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The Effect of ICT on Supply Chains of Emerging Markets

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Résumé/Abstract

The purpose of this paper is to investigate the effects of ICT (information and communication technology) on the supply chain capacity of emerging markets. To achieve this we carry out a literature review to identify an empirically verifiable hypothesis before testing it with various indicators of ICT and logistics performance using regression analysis. We find that internet infrastructure and use has a positive impact on the Logistic Performance Index (LPI) while other ICT indicators linked to phone use do not have such a strong relationship with the LPIs. Although these findings are limited by the nature of the secondary data, this research offers relevant insight for managers and policy makers on understanding the link between ICT and supply chains to evaluate and improve supply chains in emerging market.

Mots clés/Keywords: Supply chains; ICT; Emerging markets

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Introduction:

Emerging markets with their important GDP growth can have a potential global economic impact (O'Neill, 2001). Different organisations have grown and outsourced their activities in emerging countries through different business models ranging from third-party providers to fully owned subsidiaries (Jahns, et al., 2006). Even though the economic growth of emerging markets has slowed with the 2008 economic crisis, moderate growth is expected going into 2015 for developing and emerging economies (International Monetary Fund, 2014).

Companies whose supply chains are in, go through, or reach into, emerging countries need to address the issues related to poor governance to insure a smooth flow of goods, information and money to achieve their goals. Indeed one issue facing emerging markets is the poor rule of law which leads to poor protection of investors (Klapper & Love, 2004) or the presence of corruption (Rodriguez, et al., 2005) which might create additional costs in trade through extortion (Dutt & Traca, 2010). Furthermore, the poor facilitation of trade through poor institutional quality, policies and infrastructure improvements can curtail significant trade gains in certain emerging and developing markets (Otsuki, et al., 2013; Francois & Manchin, 2007). One approach available to tackle these challenges, is the use of information and communication technology (ICT). ICTs offer the possibility not only to improve productivity of firms (Zwick, 2003) but also to reduce the costs and risks associated with weak legal and political institutions in emerging economies. In the case of trade in service industries using ICT implies that the cost of searching for information on a market, advertising and establishing a distribution network can be reduced (Freund & Weinhold, 2002) while a reduction in the costs of delays and inaccuracy of information could also be expected due to the standardization and ease of use of technology (Liu & Nath, 2013). The further development of ICTs which allows an increase in volume, speed and quality and a decrease in cost of information exchanges can help play a role in reducing certain risks in emerging economies (Rao, 2001).

Current research in ICT points to the differences between ICT in emerging markets and developed markets (Saldanha, et al., 2015; Gholami, et al., 2006; Jerman-Blažič, 2008). The purpose of this paper is to investigate the effects of ICT on the supply chain of emerging markets. The role of ICT is well documented in the context of trade (Freund & Weinhold, 2002; Liu & Nath, 2013; Suh & Khan, 2003; Yushkova, 2014) while logistic capacity of countries plays a certain role in facilitating the movement of goods and has been linked positively to trade competitiveness (Hausman, et al., 2005; Navikcas, et al., 2011). However, the link between supply chains and ICT in the context of emerging markets has not been studied in a systematic way previously. To achieve its purpose the article is based on a systematic literature review of ICT and supply chains in emerging markets as well as a statistical model that explores the role of ICT indicators in relation to emerging country supply chains through the use of Logistics Performance Index (LPI) which measures specific aspects of supply chains. The findings offer a comprehensive overview of how ICT in supply chains can be developed in the context of emerging economies while providing empirical support and insights gained from a statistical analysis.

Literature review:

This paper investigates the effects of ICT on supply chain capacity of emerging markets. To better understand this phenomenon a systematic literature review is conducted. Systematic literature review is a method used to analyse the body of work relating to a specific subject. In the context of academic literature, systematic literature reviews helps summarize existing research and put forward the conceptual content found in the literature (Seuring & Muller, 2008). It offers a well-defined method to insure replicability and to help answer a specific research question. The first step of a systematic literature review is to define the

material collection in regards to our purpose investigating the effects of ICT on the supply chain capacity of emerging markets. From this question we derived the following different search terms.

