Fostering Competitiveness in European Countries with ICT: GCI Agenda

Regular Paper

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Abstract

The purpose of this paper is to identify the influence of the usage of information and communication technology (ICT) on the competitiveness of European countries. Over the last 30 years, the development and usage of ICT has increased. In order to investigate the impact of ICT on the competitiveness of European countries, we conducted a panel regression analysis. We collected data for the period of five years (2007-2011) from the European statistical database – Eurostat and Global Competitiveness Report. We found that ICT plays an important role in the achievement of global competitiveness of European countries. The results also revealed that ICT has the highest impact on the Global Competitiveness Index and Efficiency enhancers' sub-index. Additionally, we found that ICT is less influential on Basic Requirements sub-index and Innovation and Sophistication Factor sub-index.

Keywords Information and Communication Technology, Competitiveness, Innovation, Efficiency, Regression Analysis, European Countries

1. Introduction

The global economy and social environment have undergone a significant change over the last 30 years, primarily due to the influence of ICT usage. In comparison to conventional means of communication, individuals and companies use ICT for communication, business and learning purposes quite differently. It can be said that ICT usage increases competitiveness of individuals, companies and societies [1, 2].

The research community continues to examine the influence of ICT, as well as the influence of technology on competitiveness. The rapid development and adoption of ICT has a strong impact on competitiveness. It additionally impacts the economic growth of individuals, companies and countries [3, 4, 5, 6]. ICT progress and usage is a key factor in personal, economic and social development in relation to communication, business and learning. The best example of this is the state of Singapore. Singapore's strategic development plan is based on development and the use of ICT, aimed at the realisation of economic growth [1]. The government is trying to improve ICT possibilities by fostering PC and Internet access and increasing high-speed broadband connectivity. This has a positive impact on business processes and the economic model. In the area of e-government and e-learning, Singapore is the leader. It holds second place in the Global Information Technology Report 2014 [7]. Countries, such as Singapore, which base their development and progress on ICT, are more competitive than other countries. This is confirmed by their high position on the competitiveness scale (Singapore, second place, Global Competitiveness Report, 2014) [8]. Among

European countries, in the last few years, Estonia has made great progress in the area of ICT. This has also had a positive influence on its competitiveness level [9]. Estonia is among the 30 most competitive countries in the world [8]. It can be concluded that individuals, companies and countries that use ICT are expected to achieve higher competitiveness levels [10]. Looking at previous studies, it can be observed that no research has been conducted with the aim of analysing the influence of ICT usage on the components of the Global Competitiveness Index on a larger sample of countries. This would provide the data enabling subsequent comparison.

The aim of this paper is to analyse the influence of ICT usage on competitiveness indicators, measured by selected components of the competitiveness index: Global Competitiveness Index, Efficiency Enhancers sub-index, Basic Requirements sub-index, as well as Innovation and Sophistication Factor sub-index. Thereby, selected fields of ICT application are used: e-learning, personal Internet usage, e-business and high-technology transfer among companies and e-government.

The analysis will be conducted on a sample of European countries. It will use data on ICT usage available in the statistical database Eurostat [11] and the data on competitiveness of these countries gathered by the World Economic Forum [12]. The period from 2007 to 2011 will be analysed using the panel regression method.

This paper is structured as follows: after the introductory section, the literature review is described; it includes the literature on the influence of the selected fields of ICT application (e-learning, personal Internet usage, e-business, high-technology transfer among companies and e-government) on competitiveness; in section three, the study design and methodology used for data analysis will be discussed while the results are presented in section four; the major implications are analysed in section five; finally, section six concludes the paper.

2. Literature Review

In this section, past research on the influence of the selected fields of ICT application (e-learning, personal Internet usage, e-business, high-technology transfer among companies and e-government) on competitiveness will be analysed.

