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The impact of e-commerce and R&D on economic development in some selected countries

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Abstract

This paper investigated the impact of e-commerce and R&D and two other variables on economy development in 21 selected countries. This study used panel data technique with Generalized Least Square Regression (GLS) method during the period of 2005 to 2013. The results showed that e-commerce and R&D had a positive and significant impact on GDP (Gross Domestic Product) per capita based on purchasing power parity, with e-commerce having a stronger development-enhancing effect in comparison to R&D. Health expenditure and government size as other dependent variables also had a positive influence on GDP per capita, which could be effective in improving and growing the economy.

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Keywords: E-commerce; Economic development; R&D; Panel data analysis

1. Introduction

These days, information and communications technology is the focus of most countries in the world. In the past two decades, the ongoing application and diffusion of the Internet and e-commerce as well as advances in information technology (IT) have radically altered global economic activity. From the firm perspective, the ability to effectively apply Internet and electronic technology has become both a major opportunity and a big challenge (Kambil, 1995). The advancement of technology has assisted international business. It is undeniable that millions of people worldwide use the Internet to do everything, from conducting research to purchasing products online. The Internet is profoundly affecting almost all businesses. Specifically the multiple uses of the Internet by business entities include the ability to advertise, generate, or otherwise perform regular business functions. Therefore, many firms are embracing the Internet for many of their activities. One impact for e-commerce is to intensify competition and produce benefits for

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consumers, with lower prices and more choices (Malkawi, 2007). In other words, the Internet and e-commerce lead to efficiency improvements, better asset utilization, faster time to market, reduction in total order fulfillment times, and enhanced customer service (Terzi, 2011).

The Internet is also dramatically expanding opportunities for business-to-business and business-to consumer e-commerce transactions across borders. For business to consumer transactions, the internet specifically sets up a potential revolution in global commerce: the individualization of trade. Technology has expanded the consumer marketplace to an unprecedented degree (Ham and Atkinson, 2001). The adoption of information technology similarly exhibits network externality brought about by more users, with the resulting benefits for the users, e.g., fax machine (Economides & Himmelberg, 1995) and cellular phone (Jha & Majumdar, 1999). Over the past few decades, numerous studies have considered R&D as a proxy variable for knowledge capital when examining the relationship between knowledge capital and productivity. Along with the substantial and rapid development of ICT, e-commerce technologies have emerged as an important type of knowledge capital for operating a business.

On the other hand, the growing size of governments during the twentieth century, and especially since the 1960s, has captured the attention of many economists. They have tried to present different theories to explain this phenomenon. According to many theories of growth in the size of governments, with the development of countries, the structure and economic needs change and as a result, the size of government is affected too (Tanzi & Schuknecht, 2000).

In economic literature, there are numerous studies regarding the impact of ICT with GDP growth and trade as macroeconomic variables, but the studies addressing e-commerce and development are so fee and most discussion has been centered on statistical expression and discretion. However, the existing literature does not clarify the impact of e-commerce on economic development very well. The main purpose of this study was to examine the relationship between knowledge capital (including both e-commerce and R&D expenditure) with GDP based on the purchasing power parity. We used a panel data for the selected countries during 2005–2013.

The paper is organized as follows. Section 2 presents a brief review of the existing literature. Section 3 describes the methodology. Section 3.1. describes research goal. Section 3.2. relates the empirical models and data sources. Section 3.3. presents the empirical results. Finally, section 4 draws the conclusions.

2. Literature Review

2.1. E-commerce, R&D, and GDP growth

Information and communication affect to both the supply and demand sides. ICT have effects on the economic behavior of consumers through the utility function on the demand side, and it is also influential on the producer treatment on the supply side. The relationship between ICT and economic growth and efficiency on the supply side of the economy is determined by some complementary factors including organization and management experience, organizational and legislative part, and communications structure as an output on the supply side of the economy, among other factors entering into the capital, thereby leading to the improvement of the production process through capital deepening, advances in technology, and the quality of the labor force. As a result, the value added to output at three levels of the enterprise, sector and country will be increased; ultimately, it will lead to economic growth, labor productivity growth, profitability and the welfare of the consumer (Dedrick, Gurbaxani, & Kraemer, 2003). Empirical studies and theories show that the relationship between ICT on the economic growth can be investigated through three ways: if the theories of economic growth have more emphasis on three factors including population, capital and alteration of technology, the effects of these factors have examined by classic economists. Adam Smith knows Large-scale production as the economy's progress, and Ricardo Malthus defined the limits of economic growth by clarifying the principle of "diminishing returns". Joseph Schumpeter knows Innovation and technological changes (traditional vs. modern) as the most important economic process leading to economic growth.

E-commerce can be defined as the use of the Internet to conduct business transactions nationally or Internationally, as represented by WTO (1998). E-commerce has come to take on two important roles; first as a more effective and

efficient conduit and aggregator of information and second, as a potential mechanism for the replacement of many economic activities once performed within a business enterprise by those that can be done by outside suppliers that compete with each other to execute these activities, as shown by ECLAC (2002).

