The influence of Information and Communication Technologies on Enabling Trade: A Cross-Country Investigation

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Abstract

This paper investigates the relationship between network readiness (individual, business and government) and determinants of trade facilitation (border administration, transport and communication infrastructure, business environment). The research is based on data from 121 countries and structural equation modelling is used in estimation. The results of this study support the hypothesis that the relationship between network readiness and enabling trade is positively and fully mediated through economic environment (market environment, political and regulatory environment, infrastructure environment).

Keywords: Network readiness, Economic environment, Enabling trade, Usage of ICT.

Introduction

This paper is the third of a series of papers that investigates the influence of determinants of information and communication technologies (ICT), on important economic variables. The first paper in this series, referring to the 27 European Union member-states, concluded that the relationship between economic system and global national competitiveness is positively and partially mediated through information and communication technologies (Katos, 2009a). The second paper in the series, referring to 16 non-European Union Eastern Europe and Central Asia countries, concluded that the relationship between economic system and global national competitiveness is positively and fully mediated through information and communication technologies (Katos, 2009b).

The purpose of this third paper is to investigate the relationship between factors of network readiness and factors that facilitate international trade. Specifically, the country coverage of the study refers to the 121 countries that are included in the World Economic Forum database (Lawrence, Blanke, Hanouz, Gieger, & He, 2008). The term '*network readiness*' refers to the individual, business and government awareness of the various benefits that are associated with the use of information and communication technologies (Duta & Mia, 2009). The term '*facilitation of international trade*', or '*enabling trade*' refers to the national awareness of the various benefits to international trade that are associated with reducing barriers to trade, improving border administration activities, developing transport and communication infrastructure, and developing a secure economic environment (Lawrence et al., 2008).

Therefore, given the importance of international trade on economic development, the primary questions examined in this research are:

1. What is the impact (if any) of network readiness on factors that facilitate international trade?
2. What is the relationship between network readiness and factors that facilitate international trade?

Section two presents the operational model and develops the hypotheses to be tested. Data, measures and constructs and the statistical analysis used in estimation, are described in section three. The statistical estimates of the model and discussion of the meaning of these estimates is presented in section four. Finally, section five presents the conclusions of the study.

Theory and Hypotheses

Over the last 30 years the adoption of information and communication technologies and the increasing use of these technologies have been the two most important drivers of change in customs administration and in customs processes that facilitated international trade (Holloway, 2009; Jackson, 2009). These changes came as a "respond to the demands of increased volumes of international trade and the documents to support it" (Holloway, 2009, p. 13). The importance of information and communication technologies in facilitating trade has been emphasized by international organizations, such as the World Customs Organization and the World Trade Organization. Thus, the investigation of the relationship between cross-country network readiness and the factors that facilitate international trade it would also be important.

   The proposed model presented in Figure 1 advocates that international trade, or more precisely the factors that facilitate international trade, depends directly on both the levels of investment in information and communication technologies, and on the advancement of a good economic environment. However, the advancement of a good economic environment may be a result of higher investment in the economy and specifically, of higher investment in information and communication technologies. If this is the case, then the model presented in Figure 1 is a mediation model where the relationship between network readiness and enabling trade is mediated by economic environment. Additionally, the model assumes that the need for more use of ICT pools ICT investment to higher levels. Thus, the proposed model presents a framework where network readiness influences enabling trade both, directly and indirectly via economic environment.
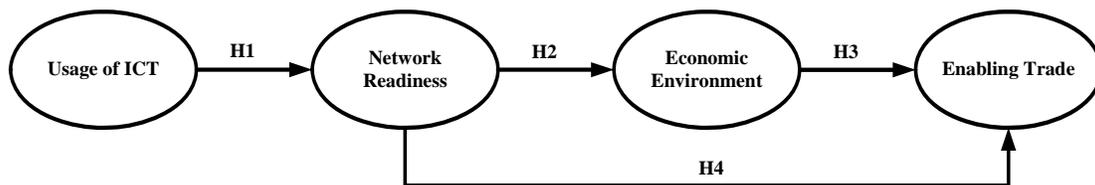

Figure 1. Mediating Model

From the discussion thus far and according to the relationships depicted in the operational model presented in Figure 1, we hypothesize that:

Hypothesis 1:   A positive relationship exists between the need for information and communication technologies use and information and communication technologies investment.

