximately between -2 and 2. The description of each indicator is available in section A2. Unless otherwise specified, the measure of institutions is obtained by taking a simple mean of the six WGI institutional indicators.

Data on services exports comes from the International Trade Center TradeMap platform and covers years 2000-2018. We are specifically interested in computer and information services which is defined in the Balance of Payments Manual to include development storage of databases, data-processing, hardware consultancy, software development, computer repairs, etc. Complete definition of computer and information services is presented in A3. The definition also includes information services such as provision of news and photographs that are less interesting for our analysis. However as computer services appear separately from information services only from around 2005 and data availability is lower.[5] We include computer services separately with a shorter panel in the robustness analysis.

Some countries report zero ICT services export, and this is distinct from non-reporting, i.e. missing observations. Data on average years of schooling is available only for years 2000, 2005 and 2010. Definition and construction of variables 'RCA in ICT services' and 'Probability of RCA' is provided in section 4.

As a measure of human capital we use average schooling years for population aged between 25 and 50 years. The data is available from Barro and Lee (2013) dataset on schooling and educational attainment.

Table 1 shows that higher human capital level has similarly positive impact on exports of ICT goods and ICT services, while institutional quality has different impact on goods and services. The table presents simple exploratory regressions that regress exports of ICT goods (columns (1) and (2)) and ICT services (columns (3) and (4)) on institutional quality, human capital, GDP and GDP per capita. In the columns (1) and

5. Countries are required to report computer services separately from information services only after BPM6 system methodology was introduced, which happened in 2005.

TABLE 1
Log of ICT goods services

	(1) Goods	(2) Goods	(3) Services	(4) Services
Average Schooling	0.19**	0.18**	0.27***	0.26***
	(0.070)	(0.058)	(0.068)	(0.071)
Institutions	1.50***	1.89***	0.18	0.67+
	(0.23)	(0.25)	(0.22)	(0.36)
Log GDP	1.37***	1.37***	0.91***	0.92***
	(0.099)	(0.100)	(0.10)	(0.12)
Log GDP PC	-0.34*	-0.59**	0.51**	0.18
	(0.17)	(0.18)	(0.18)	(0.28)
Year FEs	No	Yes	No	Yes
Observations	343	343	268	268
R^2	0.78	0.78	0.75	0.76

Standard errors in parentheses clustered at country level
$^{+}$ $p < 0.10$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

(2) we present the results of panel random effect regression of ICT goods export to schooling institutions, GDP and GDP per capita with and without year fixed effects. In columns (3) and (4) we present the results of panel random effect regression of ICT services to the same regressors. We can see that in both cases schooling is significant, while institutions are significant only for ICT goods export. Further in the paper we look into the difference between ICT goods and ICT services exports.

4. Empirical Strategy

We estimate the impact of institutions on revealed comparative advantage in ICT services over goods in total ICT exports. The identification relies on the notion of revealed comparative advantage. Here we assess the role of institutions on the probability of having a comparative advantage in ICT services over goods. That is, a country has a revealed comparative advantage in ICT services if share of ICT services

in exports of ICT goods and services is higher than for world average. The revealed comparative advantage index is calculated as follows:[6]

$$RCA_{it} = \frac{E^s_{it}/(E^s_{it} + E^g_{it})}{\sum\limits_i E^s_{it} / \sum\limits_i (E^s_{it} + E^g_{it})} \tag{1}$$

A country i has a revealed comparative advantage in services exports of ICT in year t is greater than 1.