2.1 Influence of E-learning Usage

E-learning refers to ICT usage in the educational process, i.e., the use of technology and the Internet for instruction purposes regardless of time, place and modality of learning [13]. There are numerous advantages of e-learning. For example, cost reduction for the institution and for students, providing more flexible learning and time reduction [14]. In several ways, the use of e-learning contributes to an improvement in competitiveness. It leads to a higher quality of educational system, increases the number of highly educated employees and enables access to information required for work. Furthermore, it enhances the development of social and economic environment. E-learning additionally leads to a decrease in the immigration of educated work forces to more developed countries [15]. The best example of this is the United States of America. Here, certain universities offer complete programmes conducted via e-learning [16, 17]. This leads us to our first research hypothesis:

H1: The Increase in the Use of E-learning has a Positive Influence on a Country's Competitiveness.

2.2 Influence of Personal Internet Usage

For the purpose of this paper, personal Internet usage includes the use of online banking and the use of the Internet as a job-search tool.

The use of online banking has a strong influence on the development of the financial sector, which contributes to the improvement of competitiveness [18, 19]. Banks without a developed system of financial services offered through the Internet lag behind on the financial market. This is mainly the case with banks operating in the developing countries whose inhabitants use the Internet to a lesser extent, in general, as well as for financial operations. This is due to their insufficiently developed infrastructure, a lack of e-skills and the high price of Internet access [20].

In developing countries, a great number of unemployed individuals use the Internet as a job-search tool. The development of ICT skills contributes to productivity growth and competitiveness. Not only does this result in new jobs, but also in wider possibilities of job searches [21]. Using the Internet as a job-search tool offers great possibilities to both individuals and companies. It is important to underline a better communication between employees and employers. Research conducted in Germany and South Korea revealed that individuals using the Internet in their job searches have a greater chance of gaining employment, i.e., they find a job faster using the Internet [22]. This leads us to our second research hypothesis:

H2: Increased Activity of Individuals on the Internet has a Positive Influence on a Country's Competitiveness.

2.3 Influence of E-business Usage

E-business means the use of the Internet in performing everyday business activities [23]. It represents one of the basic determinants of an increase in business efficiency, i.e., competitiveness on the international market [24, 25]. The bases of e-business development are the developed IT infrastructure [1] and a legal business framework, i.e.,

the strategy of e-business development at state level [26, 27]. Countries encouraging ICT development and its application can also ensure conditions for the development of electronic business, which has competitive advantages [28, 29]. The United States of America leads in the use of e-business [30]. There are several benefits for companies that use ICT in their business activities: innovative business models, productivity and strategic growth, customer satisfaction and better relation with clients, sales increase, improvement of supply chain and international communication, as well as product quality [2]. This leads us to our third research hypothesis:

H3: Increase in E-business has a Positive Influence on a Country's Competitiveness.

2.4 Influence of High-technology Transfer

The increase in high-technology transfer has a positive influence on productivity. This improves competitiveness of both countries and companies [31, 32]. Imports from developed countries introduce new products/ services to developing countries. As a result, high-technology, knowledge and innovation are transferred, improving socio-economic development of the countries [33, 34]. For many countries and companies, it is crucial to be involved in high-technology transfer. In this way, they are able to keep a competitive position on the dynamic market [35]. Knowledge and technology transfer are key factors in enhancing companies' innovation processes. Technology transfer also has a significant influence on knowledge transfer and innovation, which are both closely related to competitiveness [32, 36, 37]. This leads us to our fourth research hypothesis:

H4: Increase in High-technology Transfer has a Positive Influence on a Country's Competitiveness.

2.5 Influence of E-government Usage

Many countries are trying to improve public administration, public management and civil services in order to achieve higher efficiency, transparency and accountability [38]. In recent years, there have been significant investments in ICT usage in the area of public administration. The main reasons for this are the efficiency of government operation, strengthening of democracy, enhanced transparency and better communication and services to users (individuals and companies) [39]. Significant investments of European countries into the development of e-government, as well as launching various programmes to encourage further enhancement and development, indicate the positive influence of e-government usage on achieving countries' competitive advantage [40]. In most developing countries, e-government services are insufficiently developed and used. Nevertheless, developing countries invest significant resources into developing and using e-government

services. Such investments contribute to the economic and social progress of those countries. The best example that demonstrates this is Estonia. In recent years, Estonia has been among the leading developing European countries in the application of ICT in the field of public administration. In comparison with other central European countries which became members of the EU in 2004 and 2007, Estonia has significantly progressed [9]. In addition to Estonia, Singapore is considered as a global leader in developing and using e-government. It places particular emphasis on the functionality of e-government websites, as well as conducting operations and transactions over e-government websites [41, 1]. This leads us to our fifth research hypothesis:

H5: Increase in E-government Usage has a Positive Influence on a Country's Competitiveness.