- "ICT" AND "supply chain*" AND "emerging market" OR "emerging economy"
- "It" OR "information technology*" AND "supply chain" AND "emerging market" OR "emerging economy"

Once the search terms were established a search was conducted in the following databases: Business Source Complete (EBSCO), Emerald Journals, JSTOR-Business Collection (XML), Sage Journals Online, ScienceDirect (Elsevier), Wiley Online Library and Emerald Jornals. The search was conducted in February 2014 with no requirements on publications year. The first search yielded 236 articles, which then underwent a content analysis. First the articles were categorized as relevant based on the title and abstract. The article needed to meet three specific categories to be relevant: discuss information technology or ICT focused on emerging markets, or emerging economies, and mention supply chains. This left us with 44 articles that where categorised in themes (Appendix 1). Since the keywords were found to be used in alternative meanings; an analysis of latent content became necessary. Saldaña (2013) suggests a number of different coding techniques for the assessment of latent content, from values coding to pattern coding. Seuring and Gold (2012) state that content analysis should follow four steps, material collection, descriptive analysis, category selection, and material evaluation. We used structural coding for the identification of texts on a given topic, and analysed then these more in detail for their latent meanings. Still, we used the labels from the search as the basis for identifying the structures. The use of a coding scheme and clear decision rules for categorisation improves both the objectivity and transparency of the content analysis (Krippendorff, 2004). We first analysed each article separately for each category before proceeding to a category-based cross-document and thus, cross-case analysis.

Table 1 search criteria results for the systematic review

	First search	Relevant
"ICT" AND "supply chain*" AND "emerging market" OR "emerging economy"	181	29
"IT" OR "information technology" AND "supply chain" AND "emerging market" OR "emerging economy"	54	15

The coding revealed 51 different topics relevant to the effects of the ICT in emerging markets these codes ranged from the type of IT tools (RFID, knowledge management systems, electronic money), geographic considerations of activities (either India or China) to management considerations (investments, competences and industry wide considerations). The structural coding then led to a final reduction of 11 categories (table 2). The categories arose from both the stated overarching theme presented in the article and from the presented and the latent understanding of ICT. The categories with most articles where: "electronic", "organisation IT", and "ICT infrastructure". The themes presented in the articles ranged from

macro (e.g. it –infrastructure) to micro level (e.g. organisational it). While a few articles focused on a specific sub-function within the concept of ICT (e.g. telecommunication).

Table 2: final coding categories per topic on literature on ICT and emerging markets:

Category	# articles
Organisational IT	17
Electronic	9
ICT infrastructure	4
Communication technology	3
IT industry	3
IT investment	2
Telecommunication	2
ICT industry	1
Internet	1
IT transfer	1
Social media	1

Organisational IT focuses on specific organisation of activities and their use of IT with the alignment of firm resources inside firms and in between firms, IT adoption, information sharing, capabilities and capacity being highlighted as being relevant for performance (Fei & Wang, 2013; Saldanha, et al., 2015; Pérez-López & Alegre, 2012; Wang & Shi, 2011). To these general themes are added more specific categories such as organisational cultural factors (Juris & Deniņš, 2012; Chase, 1997), specific HR capabilities (Soja, 2008) or specific performance such as supply chain performance (Baofeng, et al., 2014; Jie, 2014) or environmental performance (Wang, et al., 2015). The electronic articles focus on the role of internet based economies with investigating country characteristics of e-commerce market activities (Jerman-Blažič, 2008) as well as what drives companies to adapt or fail at implementing electric commerce activities (Abou-Shouk, et al., 2013; Kaynak, et al., 2005). The articles categorised under ICT infrastructure focus on the role of government policies and institutional issues (Cho & Ha, 2009; Chelariu & Osmonbekov, 2014; Goh & Ling, 2003) and how they affect ICT activities inside a country. The other categories present a mixture of subjects such as a framework (Chou, et al., 2005) or conceptual model (El-Haddadeh, et al., 2012), ICT investment activities (Ho, et al., 2011; Samoilenko & Osei-Byron, 2008; Lin & Chiang, 2011), and the role of entrepreneurs in ICT (Varma, 2011; Kundu & Renko, 2005).