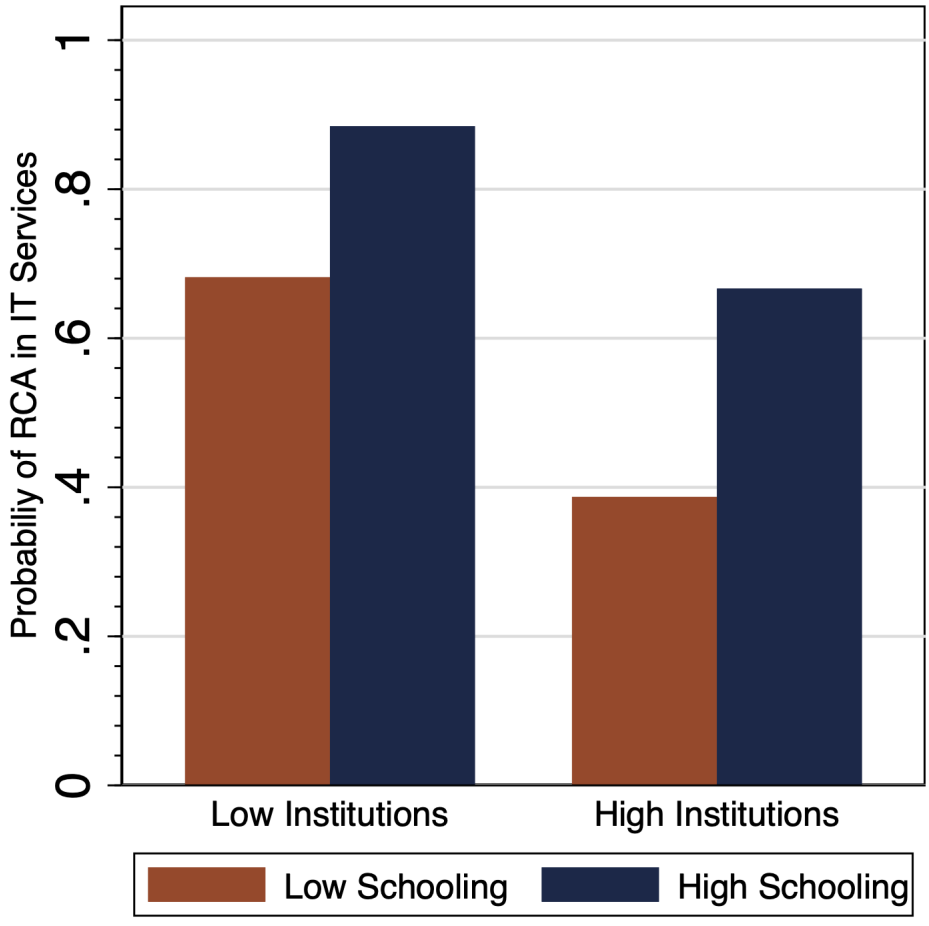
Figure 1 presents the average probability of having a revealed comparative advantage in services over goods in ICT exports.[7] The cross-sectional figure groups low and high institutions (relative to median country), and country-year observations into low and high schooling (relative to median country). Countries with low institutions and countries with high schooling have higher probability of revealed comparative advantage in services. Given schooling, probability of having a revealed comparative advantage is higher for countries with low institutions. Given the institutional quality, probability of having a revealed comparative advantage is higher for countries with high schooling. Put together, highest probability of having a comparative advantage in services is for countries with low institutions and high schooling at about 0.8.

Large number of the observations within the low institutions and high schooling group come from transition economies, which are known to have high human capital and low institutional indicators. Although human capital and institutions are strongly correlated, institutional indicators, such as corruption, rule of law, political stability, etc., of transition countries are still below other developing countries. These economies, endowed with high human capital and low institutional indicators, demonstrate high ICT services (e.g., software development) provisions and low ICT goods exports. Until recently Belarus presented a great example of countries like this. ICT services exports of Belarus, a country with significant institutional barriers for private market goods production but strong human capital, had been thriving: over

6. Following Balassa (1965).

7. Section 4 defines in detail revealed comparative advantage in services in ICT exports.

FIGURE 1
RCA in ICT Services, by education and institutions



the 10 years from 2008 to 2017 the growth of ICT service is more than 8 times (from 150M USD in 2008 to 1.2B USD in 2017). As of early 2020, Belarus was one of the world leaders in ICT service exports per capita. At the same time, ICT goods exports had not been growing even close to the level of ICT services export. Over the same time period ICT had grown only about 1.3 times: from $105 million of ICT goods exports in 2008 to $140 million USD in 2016.