Hypothesis 2:   Advancements in information and communication technologies have a positive impact on economic environment.

Hypothesis 3:   Better economic environments positively influence enabling international trade.

Hypothesis 4:   Advancements in information and communication technologies have a positive impact on enabling international trade.

Methodology

Data, measures and constructs

All data in this study were taken from the World Economic Forum database. Table 1 presents the characteristics of all the variables used in the study. All measurements were composed of indices measured in a scale from '1' = very little to '7'=very much. A high score in the overall enabling trade index indicates that the country is relatively successful at overcoming trade frictions (Lawrence et al., 2008). Specifically:

Table 1. Characteristics of all the variables used in the study

Variable / Construct	Items	Cronbach Alpha	Percent of variance explained
Enabling trade	• Market access • Border administration • Transport and communication infrastructure • Business environment	0.939	89.964
Economic environment	• Market environment • Political and regulatory environment • Infrastructure environment	0.923	88.903
Network readiness	• Individual readiness • Business readiness • Government readiness	0.913	88.253
Usage	• Individual usage • Business usage • Government usage	0.898	88.291

Note: The market access variable did not produce significant results in estimation.

The '*enabling trade*' construct, measuring the countries' institutions, policies, and services, facilitating the free flow of goods over borders and to destination, was composed of four indices as follows (Lawrence et al., 2008):

- Market access, referring to 'tariff and non-tariff barriers' and 'proclivity to trade'.
- Border administration, including 'efficiency of customs administration', 'efficiency of import-export procedures' and 'transparency of border administration'.
- Transport and communication infrastructure, comprising 'availability and quality of transport infrastructure', 'availability and quality of transport services' and 'availability of information and communication technologies'.
- Business environment, consisting of 'regulatory environment' and 'physical security'.

The '*economic environment'* construct was composed of three indices as follows (Duta & Jain, 2004):

- Market environment
- Political and regulatory environment
- Infrastructure environment

The '*network readiness'* construct, depicting ICT investment, was composed of three indices as follows (Duta & Jain, 2004):

- Individual readiness
- Business readiness
- Government readiness

Finally, the '*usage of ICT'* construct, representing the need for ICT use, was composed of three indices as follows (Duta & Jain, 2004):

- Individual usage
- Business usage
- Government usage

Construct consistency and validity

Construct internal consistency was investigated using Cronbach (1951) alphas. The figures in Table 1 indicate that the construct development procedure is reliable for testing the proposed framework, because all Cronbach alphas are much higher than 0.70 (Nunnally, 1978). Construct validity was examined by evaluating the percent of the total variance explained per dimension obtained by applying confirmatory factor analysis (CFA) using LISREL (Jöreskog & Sörbom, 2004). The percentage of total variance explained values reported in Table 1, are much higher than 50.0% indicating acceptable construct validity (Hair, Anderson, Tatham & Black, 2006).

Statistical analysis

To test the raised research questions of the proposed framework the methodology of '*structural equation models'* (SEM) or '*latent variable models'* (Hair et al., 2006) was used, via LISREL and the maximum likelihood estimation (MLE) (see Jöreskog and Sörbom, 2004). SEM is effective when testing models that are path analytic with mediating variables, and include latent constructs

that are being measured with multiple items (Luna-Arocas & Camps, 2008). MLE was used because tests of departure from normality, skewness and kurtosis for all variables used were within acceptable statistical limits.

The overall model fit was assessed following Bollen's (1989) recommendation to examine multiple indices, since it is possible for a model to be adequate on one fit index but inadequate on many others. We used the chi-square and the normed-chi-square tests, the goodness of fit index (GFI), and the root mean squared error of approximation (RMSEA) (Jöreskog & Sörbom, 2004). A non-significant chi-square (i.e. $p > 0.05$) indicates that the proposed model is an adequate presentation of the entire set of relationships. However, in cases of significant chi-squares and high numbers of degrees of freedom, the value of the normed-chi-square (i.e. value of chi-square / degrees of freedom) should be used. The most flexible acceptance value of the normed chi-square must not be higher than 5 (Pedhazur & Pedhazur-Schelkin, 1991). The GFI should not go lower than 0.80, or 0.70 in the case of complex models (Judge & Hulin, 1993). The RMSEA considers the fit of the model to the population covariance / correlation matrix and a value of RMSEA less than 0.08 represents a good approximation respectively. Furthermore, the normed fit index (NFI) (Bentler & Bonett, 1980) and the comparative fit index (CFI) (Bentler, 1990) are also used, for investigating the structure that best fits the empirical data. These indices should not go lower than 0.90, but in complex models, the lowest acceptable level for the NFI and CFI is 0.80 (Hart, 1994).