In recent years, some scholars have investigated the relationship between ICT and economic growth and productivity growth. Many of these studies have concluded that there is a positive relationship between Internet use, ICT, and productivity growth. In addition, most of the studies in the level of firms show that ICT can help to increase efficiency. Recent studies have confirmed this positive relationship can be strengthened (Sichel, 1997; Berndt, Morrison, & Rosenblum, 1992; Parsons, Gottlieb, & Denny, 1993). Lund and McGuire (2005) focused on inputs and development of electronic commerce and economic growth, declaring that e-commerce increased profits for firms and led to the development of countries. Their findings showed that e-commerce was a key force in the integration of LDCs (low development countries) in the multilateral trading system. In this paper, the emphasis has been placed on the issue of whether social and economic reforms can encourage e-commerce. The results showed that practically, no presence of the government in the field of e-commerce could lead to economic growth and increase the share of e-commerce tools in e-commerce. Liu et al. (2013) investigated the impact of e-commerce and R&D on productivity, using a unique panel dataset obtained from Taiwanese manufacturing firms for the period of 1999 to 2002. They found that both e-commerce and R&D capital had a positive influence on productivity, while R&D exhibited a larger productivity- enhancing effect. Over the past four decades, the role of R&D in productivity growth has been well recognized as a large number of economic research centers have been developed, showing the importance of public investment in the public politics. To further understand this, the research by scholars such as Coa & Moghadam, 1993; Griliches 1998, can be viewed.

2.2. Government size, health expenditure , and GDP growth

Governments tend to absorb a sizeable share of society's resources and, therefore, they affect economic development and growth in many countries. However, despite necessary, government intervention is not a sufficient condition for prosperity, if it leads to the monopolization of the allocation of resources and other important economic decisions, ; and as such societies do not succeeded in attaining higher levels of income. The existing literature presents mixed results as to the relationship between government size and economic development. On the one hand, government activities may also have positive effects due to beneficial externalities, the development of a legal, administrative and economic infrastructure, and interventions to offset market failures (Afonso & Lalles, 2011).

On the other hand, the former may impact economic growth negatively due to government inefficiencies, crowding-out effects, the excess burden of taxation, the distortion of the incentives systems and interventions to free markets (Barro, 1991; Bajo-Rubio, 2000). Indeed, several studies report that the efficiency of government spending can increase, either by delivering the same amount of services with fewer resources or by using more efficiently the existing spending levels (see Afonso, Schuknecht, & Tanzi, 2005, 2011). Moreover, Slemrod (1995) and Tanzi and Zee (1997) found a negative impact if the size of government exceeds a certain threshold. The rationale behind this argument is that in countries with big governments, the share of public expenditures designed to promote private sector productivity is typically smaller than that in countries with small governments (Folster and Henrekson, 2001). On the other hand, government activities may also have positive effects (see Ghali, 1998; Dalagamas, 2000).

In recent years, there has been a renewed interest in studying the determinants of economic growth (Krmendi & Meguire, 1985; Barro 1989, 1991). Previous empirical studies have readily acknowledged that government has both positive and negative effects on growth. These counterbalancing influences have been taken into account, for the most part, either by acknowledging the possibility that the coefficient measuring the net impact of government on growth may be positive or negative (Landau, 1983; ram, 1986; Grier & Tullock, 1989). Many studies confirmed the positive nexus of health expenditure and income for panel data such as (Gerdtham & Lothgrem, 2000; Hitiris & Posnett, 1992; Viscusi, 1994; Hansen & King, 1996; Blomquist & Carter, 1997.

3. Methodology

3.1. Research Goal

The main goal of this study was to examine the relationship between e-commerce, research and development (R&D) expenditure, health expenditure, government size and economic development (GDP per capita based on the purchasing power parity) in 21 selected countries[1].

3.2. Sample and Data Collection

This study used the panel model technique with GLS method during the period of 2005 to 2013, due to its many advantages Baltagi (2005). The following model was employed. The model could be specified as follows:

$$GDPP_{it} = \alpha + \beta_1 EC_{it} + \beta_2 R\&D_{it} + \beta_3 GS_{it} + \beta_4 HE_{it} + \varepsilon_{it} \quad (1)$$

Where α is the intercept, β_1, β_2, β_3 and β_4 are the slope coefficients of the models, t is time i is the cross section unit (ith country). GDPP is the GDP per capita based on the purchasing power parity measured in current US dollars. EC is the e-commerce measured in Internet purchases by individuals. R&D is the research and development expenditure. GS is the government size based on general government final consumption expenditure measured in current US dollars. HE is the health expenditure, total measured in percentage of GDP. Government size and GDP per capita based on the purchasing power parity are taken from the World Development Indicators (WDI). Research and development expenditure and e- commerce are taken from the Eurostat.