We run probit regressions to assess the impact of institutional quality on the probability of having a revealed comparative advantage in services in exports of ICT goods and services.[8] Following Wooldridge (2010) we apply the Mundlak (1978) approach to panel data with fixed effects for probit models due to inconsistency of probit estimator in a model of panel with fixed effects. The specification for the underlying latent variable is as follows:

$$Y^*_{it} = \alpha I_{it} + \boldsymbol{\beta X_{it}} + \lambda \overline{I}_{it} + \boldsymbol{\theta} \overline{\boldsymbol{X}}_{\boldsymbol{it}} + \gamma_t + \varepsilon_{it}, \tag{2}$$

where Y^*_{it} denotes whether country i has revealed comparative advantage in ICT services in year t, controls I_{it} denote quality of institutions, $\boldsymbol{X_{it}}$ - vector of controls, γ_t denote the year fixed effects, $\overline{I}_{it}$ and $\overline{X}_{it}$ are country averages of instituions and all control variables that are proxying country-fixed effects in the Mundlak (1978) approach, and ε_{it} - error term.

We choose the probit model as we would like to test the role of institutions on having a comparative advantage in services or not. In this quest we are not as interested in the assessment of the specific value of RCA. However one might consider that the factors that determine the presence or absence of comparative advantage, might also affect the intensity of the revealed comparative advantage. To address this, we estimate an alternative specification where the dependent variable is the natural logarithm of RCA as an extension of our main approach. As in this specification the dependent variable is continuous, it is estimated using a panel OLS with fixed effects.

All standard errors are clustered at the country level.

5. Results

Table 2 presents marginal effects of Probit regressions where the dependent variable is the probability to have an RCA in services in ICT exports. Improvement in institutions by one, on average, leads to a decrease in probability to have RCA in ICT

8. Results are similar for a linear probability model, see Table 7.

services exports by $0.26 - 0.28$, and the effect is highly statistically significant in all specifications. The effect is economically important as it means that one standard deviation increase of institutional quality reduces the probability of RCA in ICT services by $0.24 - 0.26$.[9] GDP and GDP per capita have expected signs, although the coefficients are not precisely estimated. Larger economies are less likely to have an RCA in ICT services, this is in line with trade theory as large countries have high domestic demand and factor supply are more likely to goods attract production with fixed costs, while services provision might be less reliant on fixed costs. Countries with higher income per capita are more likely to have an RCA in ICT services.

TABLE 2
Probability of RCA in ICT services, marginal effects

	(1) Pr RCA	(2) Pr RCA	(3) Pr RCA	(4) Pr RCA	(5) Pr RCA
Institutions	-0.27***	-0.26***	-0.28***	-0.27***	-0.43^{+}
	(0.068)	(0.072)	(0.069)	(0.068)	(0.23)
Log GDP	-0.028	-0.29*	-0.31*	-0.24*	-0.53
	(0.14)	(0.15)	(0.12)	(0.12)	(0.49)
Log GDP PC	0.082	0.26^{+}	0.28*	0.20	0.54
	(0.15)	(0.15)	(0.13)	(0.13)	(0.48)
Schooling					-0.18*
					(0.077)
Year FEs	No	Yes	Yes	Yes	Yes
Sample[1]	$X_{ICT} \geq 1M$	$X_{ICT} \geq 1M$	$X_{ICT} > 0$	All	$X_{ICT} > 0$
Observations	1295	1295	1559	1574	252

Standard errors in parentheses clustered at country level.
$^{+}$ $p < 0.10$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$
All regressions include country averages over time for all controls proxying fixed effects following Mundlak approach.
[1] Regressions with sample restriction $X_{ICT} \geq 1M$ and $X_{ICT} > 0$ include countries with total ICT exports of at least USD 1 million and non-zero exports of ICT services and ICT goods, respectively. Discussion of 2 in section 5 provides more details.