Due to the chosen key-word, all of the 44 articles focused on emerging markets with articles discussing a single country or multiple countries. Additionally the articles also addressed the topic of supply chains in different depth. What can be concluded from the lit review is that in emerging markets ICT utilisation is linked to supply chain performance (Baofeng, et al., 2014; Jie, 2014) and organisations use ICT to achieve their supply chain goals but are constrained by the different governmental and institutional policies (Cho & Ha, 2009; Chelariu & Osmonbekov, 2014; Goh & Ling, 2003) and the general ICT infrastructure of an emerging economy. This literature review allows us to formulate a general hypothesis to guide our research: *better ICT connectivity helps improve supply chain performance in emerging countries*. To measure the reach of ICT connectivity in emerging countries we use a series of ICT indicators that allow an approximation of the infrastructure, use and reliability of the internet network (Secure Servers (per 1M people), Internet

Users per (100 people) and Average DL speed (kbs/s)) as well as an estimation of the size and use of the mobile phone and land line connections (Mobile Subscribers (per 100 people) and Phone line Connection (per 100 people)). The source for these indicators is presented in the next section. There are many studies that use similar indicators to analyze different effects of ICT and which include research on international trade (Vemuri & Siddiqi, 2009), trade in different technology groups (Yushkova, 2014) import and export shares in emerging markets (Liu & Nath, 2013), exports in trade blocks (Suh & Khan, 2003), levels of institutionalized democracy and foreign direct investment in emerging societies (Soper, et al., 2012), development projects (Hosman, et al., 2008) inward foreign investment (Suh & Boggs, 2011) and as a source of economic growth (Vu, 2011).

Statistical analysis: data and method:

There is no single comprehensive list for emerging economies and in this research we have based our choice of countries on the criteria put forward by the International Monetary Fund (IMF). The IMF makes a distinction between advanced economies and emerging and developing markets even though they do not use a strict criteria they use this dichotomous distinction to offer a method to organize data and the country selected are representative of the categories presented in the IMF World Economic Outlook of October 2014 which at the time included 153 countries (International Monetary Fund, 2014).

The dependent variable chosen to measure the performance of supply chains is the Logistics Performance Index (LPI). The LPI data comprises of a series of different indicators compiled by the World Bank that include rankings and scores of different countries the scores are based on a scale of 0 to 5 for each indicator. There is an overall indicator ("LPI: Overall") as well as sub-indicators which are as follows: "LPI: Customs" for the efficiency of border and customs clearance process, "LPI: Infrastructure" for the quality of trade and transport-related infrastructure, "LPI: Ease of arranging shipments" for the ease of arranging competitively priced shipments, "LPI: Quality of logistics service" for the competence and quality of logistics services, "LPI: Tracking and tracing" for the ability to track and trace consignments, "LPI: Timeliness" for the frequency with which shipment reach consignee within schedule or expected time ((a) World Bank, 2015). The LPI is based on a bi-annual survey to evaluate different country's logistic performance by professionals working in the logistic industry ((a) World Bank, 2015).

The independent variables that are used to represent the different information technology characteristics consist of different measures for internet and phone connectivity. The first measure is the number of secure internet servers per 1 million people which offers an overview of servers that allow safe encrypted transactions ((b) World Bank, 2015). The second measure is the number of internet users per 100 people which accounts for the use of the internet by a countries population ((c) World Bank, 2015). The third measure is related to the download speed (in kilobytes per second) per year based on multiple tests taken during a year done by Ookla (Ookla, 2014) The fourth measure is the number of mobile subscriptions per 100 people in a country which includes all forms of subscription to a mobile service that uses cellular technology ((d) World Bank, 2015). The final measure is the number of phone lines which also includes digital networks and fixed wireless ((e) World Bank, 2015).