3. Methodology

3.1 Methodological Approach

For this paper, panel regression analysis was used with the aim of examining the hypotheses in order to estimate the influence of ICT technologies on competitiveness of European countries. Panel regression analysis is a statistical method using two-dimensional panel data distributed over the years and units examined. The data are gathered over a certain time-period for the same group of units examined. A regression analysis is subsequently performed for the two named dimensions [42].

The advantage of panel regression, over cross-section regression, is that it estimates the contribution of independent variables to the dependent variables, whilst taking into account a longer period of time. This overcomes the problem of bias caused by unobserved heterogeneity [43]. Thus, by using panel regression, we can analyse the change over time and, in our case, the change of competitiveness as a result of ICT usage over time. Additionally, in contrast with a cross-sectional approach, panel regression models can be used to inform policy makers on needed actions. This is because they provide better performing estimates due to multiple observations during the period of time.

There are different methods commonly used in the estimation of parameters. In this case, the following steps were applied: (i) Ordinary Least Squares method was used in order to estimate the parameters; (ii) approximation of the variance-covariance matrix of the estimates was used.

Parameter estimations were conducted, taking into account that the following errors in panel data did not occur: (i) Heterogeneous serial correlation, (ii) Heterogeneous spatial correlation, (iii) Heterogeneous heteroscedasticity and (iv) Serial-spatial correlation.

3.2 Data Collection and Measurement

3.2.1 Data Collection

The data were gathered from the statistical database of the European Commission – Eurostat [11] and from the Global Competitiveness Report issued annually by the World Economic Forum [12]. The research refers to the period from 2007 to 2011 in 32 selected European countries.

Data on ICT usage were collected for 32 European countries (EU countries, Iceland, Norway, Macedonia and Turkey) in the period 2007 to 2011. Data were collected for 17 variables from the statistical database of the European Commission – Eurostat [11], section on the Information society. The selected variables were classified into five areas of ICT: e-learning, personal Internet usage, e-business, high-technology transfer among companies and e-government.

3.2.2 Dependent Variables

A country's competitiveness was used as the dependent variable. Quantitative and qualitative data were used for computing the Global Competitiveness Index [44]. Quantitative data were gathered from national statistic offices and international agencies (United Nations – Statistics Division, International Monetary Fund, and World Health Organisation). Qualitative data were gathered by means of a survey, conducted among executive managers of leading world companies. The World Economic Forum measured the competitiveness of 142 countries with one overall index based upon three different sub-indices and 12 pillars of competitiveness. From the overall data for 142 countries, the data for 32 selected European countries for the period 2007-2011 were used in the analysis.

The following WEF indices were used as dependent variables: Global Competitiveness Index, Efficiency Enhancers sub-index, Basic Requirements sub-index, as well as Innovation and Sophistication Factor sub-index.

3.2.3 Independent Variables

In contemporary society, ICT is used in a number of different areas. Blackman (2004) [45], Zott (2000) [30] define the most important areas of ICT usage as: e-learning, personal Internet usage, e-business usage, high-technology transfer and e-government.

In order to analyse the influence of ICT on a country's competitiveness, indicators within these five areas were examined. Data were collected from the Eurostat database [11], using indicators that represent the above mentioned five ICT usage groups, included in the following European Union Policies: Benchmarking Digital Europe 2011-2015, and i2010 benchmarking indicators.

Indicators for three areas refer to personal ICT usage (e-learning, personal Internet usage and e-government) while the remaining two indicators refer to companies' ICT usage (e-business, high-technology transfer among companies). Table 1 presents the independent variables that were used in order to test the impact of the ICT usage to the countries' competitiveness.