All estimations include year fixed except for column (1), and all columns include country averages of all controls that serve as analogues of country fixed effects in

9. Standard deviation of institutions variable is 0.92 – see Table A1

Mundlak (1978) approach for Probit model. Columns (1) and (2) exclude observations with very small export values: sample includes exports of at least USD 1 million of ICT services and goods. Very small values of ICT exports introduce noise in RCA variable: it is not very relevant to speak about an RCA in ICT services versus goods of a country that does not really export either. Column (3) relaxes this sampling requirement, keeping only observations with positive exports of ICT goods and services. The restriction of positive export values is further relaxed in column (4) where we include also zeros. The results are robust to the sample choice: both the coefficient and standard errors are practically unaffected.[10] Column (5) includes additional control for schooling, however the use of this control in a panel setting is difficult due to data availability only for 3 years during the sample period (2000, 2005 and 2010). Insignificant coefficient of schooling can also be seen as meaning that schooling is similarly important for both ICT goods and services.

Preferred regression is presented in column (2) and includes year fixed effects, GDP, GDP per capita and excludes observations with very small ICT exports. Improvement in institutions by one, on average, leads to a decrease in probability to have RCA in ICT services exports by 0.26 (significant at 0.1%).

Table 2 includes measure of institutional development as a mean of six WGI institutional indicators. Various institutional indicators, although correlated, represent different aspects of institutional development. Table 3 includes separate estimations with each institutional indicator.

Table 3 presents regressions analogous to preferred regression in column (2) of Table 2 separately for each individual institutional indicator instead of an average measure. First, note that all individual indicators have lower magnitude of impact than average measure of institutions, suggesting that the complex of institutional indicators are jointly relevant for comparative advantage. Corruption, government efficiency, regulatory quality, and rule of law, have comparably strong impact, both in magnitude and statistical significance. To illustrate the effect, one standard deviation

10. Furthermore, the results are unaffected if instead of USD 1 million we choose other cutoffs. For example, a cutoff of USD 200 thousand excludes bottom 5% of countries with smallest average exports of ICT services and goods.

TABLE 3
Probability of RCA in ICT services, marginal effects[1]

	(1)	(2)	(3)	(4)	(5)	(6)
Corruption	-0.14**					
	(0.048)					
Government Efficiency		-0.15**				
		(0.048)				
Political Stability			-0.0035			
			(0.027)			
Regulatory Quality				-0.17***		
				(0.052)		
Rule of Law					-0.16**	
					(0.057)	
Accountability						-0.099*
						(0.040)
Log GDP	-0.30*	-0.29+	-0.19	-0.28+	-0.28+	-0.20
	(0.15)	(0.15)	(0.15)	(0.15)	(0.15)	(0.14)
Log GDP PC	0.23	0.23	0.086	0.23	0.22	0.11
	(0.15)	(0.15)	(0.15)	(0.15)	(0.15)	(0.14)
Year FEs	Yes	Yes	Yes	Yes	Yes	Yes
Country FEs	Yes	Yes	Yes	Yes	Yes	Yes
Observations	1295	1295	1295	1295	1295	1295

Standard errors in parentheses clustered at country level.
$^{+}$ $p < 0.10$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$
[1] All regressions are analogues of regression in column 2 of Table 2 run separately for each institutional indicator instead of an average.

improvement in corruption index leads to a reduction of probability of having an RCA in ICT services by 0.14[11]. Accountability has somewhat smaller impact while political stability appears to have no significant impact on the comparative advantage.

11. Standard deviation of each of the individual institutional characteristics is about one

6. Extensions and robustness

6.1. Extension: level of comparative advantage

Our main identification strategy focuses on the probability of having a revealed comparative advantage in ICT services over goods, and thereby ignores how strong the comparative (dis-)advantage is. To assess whether and how the institutional factors also influence the intensity of comparative advantage, Table 4 presents OLS estimations with the logarithm of RCA as dependent variable.

TABLE 4
Level of RCA in ICT services (log)

	(1)	(2)	(3)	(4)
Institutions	-0.43^{+}	-0.43^{+}	-0.70*	-0.80
	(0.24)	(0.25)	(0.32)	(0.53)
Log GDP	-0.33	-0.74	-0.49	-3.42
	(0.95)	(1.12)	(1.51)	(2.20)
Log GDP PC	0.42	0.72	0.31	3.28
	(0.99)	(1.14)	(1.53)	(2.11)
Schooling				-0.024
				(0.23)
Year FEs	No	Yes	Yes	Yes
Country FEs	Yes	Yes	Yes	Yes
Sample[1]	$X_{ICT} \geq 1M$	$X_{ICT} \geq 1M$	All	$X_{ICT} > 0$
Observations	1295	1295	1559	252
R^2	0.007	0.043	0.035	0.086
Adjusted R^2	0.005	0.029	0.023	0.064