Results

Table 2 displays the means, standard deviations, and bivariate correlation coefficients between all the variables used in the study. We observe strong, positive and significant correlations between all the variables involved. These results indicate that the usage of ICT is positively associated with network readiness, thus supporting hypothesis 1. Furthermore, network readiness is positively associated with economic environment, therefore supporting hypothesis 2. Additionally, economic environment is positively associated with enabling trade, hence supporting hypothesis 3. Finally, network readiness is positively associated with enabling trade, consequently supporting hypothesis 4.

However, results based on correlations, although interesting, may be misleading due to the interactions between several variables. Therefore, in order to isolate the possible links between the variables involved in the operational model presented in Figure 1, the estimated path diagram for this proposed framework is presented in Figure 2. The boxes represent exogenous or endogenous observed variables and the circles represent the related latent variables. The light arrows indicate the observed variables that constitute the related latent variable and the bold arrows indicate the structural relationships between the corresponding variables. The numbers that are assigned to each arrow show the estimated standardised coefficients, which are all significant at a 0.01 level. The goodness-of-fit indexes confirmed the validity of the operational model (Chi-square = 67.97, df = 51, p-value = 0.056, Normed-chi-square = 1.33, RMSEA = 0.129, NFI = 0.93, CFI = 0.99, GFI = 0.64), although at a rather flexible level for RMSEA and GFI.

The results in Figure 2 show that:

- Information and communication usage has significant and positive influence on network readiness (standardised coefficient = 1.00), thus supporting hypothesis 1.

- Network readiness has significant and positive influence on economic environment (standardised coefficient = 0.98), hence supporting hypothesis 2.

- Economic environment has significant and positive influence on enabling trade (standardised coefficient = 1.00), therefore supporting hypothesis 3.

- Network readiness is not significantly influencing the variable of enabling trade, consequently not supporting hypothesis 4. Because this result is not significant, it is not shown in Figure 2.

It must be emphasized here that the index of 'market access' is not reported between the indices that constitute the construct of enabling trade in Figure 2. This is because this index did not produce significant results in estimation. However, a possible explanation for this result may be the fact that this index includes the measurement of 'tariff and non-tariff barriers', which is an exogenously determined economic policy variable, and not an endogenously determined variable as it was initially assumed in the operational model.

Furthermore, considering that the study supports hypotheses 2 and 3 and at the same time is not supporting hypothesis 4, it may be argued that economic environment fully mediates the relationship between the variables of network readiness and enabling trade (Baron & Kenny, 1986). Additionally, in terms of the strength of this relationship it is seen that business readiness (standardised loading = 0.93) and government readiness (0.93), influence the most market environment (0.93) and political and regulatory environment (0.93), which in turn positively influence transport and communications infrastructure (0.96) and border administration (0.94).

Conclusions

The results of this study support the view that individual, business and government network readiness, influence border administration, transport and communication infrastructure, and business environment. However, this influence in not direct but it takes place through the improvement of the market, political and regulatory, and infrastructure environment. Furthermore, it is supported that network readiness is influenced by the need of individuals, businesses and government to use information and communication technologies.

These conclusions are important for policy purposes because it has been estimated that increasing global capacity in trade facilitation by half, would increase world trade by 9.7 percent in global trade. Furthermore, it is argued that the largest gain in global trade would come from improvements in the service sector infrastructure as well as the increased use of information technology (Wilson, Man, & Otsuki, 2004, cited in Hansen and Annovazzi-Jakab, 2008).

The conclusions above, nonetheless, should be treated with caution. This is because biases in estimating equations employing weighted average indexes may have distorted the results (Katsouli, 2006). Therefore, further research is needed using disaggregated variables.