Adding to these dependent variables and independent variables each of the model also included control variables to help assess the independent variables and insure that underlying effects that also affect supply

chains in countries are taken into account. The first control variable is the GDP (current US$) to account for the economic activity of the country ((f) World Bank, 2015). The second control variable consist of the population density which accounts for both the size and population of the countries ((g) World Bank, 2015). The third control variable takes into account the development level of the country and consists of the human development index (HDI) a composite statistic with sub indicators on life expectancy, education and income (United Nations Development Programme, 2015). The final control variable is government efficiency and serves as a proxy to take into account the impact of governance through regulation and its enforcement and is one indicator from a compilation of different governance indicator (World Bank, 2014). This indicator is put on a scale of -2.5 to 2.5.

As the LPI is available only bi-annually and its compilation started fairly recently, the data only includes three years: 2010, 2012 and 2014. For the year 2014, some data were unavailable and were estimated based on their 2012-2013 values. The data set was further restricted by countries for which all data or certain years were missing and these countries were removed. This process left a total of 277 entries (N=277) to analyze over the three years (table 2). All calculations were done using STATA software (version 12). The significance levels in this study are: * significant at $\rho < 0.1$, ** significant at $\rho < 0.05$ and *** significant at $\rho < 0.01$. The first statistical test was done with a simple Pearson correlation while this was followed with more complex models with a combination of 7 LPIs and 5 ICT indicators this led to 35 different models for which the statistical tool used for this research is a multiple linear regression model using the following equation:

LPI = Constant + GDP (Current US$) + HDI + Population density (people per square km of land) + Government effectiveness + ICT indicator

Table 3: Descriptive statistics:

Variables	Minimum	Maximum	Mean
LPI: Overall	2.02	3.78	2.75
LPI: Customs	1.63	3.61	2.50
LPI: Infrastructure	1.63	3.84	2.56
LPI: Ease of arranging shipments	1.86	3.64	2.77
LPI: Quality of logistics service	1.74	3.74	2.67
LPI: Tracking and tracing	1.85	3.83	2.76
LPI: Timeliness	2.05	4.52	3.21
GDP (Current US$)	1.74E+09	1.04E+13	2.84E+11
Human Development Index	0.33	0.85	0.67
Pop Density (people per sq. km of land area)	1.75	1771.94	140.75
Government Effectiveness	-1.73	1.26	-0.25
ICT 1: Secure Servers (per 1M people)	0.02	352.29	40.05
ICT 2: Internet User per (100 people)	1.26	104.99	34.38
ICT 3: Average DL speed (kbs/s)	240.97	33654.84	4506.55
ICT 4:Mobile Subs per (100 people)	22.37	230.78	105.15
ICT 5: Phone line Connection (per 100 people)	0.03	48.68	13.07

Results:

Statistical analysis: Results

The first test that was conducted with the data was a simple Spearman correlation between LPIs and ICT indicators (table 4). This preliminary testing showed that there was a positive correlation between all LPIs and ICT. This was interesting and what was expected, however the regression models show a different outcome than the correlation analysis.

Table 4: Pearson correlation results for ICT and the logistic performance index:

	LPI: Overall	LPI: Customs	LPI: Infrastructure	LPI: Ease of arranging shipments	LPI: Quality of logistics service	LPI: Tracking and tracing	LPI: Timeliness
Secure Servers (per 1M people)	0.494***	0.482***	0.471***	0.367***	0.445***	0.455***	0.418***
Internet User (per 100 people)	0.604***	0.509***	0.621***	0.495***	0.572***	0.581***	0.456***
Average DL speed (kbs/s)	0.289***	0.227***	0.262***	0.271***	0.251***	0.271***	0.259***
Mobile Subs (per100 people)	0.444***	0.411***	0.472***	0.325***	0.416***	0.432***	0.327***
Phone line Connection (per 100 people)	0.390***	0.285***	0.396***	0.324***	0.378***	0.380***	0.319***