Standard errors in parentheses clustered at country level.
$^{+}$ $p < 0.10$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$
[1] Regressions with sample restriction $X_{ICT} \geq 1M$ and $X_{ICT} > 0$ include countries with total ICT exports of at least USD 1 million and non-zero exports of ICT services and ICT goods, respectively. Discussion of 2 in section 5 provides more details.

Overall findings remain unchanged, although the statistical significance of estimated coefficients is reduced relative to those in Table 2. Improvement in institutions by one unit is associated with a decrease in RCA in ICT services by

$43 - 70\%$ across specifications.[12] As an example, one standard deviation increase in institutional quality corresponds to about 40% reduction in RCA index in the preferred regression in column (2).

Table 5 is analogous to Table 3 but with the dependent variable the logarithm of RCA. The corruption index has both the largest magnitude of the impact on the level of RCA with the coefficient -0.36 as well as the only institutions indicator that has statistically significant impact.

6.2. Robustness: alternative definition of ICT services

This subsection provides a robustness test to our baseline definition of ICT services. The baseline definition of ICT services includes both computer and information services. This is necessary as before 2005 the countries were reporting services data under a different classification that combines the two. The alternative definition that we consider in this subsection includes only computer services. This is associated with shorter panel as only observations reported in newer BPM6 classification can be included.

Table 6 provides the results of the alternative definition of ICT services that includes only computer services. All specifications in columns (1) to (6) are analoguous to Table 2. The number of observations is reduced by about 30% due to the shorter sample period when computer services trade is reported. The findings are very similar to those from Table 2: unit improvement in institutional quality reduces the probability of having an RCA in ICT services by $0.24 - 0.27$. Note that there is no analogue of column (2) of Table 2 that includes human capital as a control due to the data availability: there are only 145 observations where both computer services and human capital are reported.

TABLE 5
Level of RCA in ICT services (log)[1]

	(1)	(2)	(3)	(4)	(5)	(6)
Corruption	-0.36*					
	(0.16)					
Government Efficiency		-0.18				
		(0.25)				
Political Stability			-0.14			
			(0.12)			
Regulatory Quality				-0.059		
				(0.21)		
Rule of Law					0.0048	
					(0.21)	
Accontability						-0.24
						(0.18)
Log GDP	-0.79	-0.77	-0.58	-0.65	-0.63	-0.60
	(1.10)	(1.17)	(1.12)	(1.14)	(1.13)	(1.12)
Log GDP PC	0.74	0.70	0.52	0.57	0.53	0.52
	(1.11)	(1.20)	(1.13)	(1.17)	(1.14)	(1.13)
Year FEs	Yes	Yes	Yes	Yes	Yes	Yes
Country FEs	Yes	Yes	Yes	Yes	Yes	Yes
Observations	1295	1295	1295	1295	1295	1295
R^2	0.051	0.042	0.043	0.039	0.038	0.045
Adjusted R^2	0.036	0.027	0.028	0.023	0.022	0.030

Standard errors in parentheses clustered at country level.
$^{+}$ $p < 0.10$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$
[1] All regressions are analogues of regression in column 2 of Table 2 run separately for each institutional indicator instead of an average.

6.3. Robustness: linear probability model

Our baseline results in Table 2 are qualitatively unaffected when using linear probability model estimated with panel OLS with fixed effects (Table 7). Estimated coefficients of institutions are close to the baselines coefficients and are in the range of $0.24 - 0.31$ in columns (1)-(4), and remain statistically significant, albeit the at

12. Since schooling is available only for three years, quantitative predictions of column (6) are less relevant than its qualitative predictions