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Table 2. Means, Standard deviations, and Correlations of all the variables used in the study

|	Variables	Mean	Standard deviation	1	2	3	4	5	6	7	8	9	10	11	12
1	Border administration	4.047	1.088	1											
2	Transport and communication infrastructure	3.680	1.045	0.909	1										
3	Business environment	4.453	0.283	0.834	0.805	1									
4	Market environment	4.034	0.691	0.889	0.864	0.824	1								
5	Political and regulatory environment	4.231	0.859	0.872	0.872	0.905	0.898	1							
6	Infrastructure environment	3.119	1.013	0.829	0.915	0.735	0.791	0.810	1						
7	Individual readiness	4.936	1.134	0.797	0.834	0.661	0.754	0.699	0.787	1					
8	Business readiness	4.356	0.786	0.860	0.891	0.748	0.854	0.834	0.854	0.863	1				
9	Government readiness	4.098	0.752	0.852	0.848	0.838	0.875	0.880	0.806	0.762	0.845	1			
10	Individual usage	2.535	1.401	0.876	0.936	0.740	0.820	0.824	0.912	0.772	0.839	0.802	1		
11	Business usage	4.510	0.813	0.877	0.895	0.786	0.895	0.885	0.842	0.793	0.922	0.896	0.836	1	
12	Government usage	3.882	0.925	0.812	0.800	0.762	0.830	0.840	0.753	0.681	0.798	0.939	0.761	0.874	1
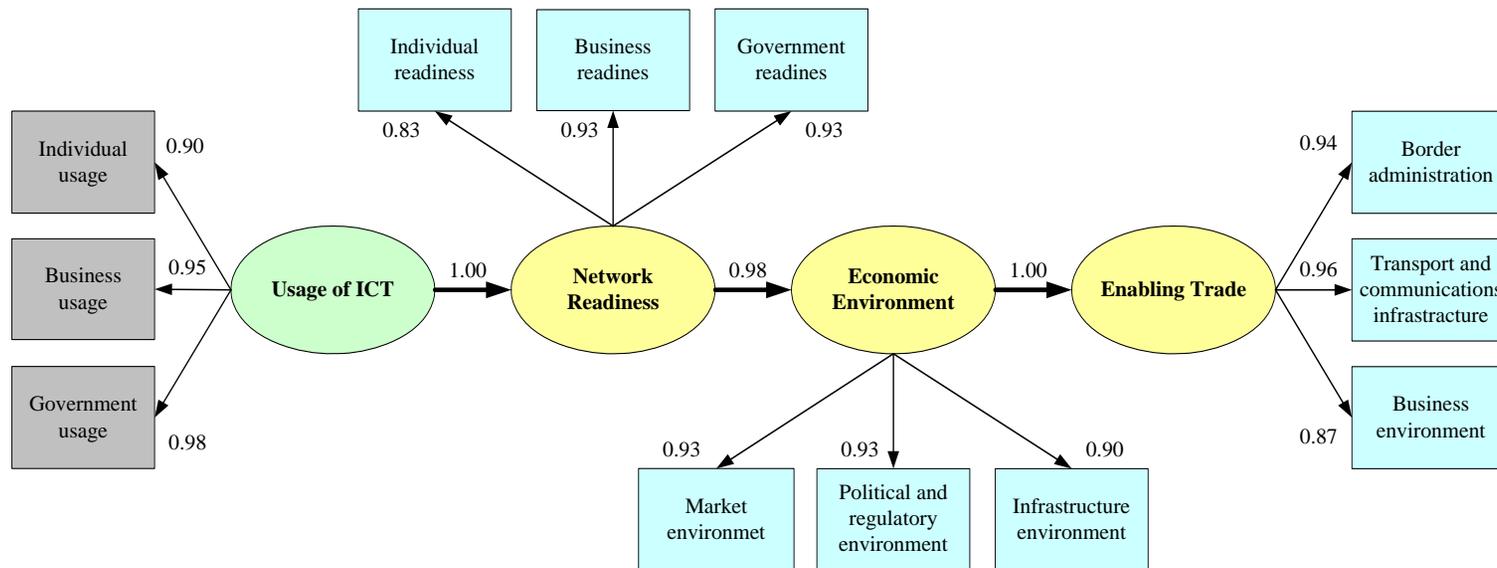
Figure 2. Estimation results of the hypothesized mode