For the regression models the results were not as expected for all data but the models nevertheless have adequate adjusted R-squares ranging from 0.566 to 0.320 depending on the model (tables 5-11).In terms of the control variables, it was interesting to note that the control variables for the size of the economy and government effectiveness were always significant at the $\rho < 0.01$ and positively linked to logistics capacity of countries even though the coefficient for the GDP was relatively small . This was one of the results that were expected as both the size of the economy and the actions of governance has been linked to trade. The HDI which was controlling for the quality of life in the country was found not significant in 10 out of 35 models, this might be partially explained by a high correlation (0,808) between the HDI and the ICT indicator of number of Internet User (per 100 people) and this would account for 7 of the 10 non-significant HDI. Finally what was unexpected in the control variables was the non-significance of the population density with the exception of a single model where the coefficient was quite small (table x) when looking at tracking and tracing and average download speed.

As for the independent variables on ICT tested some results were found to have a significant positive coefficient in relation to the LPIs as expected while others were not significant or even had a negative relationship with the LPIs, these findings are displayed in the tables 5 through 11. The number of secure servers (per 1M people) and the number of internet users (per 100 people) were significant for 6 out of the 7 LPIs while mobile subscriptions was found to only be significant for 4 out of the 7 LPIs. However, the ICT indicator for quality in the form of average download speeds (kbs/s) was found to be only significant with the LPI for the ease of arranging shipments which was unexpected. Finally, an even more unexpected results was for the indicator for the number of phone line connections (per 100 people) was not significant for 4 of the LPIs but for 3 out of 7 LPIs it had a negative coefficient. This negative coefficient can be explained by the fact that for the time period covered by the data the number of phone line connections (per 100 people) was slightly decreasing as people are moving away from phone lines and adopting cellular phone technology.

Table 5. Regression results for all ICT independent variables with the LPI: Overall as the dependent variable, 2010-2014.

	ICT 1	ICT 2	ICT 3	ICT 4	ICT 5
GDP	1.06e-13***	9.90e-14***	9.89e-14***	1.03e-13***	1.02e-13***
HDI	0.6484803***	0.0706606	0.6873232***	0.5631701***	1.068163***
Population density	0.0000453	0.0000319	0.0000684	0.000498	0.0000409
Government effectiveness	0.2170545***	0.2321607***	0.2469312***	0.2478802***	.249271***
Secure Server Per 1M	0.0006999**				
Internet User Per 100		0.0049736***			
Average download speed			0.00000514		
Mobile subscription per 100 people				0.0008743	
Phone line connection per 100 people					-0.0045933*
Constant	2.307017***	2.558272***	2.291942***	2.308031***	2.123959***
Adjusted R-square	0.5227	0.5471	0.5187	0.5188	0.5218

Table 6. Regression results for all ICT independent variables with the LPI: Customs as the dependent variable, 2010-2014.

	ICT 1	ICT 2	ICT 3	ICT 4	ICT 5
GDP	7.60e-14***	6.72e-14***	6.75e-14	7.34e-14***	7.06e-14***
HDI	0 .1841596	-0.3206279	0.280873	-0.0100517	0.7580527**
Population density	0 .000061	0.0000518	0.0000823	0.0000657	0..0000551
Government effectiveness	0.2656278	0.294685**	0.3098797***	0.3067891***	0.3101077***
Secure Server Per 1M	0.0009656**				
Internet User Per 100		0 .0047142***			
Average download speed			3.43e-06		
Mobile subscription per 100 people				0.0015686**	
Phone line connection per 100 people					-0.0062636**
Constant	2.3753***	2.600721***	2.34423***	2.389336***	2.125201***
Adjusted R-square	0.4151	0.427	0.4027	0.4139	0.4133

Table 7. Regression results for all ICT independent variables with the LPI: Infrastructure as the dependent variable, 2010-2014.