TABLE 6
Probability of RCA in ICT services, marginal effects

	(1) Pr RCA	(2) Pr RCA	(3) Pr RCA	(4) Pr RCA
Institutions	-0.24***	-0.25**	-0.27***	-0.27***
	(0.068)	(0.078)	(0.078)	(0.078)
Log GDP	-0.10	-0.14	-0.24	-0.24
	(0.14)	(0.16)	(0.17)	(0.17)
Log GDP PC	0.12	0.10	0.26	0.26
	(0.15)	(0.18)	(0.19)	(0.19)
Year FEs	No	Yes	Yes	Yes
Sample[1]	$X_{ICT} \geq 1M$	$X_{ICT} \geq 1M$	$X_{ICT} > 0$	All
Observations	885	885	1029	1029

Standard errors in parentheses clustered at country level.
$^{+}$ $p < 0.10$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$
All regressions include country averages over time for all controls proxying fixed effects following Mundlak approach.
[1] Regressions with sample restriction $X_{ICT} \geq 1M$ and $X_{ICT} > 0$ include countries with total ICT exports of at least USD 1 million and non-zero exports of ICT services and ICT goods, respectively. Discussion of 2 in section 5 provides more details.

lower significance level. Coefficient of the column (5) is the same as in the baseline regression.

6.4. Robustness: additional regressors

This subsection provides a robustness test to our original choice of regressors. We take the baseline specification of column (2) in Table 2 and include a number of additional controls. Section A1 provides a more detailed description of all additional regressors and descriptive statistics. In all cases our main variable institutions remains significant, and quantitatively coefficients change only slightly.

Table 8 adds as controls total export of goods (log), population (log), oil rents, education expenditures, research and development (R & D) expenditure. The only statistically significant additional control is total goods exports with a negative sign but has no impact on the institutions coefficient. Education expenditure and R & D expenditure reduce the sample size by about 30% and are insignificant.

TABLE 7
Probability of RCA in ICT services: linear probability model

	(1) Pr RCA	(2) Pr RCA	(3) Pr RCA	(4) Pr RCA	(5) Pr RCA
Institutions	-0.27*	-0.24+	-0.32*	-0.31*	-0.43*
	(0.13)	(0.13)	(0.12)	(0.12)	(0.19)
Log GDP	-0.067	-0.42	-0.33	-0.22	-0.50
	(0.27)	(0.38)	(0.35)	(0.37)	(0.61)
Log GDP PC	0.13	0.37	0.28	0.16	0.52
	(0.31)	(0.38)	(0.34)	(0.36)	(0.59)
Average Schooling					-0.15*
					(0.071)
Year FEs	No	Yes	Yes	Yes	Yes
Country FEs	Yes	Yes	Yes	Yes	Yes
Sample[1]	$X_{ICT} \geq 1M$	$X_{ICT} \geq 1M$	$X_{ICT} > 0$	All	$X_{ICT} > 0$
Observations	1295	1295	1559	1574	252
R^2	0.017	0.040	0.032	0.032	0.063
Adjusted R^2	0.015	0.027	0.021	0.021	0.040

Robust standard errors in parentheses clustered at country level.
$^{+}$ $p < 0.10$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$
[1] Regressions with sample restriction $X_{ICT} \geq 1M$ and $X_{ICT} > 0$ include countries with total ICT exports of at least USD 1 million and non-zero exports of ICT services and ICT goods, respectively. Discussion of 2 in section 5 provides more details.

Table 9 presents the results of including broadband subscriptions, percentage of Internet users, percentage of telephone subscriptions, percentage of mobile phone users, and consumer price index (CPI). Estimated impact of institutions is not qualitatively affected by the additional controls. Percentage of broadband subscriptions is associated with a higher probability of RCA in ICT services exports while number of Internet users and telephone subscriptions – negatively.