CODE	Research construct
E-learning usage indicators	
EL1	Purchase of e-learning applications and courses (% individuals)
EL2	Information search on education, training and courses (% individuals)
EL3	Use of the Internet for education and training (% individuals)
EL4	Use of the Internet for decision-making on learning (% individuals)
Personal Internet usage indicators	
EIND1	Use of online banking (% individuals)
EIND2	Use of the Internet as a job-search tool (% individuals)
Indicators of e-business usage in companies	
EBUSS1	CRM software usage (% companies)
EBUSS2	Selling goods or services over Internet (% companies)
EBUSS3	Placing orders over the Internet (% companies)
Indicators relating to high-technology transfer among companies	
HTT1	High-technology import within EU27 (% of total import)
HTT2	High-technology import outside EU27 (% of the total import)
HTT3	High-technology import in the world (% of the total import)
HTT4	High-technology export within EU27 (% of the total export)
HTT5	High-technology export outside EU27 (% of the total export)
HTT6	High-technology export in the world (% of the total export)
e-government usage indicators	
EG1	Sending forms through public administration sites (% individuals)
EG2	Communication with public administration units (% individuals)

Source: Author's research based on Eurostat.

Table 1. Indicators of ICT usage utilized as the independent variables

4. Results

The panel regression analysis model was used in order to estimate the relation between ICT and countries' competitiveness. Table 2 presents the regression coefficients and goodness of fit for all regression models. Here, the dependent variables are shown in the header row.

The highest number of independent variables influences Efficiency Enhancers sub-index (64, 71%) and Global Competitiveness index (58, 82%). The lowest number of independent variables influences Basic Requirements sub-index (41, 17%) and Innovation and Sophistication Factor sub-index (35, 29%).

	Global Compet. Index	Basic Requirements sub-index	Efficiency Enhancers sub-index	Innovation and Sophistication Factor sub-index
Constant	3.8818***	4.3590***	3.7666***	3.0464***
E-learning usage indicators				
EL1	0.0170***	0.0131***	0.0135***	0.0257***
EL2	-0.0065**	0.0015	-0.0122***	-0.0075
EL3	0.0131**	0.0061	0.0219***	0.0185
EL4	-0.0111**	-0.0068	-0.0166***	-0.0135
Personal Internet usage indicators				
EIND1	0.0079***	0.0089***	0.0069***	0.0090***
EIND2	-0.0051	-0.0110**	0.0006	-0.0159**
Indicators of e-business usage in companies				
EBUSS1	0.0036	0.0045	0.0021	0.0080
EBUSS2	0.0085***	0.0059**	0.0088***	0.0158***
EBUSS3	-0.0027	0.0027	0.0001	-0.0108**
Indicators relating to high-technology transfer among companies				
HTT1	-0.0119	-0.0082	-0.0003	-0.0005
HTT2	-0.0191***	-0.0136**	-0.0153***	-0.0268***
HTT3	0.0329**	0.0003	0.0322**	0.0399
HTT4	0.0313***	0.0225	0.0406***	0.0352
HTT5	0.0123	0.0018	0.0169***	0.0171
HTT6	-0.0275	0.0032	-0.0469***	-0.0318
e-government usage indicators				
EG1	-0.0053	-0.0096**	-0.0036	-0.0047
EG2	0.0052**	0.0111***	0.0014	0.0071
Goodness of fit indicators				
R2	0.8142	0.7607	0.8563	0.7900
Adjusted R2	0.7920	0.7321	0.8391	0.7649
% of statistically significant variables				
Total =17 (100%)	10/17 (58,82%)	7/17 (41,17%)	11/17 (64,71%)	6/17 (35,29%)

Source Author's research based on Eurostat and GCI Report.

Note: statistically significant at *** 1%, ** 5%; R2 is coefficient of determination; Adjusted R2 is adjusted coefficient of determination.