	ICT 1	ICT 2	ICT 3	ICT 4	ICT 5
GDP	1.39e-13***	1.32e-13***	1.33e-13***	1.40e-13***	1.35e-13***
HDI	0.7646313***	-0.1696535	0.8216858***	0.458665*	1.170632***

Population density	0.0000201	-4.84e-06	0.0000385	0.0000201	0.0000162
Government effectiveness	0.2747397***	0.2796419***	0.3057319***	0.3014212***	0.3068275***
Secure Server Per 1M	0.0006956*				
Internet User Per 100		0.0075872***			
Average download speed			3.54e-06		
Mobile subscription per 100 people				0.0019163**	
Phone line connection per 100 people					-00044057
Constant	2.048934***	2.447903***	2.029557***	2.086474***	1.872326***
Adjusted R-square	0.5206	0.5662	0.5165	0.5297	0.5197

Table 8. Regression results for all ICT independent variables with the LPI: Ease of arranging shipments as the dependent variable, 2010-2014.

	ICT 1	ICT 2	ICT 3	ICT 4	ICT 5
GDP	8.74e-14***	8.39e-14***	8.34e-14***	8.54e-14***	8.57e-14***
HDI	0.5730872**	-0.0208109	0.5272162**	0.5754637*	0.7881993**
Population density	0.0000681	0.0000514	0.0000945	0.0000711	0.0000653
Government effectiveness	0.1787828****	0.1767672***	0.1882648***	0.1939682***	0.1937507***
Secure Server Per 1M	0.0003276				
Internet User Per 100		0.0047035**			
Average download speed			7.85e-06*		
Mobile subscription per 100 people				0.0002089	
Phone line connection per 100 people					-0.0024177
Constant	2.385403***	2.6371***	2.393603***	2.37889***	2.290768***
Adjusted R-square	0.3216	0.3485	0.33	0.32	0.3218

Table 9. Regression results for all ICT independent variables with the LPI: Quality of logistics service as the dependent variable, 2010-2014.

	ICT 1	ICT 2	ICT 3	ICT 4	ICT 5
GDP	1.21e-13***	1.15e-13***	1.15e-13***	1.20e-13***	1.17e-13***
HDI	0.6365499**	-0.0673562	0.6785118**	0.4942499**	0.9187917**
Population density	0.0000777	0.0000597	0.0000965	0.0000804	0.0000774
Government effectiveness	0.2237282***	0.2318801***	0.2508684***	0.2500116***	0.2529849***
Secure Server Per 1M	0.0006237*				
Internet User Per 100		0.0058202***			
Average download speed			3.96e-06		
Mobile subscription per 100 people				0.001093**	
Phone line connection per 100 people					-0.0027776

Constant	2.229376***	2.531631***	2.214192***	2.241227***	2.110234***
Adjusted R-square	0.4603	0.4924	0.457	0.4607	0.457

Table 10. Regression results for all ICT independent variables with the LPI: Tracking and tracing as the dependent variable, 2010-2014.

	ICT 1	ICT 2	ICT 3	ICT 4	ICT 5
GDP	1.17e-13***	1.09e-13***	1.09e-13***	1.14e-13***	1.12e-13***
HDI	0.8898012***	0.1981174	0.92674***	0.7550207**	1.308943***
Population density	0.0001146	0.0000979	0.0001409*	0.0001186	0.0001112
Government effectiveness	0.2007166***	0.2152573***	0.2327403***	0.2333754***	0.2358539***
Secure Server Per 1M	0.0007587*				
Internet User Per 100		0.0058712***			
Average download speed			6.01e-06		
Mobile subscription per 100 people				0.0011481*	
Phone line connection per 100 people					-0.0044658
Constant	2.135822***	2.435267***	2.120712***	2.143909***	1.954548***
Adjusted R-square	0.4476	0.4735	0.4448	0.4461	0.4455

Table 11. Regression results for all ICT independent variables with the LPI: Timeliness as the dependent variable, 2010-2014.