7. Conclusion

This article studies the impact of institutions on the determination of comparative advantage patterns in services relative to goods production. We find that improvements in institutions lead to reduction in the likelihood of having an RCA

TABLE 8
Robustness test: additional regressors[1]

	(1) Pr RCA	(2) Pr RCA	(3) Pr RCA	(4) Pr RCA	(5) Pr RCA
Institutions	-0.26***	-0.25***	-0.26***	-0.26**	-0.18*
	(0.074)	(0.072)	(0.073)	(0.081)	(0.079)
Log of Total Export	-0.31***				
	(0.047)				
Log of Population		1.62			
		(2.12)			
Oil rent			-0.00099		
			(0.0064)		
Education Expendtr				0.026	
				(0.016)	
Research and Dev					0.056
					(0.041)
Log GDP	-0.65***	-1.89	-0.30*	-0.29	-0.17
	(0.17)	(2.11)	(0.15)	(0.19)	(0.17)
Log GDP PC	0.85***	1.85	0.26+	0.35+	0.14
	(0.19)	(2.10)	(0.15)	(0.18)	(0.17)
Year FEs	Yes	Yes	Yes	Yes	Yes
Country FEs	Yes	Yes	Yes	Yes	Yes
Observations	1295	1295	1295	898	907

Standard errors in parentheses clustered at country level.
+ $p < 0.10$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$
[1] All regressions are analogues of regression in column 2 of Table 2 and include additional control variables.

and the value of RCA in services relative goods. The effect is statistically and economically significant.

Our findings suggest that, although institutional constraints may well be impediment for provision and trade of both goods and services. Production of complex goods is associated with fixed costs of of production, reliable provision and availability of various inputs and goods physical infrastructure. All these factors make the institutions the to be a relatively stronger limiting factor for complex

TABLE 9
Robustness test: other regressors[1]

	(1)	(2)	(3)	(4)	(5)
Institutions	-0.21**	-0.24***	-0.26***	-0.26***	-0.26***
	(0.068)	(0.071)	(0.074)	(0.073)	(0.075)
Broadband Subscrpt	0.0051*				
	(0.0020)				
Internet Users		-0.0032**			
		(0.0010)			
Telephone Subscrpt			-0.0018***		
			(0.00048)		
Mob. Phone Subscrpt				0.00092	
				(0.0016)	
CPI					-0.00090
					(0.00076)
Log GDP	0.0041	-0.35*	-0.19	-0.30*	-0.21
	(0.17)	(0.15)	(0.16)	(0.15)	(0.16)
Log GDP PC	-0.081	0.35*	0.26	0.26+	0.18
	(0.18)	(0.15)	(0.16)	(0.16)	(0.16)
Year FEs	Yes	Yes	Yes	Yes	Yes
Country FEs	Yes	Yes	Yes	Yes	Yes
Observations	1215	1274	1280	1280	1249

Standard errors in parentheses clustered at country level.
+ $p < 0.10$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$
[1] All regressions are analogues of regression in column 2 of Table 2 and include additional control variables.

goods than complex services provision that might mainly require human capital availability.

Our study focuses on the ICT sector to isolate the differences in goods and services within one sector. ICT sector appears as an obvious choice for such analysis as it is associated with high human capital and comparably important sectoral development for both goods and services. Future research could extend our analysis for other sectors, controlling for human capital intensity and comparability of goods and services provision.

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Appendix A1: Descriptive statistics, main variables

TABLE A1
Summary statistics

	Count	Mean	Std. Dev.	Min	Max
ICT Services	2016	1.92e+09	6.22e+09	0	7.81e+10
ICT Goods	2,232	1.04e+10	4.10e+10	125.03	5.89e+11
Average Schooling	564	7.32	3.13	0.65	13.42
RCA in ICT services	1657	3.21	3.04	0.00	18.13
Probability of RCA	1657	0.70	0.46	0.00	1.00
INSTITUTIONS					
Institutions	3167	-0.08	0.92	-2.45	1.97
Corruption	3163	-0.07	1.01	-1.87	2.47
Government Efficiency	3155	-0.05	1.00	-2.45	2.44
Political Stability	3155	-0.12	0.99	-3.31	1.76
Regulatory Quality	3156	-0.05	0.99	-2.65	2.26
Rule of Law	3167	-0.10	1.00	-2.61	2.10
Accontability	3167	-0.11	0.99	-2.26	1.80
Number of countries	177				

Appendix A2: Definitions of institutional indicators

Voice and Accountability

Voice and accountability captures perceptions of the extent to which a country's citizens are able to participate in selecting their government, as well as freedom of expression, freedom of association, and a free media.