Table 2. Panel regression analysis results – overview of estimates of regression coefficients and coefficients of determination

Coefficients of determination range from 0.7607 to 0.8563. Furthermore, coefficients of determination adjusted for the number of independent variables (adjusted-R2) range from 0.7232 to 0.8391. Thus, both measures indicate adequate goodness of fit for all of the models. In the next section, we will discuss the impact of different groups of independent variables (e-learning usage, personal usage, e-business usage, high-technology transfer and e-government usage indicators) on the competitiveness indices.

5. Discussion

Table 3 presents the relation between individual independent variables (e-learning, personal Internet usage, e-business, high technology transfer among companies and e-government) and dependent variables (Global Competitiveness Index, Basic Requirements sub-index, Efficiency Enhancers sub-index and Innovation and Sophistication Factor sub-index).

The level of statistical significance was presented using common thresholds of 1% and 5%. The sign in the parenthesis represents the sign of the regression coefficient.

	Global Compet. Index	Basic Requirements sub-index	Efficiency Enhancers sub-index	Innovation and Sophistication Factor sub-index
E-learning usage indicators				
EL1	1% (+)	1% (+)	1% (+)	1% (+)
EL2	5% (-)	□	1% (-)	□
EL3	5 % (+)	□	1% (+)	□
EL4	5 % (-)	□	1% (-)	□
Personal Internet usage indicators				
EIND1	5 % (+)	1% (+)	1% (+)	1% (+)
EIND2	□	5% (-)	□	5% (-)
Indicators of e-business usage in companies				
EBUSS1	□	□	□	□
EBUSS2	1% (+)	5 % (+)	1% (+)	1% (+)
EBUSS3	□	□	□	5 % (-)
Indicators relating to high-technology transfer among companies				
HTT1	□	□	□	□
HTT2	1% (-)	5 % (-)	1% (-)	1% (-)
HTT3	5 % (+)	□	5 % (+)	□
HTT4	1% (+)	□	1% (+)	□
HTT5	□	□	1% (+)	□
HTT6	□	□	1% (-)	□
e-government usage indicators				
EG1	□	5 % (-)	□	□
EG2	5 % (+)	1% (+)	□	□

Source: Author's research based on Eurostat and GCI Report.

Note: □ is used when the regression coefficient was not statistically significant.

Table 3. Level of statistical significance of independent variables

5.1 Influence of the Independent Variable E-learning on Dependent Variables

There is a positive relation between the Global Competitiveness Index and e-learning indicators which measure the active usage of e-learning tools. This refers to the purchase

of e-learning applications and courses (**EL1**) and usage of the Internet for education and training (**EL3**). On the other hand, there is a negative relationship with e-learning indicators measuring the passive usage of e-learning tools. This refers to the information search on education, training and courses (**EL2**) and usage of the Internet for decision-making on learning (**EL4**). E-learning impacts the Efficiency Enhancers sub-index in the same way. Basic Requirements sub-index and Innovation and Sophistication Factor sub-index only relate positively to one indicator of e-learning - the purchase of e-learning applications and courses (EL1).

Based on the presented results, it could be concluded that the first hypothesis **(H1)** of this paper has been confirmed. However, the e-learning market is still unequally developed in developed and developing countries. Thus, there is growth potential of the e-learning market in almost all developing countries [15]. It can be assumed that a positive influence on innovation is derived from the fact that e-learning accelerates the exchange of ideas, knowledge and information. Furthermore, it encourages employees to cooperate through internet usage.

5.2 Influence of the Independent Variable of Personal Internet Usage on Dependent Variables

There is a positive relation between the usage of e-banking by individuals (**EIND1**) in European countries and all of the competitiveness indices. A possible explanation for this is that, in more developed countries, banks offer more innovative services over the Internet. This, in turn, enhances the speed of conducting day-to-day financial transactions [46]. Thus, the quality of financial services also increases the competitiveness of the country.

However, there is a negative relation between the indicator related to the use of Internet as a job-search tool (**EIND2**) and Basic Requirements sub-index and Innovation and Sophistication Factor sub-index. This could be because countries with a lower level of competitiveness also have a higher level of unemployment. This indicates that a higher percentage of population search for employment in general and through the Internet as well.