	ICT 1	ICT 2	ICT 3	ICT 4	ICT 5
GDP	1.01e-13***	9.30e-14***	9.23e-14***	9.21e-14***	9.64e-14***
HDI	0.8711538***	0.7613676**	0.9313382***	1.069137***	1.53046***
Population density	-0.000076	-0.0000729	-0.0000488	-0.0000638	-0.0000864
Government effectiveness	0.171395**	0.2086197***	0.210542***	0.2165497	0.2121194
Secure Server Per 1M	0.0009002*				
Internet User Per 100		0.0017449			
Average download speed			5.75e-06		
Mobile subscription per 100 people				-0.0003324	
Phone line connection per 100 people					-0.0076214**
Constant	2.614598***	2.675165***	2.592774***	2.565077***	2.321856***
Adjusted R-square	0.3482	0.3415	0.3426	0.3393	0.3527

Discussion:

The result seem to partially support the hypothesis that better ICT connectivity and use helps improve supply chain performance in emerging countries. One insight arising from the results is that when it comes to "overall performance", internet infrastructure and reach, seems to be the only relevant

aspect with a negative relation towards phone line connection. This negative relation is also found for two other LPIs and can be explained by the decline in the number of physical phone lines being used across the world. As such countries modernizing their ICT infrastructure are moving away from phone lines toward mobile subscriptions that in this case are positively related to 4 of the 7 LPI variables. Thus the technology shift in communications shows that countries modernizing their ICTs do benefit of some improvement in LPIs.

Another insight offered from the data is that the LPI variable for "timeliness" and "ease of arranging shipments" do not have many significant links with ICT indicators with one and two positive and significant coefficient respectively. This might be due to the fact that when it comes to price negotiation and goods in transit ICT factors have very little influence on the performance. However these result contrast with the LPIs for "customs", "infrastructure", "quality of logistics service", and "tracking and tracing" which are all positively related to internet infrastructure and internet use, and mobile phone use. The LPI variable "customs" which is based on government processes is positively related to ICT variables as the improvement of ICT capability in a country allows the use of electronic based processes for customs and improves communications for customs clearing. For the LPI variable "infrastructure" the results of a positive relationship are relevant but expected since country ICT levels are included in the LPI infrastructure indicator. The LPI variable "quality of logistics service" being positively linked to ICT can demonstrate the importance of ICT to communicate with transport operators, customs brokers and other relevant actors in the supply chain. Finally, the LPI variable for "tracking and tracing" is also positively linked to ICT indicators probably due to that a certain level of ICT is required to support electronic tracking tools such as bar codes, RFID and online tracking services.

Finally it is interesting to note that the ICT indicator for the average speed of download is for the most part insignificant (1 in 7) while the indicators for internet servers and internet users are for the most part significant (6 out of 7). This distinction between internet infrastructure and use and the speed show that reach and access of the internet is more important than the actual speed of data transfer for the LPIs. When it comes to the independent variables the GDP, HDI and government effectiveness were all for the most part significantly related to LPI which was expected. However, what was unexpected was that population density was not significant as higher density of population usually helps in covering fixed costs of ICT installations, this effect might be explained by the decrease in such costs with the adoption of mobile services or because the population density of the country might not be as relevant as the population density of a region or city and as such the effect of population density cannot be seen in this model.

Conclusion:

This study set out to investigate the effects of ICT on the supply chain capacity of emerging markets. This study has shown that internet infrastructure and use has a positive impact on LPI while other ICT indicators do not have such a strong relationship with LPIs. It is interesting to note that although the GDP is an important factor for activities related to supply chains and logistics, the findings in this research highlight the additional factor of ICTs in promoting supply chain performance. The findings thus partially support the hypothesis set out from the literature review: *better ICT connectivity and use helps improve supply chain performance in emerging countries.*

This research extends our knowledge of the relation between ICT and supply chains by testing a relationship that is identified in the literature in the context of emerging markets. By testing this notion over multiple countries and years this research helps in developing a more detailed understanding of which ICT themes are relevant in relations to supply chains. However, the study is limited by the underlying measures of the data it uses as well as by the constant change in the ICT sector which might make its finding less relevant in the future when ICT is ubiquitous and no longer a factor for supply chains.

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