Political Stability and Absence of Violence

Political Stability and Absence of Violence/Terrorism measures perceptions of the likelihood of political instability and/or politicallymotivated violence, including terrorism.

Government Effectiveness

Government effectiveness captures perceptions of the quality of public services, the quality of the civil service and the degree of its independence from political pressures, the quality of policy formulation and implementation, and the credibility of the government's commitment to such policies.

Regulatory Quality

Regulatory quality captures perceptions of the ability of the government to formulate and implement sound policies and regulations that permit and promote private sector development.

Rule of Law

Rule of law captures perceptions of the extent to which agents have confidence in and abide by the rules of society, and in particular the quality of contract enforcement, property rights, the police, and the courts, as well as the likelihood of crime and violence.

Control of Corruption

Control of corruption captures perceptions of the extent to which public power is exercised for private gain, including both petty and grand forms of corruption, as well as "capture" of the state by elites and private interests.

Appendix A3: Computer and Information Services

Balance of Payments Manual definition

"Computer and information services cover computer data and news-related service transactions between residents and nonresidents. Included are databases, such as development, storage, and on-line time series; data processing—including tabulation, provision of processing services on a time-share or specific (hourly) basis, and management of facilities of others on a continuing basis; hardware consultancy; software implementation—including design, development, and programming of customized systems; maintenance and repair of computers and peripheral equipment; news agency services—including provision of news, photographs, and feature articles to the media; and direct, non-bulk subscriptions to newspapers and periodicals."

Appendix A4: Description and summary statistics the World Development Indicators data

ICT Goods

Information and communication technology goods exports include computers and peripheral equipment, communication equipment, consumer electronic equipment, electronic components, and other information and technology goods (miscellaneous).

Education expenditures (% of GDP)

General government expenditure on education (current, capital, and transfers) is expressed as a percentage of GDP. It includes expenditure funded by transfers from international sources to government. General government usually refers to local, regional and central governments.

Research and Development (% of GDP)

Gross domestic expenditures on research and development (R&D), expressed as a percent of GDP. They include both capital and current expenditures in the four main sectors: Business enterprise, Government, Higher education and Private non-profit. R&D covers basic research, applied research, and experimental development.

CPI

Consumer price index reflects changes in the cost to the average consumer of acquiring a basket of goods and services that may be fixed or changed at specified intervals, such as yearly. The Laspeyres formula is generally used. Data are period averages.

Log of goods export

We take log of total export of goods. Definition of total export from WDI: *Goods exports refer to all movable goods (including nonmonetary gold and net exports of goods under merchanting) involved in a change of ownership from residents to nonresidents. Data are in current U.S. dollars.*

Log of population

Total population is based on the de facto definition of population, which counts all residents regardless of legal status or citizenship. The values shown are midyear estimates.

Oil rents (% of GDP)

Oil rents are the difference between the value of crude oil production at world prices and total costs of production.

ITU variales

We also take four variables from International Telecommunication Union (ITU). ITU Founded in 1865 to facilitate international connectivity in communications networks. They also collect data on Information and Communication Technologies availability around the world. We used the following variables: **Internet users percentage**, **broadband subscriptions** (per 100 inhabitants), **telephone subscriptions** (per 100 inhabitants) and **mobile phone users** (per 100 inhabitants).

Below we provide summary statistics for all these variables.

Summary statistics

TABLE A1
Summary statistics for additional variables

	Count	Mean	Std.Dev.	Min	Max
Education Expendtr	2089	4.52	1.77	0.00	14.06
Research and Dev	1595	0.96	0.93	0.01	4.41
CPI	3634	87.56	57.14	0.00	2740.27
Log of Goods Export	3298	22.57	2.57	14.81	28.44
Log of Population	3845	15.84	1.78	11.15	21.04
Oil rent	3746	3.95	9.89	0.00	64.01
Internet Users	3148	30.26	29.31	0.00	100.00
Broadband Subscrpt	2723	8.53	11.41	0.00	46.33
Telephone Subscrpt	3265	71.52	49.76	0.00	259.43
Mob. Phone Subscrpt	3253	17.94	18.24	0.00	74.99