Based on the presented results, it could be concluded that the second hypothesis **(H2)** of this paper has been confirmed.

5.3 Influence of the Independent Variable E-business on Dependent Variables

There is a positive relation between all of the competitiveness indices and e-business indicators. This indicates a high intensity of ICT usage in business processes (**EBUSS2**-selling goods or services over the Internet). E-business, such as purchase through the Internet and client relationship management, alters current business activities, i.e., contributes to introducing innovation in company business

activities [47]. Further progress and application of new technology contributes to the innovative manner of performing e-business activities within companies.

On the other hand, the indicator of e-business usage in companies that refers to placing orders over the Internet (**EBUSS3**) is negatively related to the Innovation and Sophistication Factor sub-index. A possible explanation is that an over reliance of buying goods over the Internet actually decreases innovativeness of European companies. Thus, having a negative impact on their competitiveness.

Based on the presented results, it could be concluded that the third hypothesis **(H3)** of this paper has been confirmed.

5.4 Influence of the Independent Variable High-technology Transfer Among Companies on Dependent Variables

Based on the results of this research, it could be concluded that the fourth hypothesis **(H4)** of this paper has been confirmed. The import of high-technology in the world (**HTT3**) has a significant positive impact on the Global Competitiveness Index and Efficiency enhancers sub-index, as well as high-technology export within EU27 (**HTT4**). High-technology export outside EU27 (**HTT5**) also has a positive impact on Efficiency enhancers sub-index.

However, high-technology import outside EU27 (**HTT2**) has a negative impact on all of the competitiveness indices. This could indicate the negative effect of a heavy reliance on the technology of the East-Asian countries.

Previous research has indicated that high-technology is a result of innovation, technology and knowledge. This means it significantly enhances business innovation and sophistication [32]. The research results of this paper confirm this conclusion.

5.5 Influence of the Independent Variable E-government on Dependent Variables

There is a positive relation between the Global Competitiveness Index and Basic Requirements sub-index with the indicator measuring active use of e-government services (**EG2**-Communication with public administration units). On the other hand, there is a negative relation between Basic Requirements sub-index and indicator measuring passive use of e-government services (**EG1-** sending forms through public administration sites).

E-government services are important for introducing changes and enhancing administrative activities within public and state institutions, as well as improving quality of their work [48]. Thus, the introduction of public administration e-services has incited the innovative manner of performing business activities. This positively impacts the competitiveness of the countries.

Based on the results of this research, it could be concluded that the fifth hypothesis **(H5)** of this paper has been confirmed.

6. Conclusion

After a detailed presentation of the relation between individual independent variables (e-learning, personal Internet usage, e-business, high-technology transfer among companies and e-government) and dependent variables (Global Competitiveness Index, Basic Requirements sub-index, Efficiency Enhancers sub-index and Innovation and Sophistication Factor sub-index) the limitations of the present work are provided. Furthermore, recommendations for future research, our methodology and results are also provided.

Panel regression analysis was used within the present research in order to estimate the relation between ICT and countries' competitiveness. Independent variables are indicators of ICT usage divided in five areas (e-learning, personal Internet usage, e-business, high-technology transfer among companies and e-government). Dependent variables included Global Competitiveness Index, Basic Requirements sub-index, Efficiency Enhancers sub-index and Innovation and Sophistication Factor sub-index. Panel regression analysis was applied on the data for the period of five years. Within panel regression analysis, time delay was not included. This means that a statistically significant relation to individual dependent variables, such as Basic Requirements sub-index and Innovation and Sophistication Factor sub-index, cannot be recognized. This is because a longer period is required to determine the influence and the relation of independent and dependent variables.

In addition to these limitations, recommendations and possibilities of future research are provided. In the first place, the analysis should include the data for a higher number of countries. For further research, it would be useful to study policies of individual countries on enhancing ICT and their influence on a country's competitiveness. This would provide a valuable insight into the steps taken by individual countries.

7. Acknowledgements

8. References

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