The unit root test is tested to examine whether the variables contain a panel unit root. If the variables contain a unit root, the cointegration test is used to examine whether the long run relationships present between the variables. If the long run relationship is present, the GLS method is tested to find out the relationship between the variables.

3.3. Analyses and Results

3.3.1. Panel unit root test

Panel unit root testing has become one of the most popular tests used by researchers because it is more powerful than the normal time series unit root. One type of unit root tests, the Levin, Lin, and Chunt (2002), was used. The unit root test was developed by Levin and Lin the following equation:

$$\Delta X_{i,t} = \rho_i X_{i,t-1} + \delta t + \alpha_i + \varepsilon_{i,t} \qquad i = 1,2,\dots,N \quad , \quad t = 1,2,\dots,T \quad (2)$$

It has also considered a separate ADF regression for each cross section:

$$\Delta X_{i,t} = \rho_i X_{i,t-1} + \delta t + \alpha_i + \sum_{j=1}^{li} \theta_{ij} \Delta X_{i,t-j} + \varepsilon_{i,t} \quad (3)$$

The null and alternative hypothesis can be written as follows:

$$\begin{cases} H_0: \rho_i = 0 \\ H_1: \rho_i = \rho < 0 \end{cases} \quad (4)$$

Where the *i* may be reordered as necessary which may be interpreted as a non-zero fraction of the individual processes.

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[1]. Austria, Belgium, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Luxembourg, Netherlands, Norway, Poland, Portugal, Slovak Republic, Slovenia, Spain, Sweden, United Kingdom.

Table 1

Panel unit root test.

Variable	Level (intercept)		First difference (intercept)	
Levin, Lin & Chunt	Statistic	Prob.	Statistic	Prob.
GDPP	-9.07565	0.0000**	-9.30724	0.0000**
EC	-0.46760	0.3200	-12.2654	0.0000**
R&D	-0.51880	0.3020	-6.98268	0.0000**
GS	-4.74038	0.0000**	-7.17583	0.0000**
HE	-9.13931	0.0000**	-15.2900	0.0000**

Note: ** denotes statistical significance at 1% level.

The above table reviews the panel unit root test results and shows that all the variables are stationary at the first difference, thereby rejecting the null hypothesis at 1% level of significance. This indicated that the variables contained a panel unit root.

3.3.2. Panel cointegration tests

Since the variables contained a panel unit root, the cointegration test was used. The Pedroni test was employed in this study to examine whether the e-commerce and R&D had a long run relationship with the GDPP in the selected countries. The panel cointegration was considered to be much better than the time series cointegration because it could show the long run relationship between the variables for N (≥ 2) countries. The Pedroni (Engle-Granger based) cointegration tests were used in this study due to the fact that Pedroni made several tests for cointegration, thereby allowing for heterogenous intercepts and trend coefficients across cross-sections. Consider the following regression:

$$y_{it} = \alpha_i + \delta_{it} + \beta_1 x_{1,it} + \beta_2 x_{2,it} + \cdots + \beta_{ki} x_{k,it} + \varepsilon_{it} \quad (5)$$

where t =1,., T; i = 1,., N; j = 1,., k; and y and x are assumed to be integrals of the order 1, i.e., I(1). The parameters α_i and δ_i are individual entity and time effects, respectively, which maybe set to zero if desired. Under the null hypothesis of no cointegration, the residuals $\mathcal{E}_{it}$ will be $I(1)$. Pedroni constructs various statistics for testing the null hypothesis of no cointegration i.e., H_0: ρ_i= 1, for all i, where ρ_i is the coefficient of the estimated residual. There are two different alternative hypotheses. The first one states that the cointegrating vector β_i is homogenous, i.e., H_1: $\rho_i = \rho < 1$; for all i, Pedroni terms are the within-dimension or panel statistics test (Pedroni, 1999).

The second one states that the cointegrating vector β_i is heterogeneous, i.e., H_1: $\rho_i < 1$; for all i, Pedroni terms are between dimension or group statistics test. These cointegration statistics are the Panel v-statistics, Panel p-statistics, Panel t-statistic (nonparametric), Panel t-statistic (parametric), Group ρ-statistics, Group t-statistics (non-parametric), and the Group statistics (parametric). The first four cointegration statistics refer to the within-dimension or panel statistics test and the last three refer to the those between dimension or group statistics test (Pham & Nguyen, 2010).

Table 2

Pedroni cointegration test result.

	Statistic	Prob.	Statistic	Prob.
Panel v-Statistic	-2.296173	0.9892	-3.555419	0.9998
Panel rho-Statistic	3.645799	0.9999	3.667499	0.9999
Panel PP-Statistic	-5.297472**	0.0000	-2.439324**	0.0074
Panel ADF-Statistic	-3.260070**	0.0006	-4.650530**	0.0000
	Statistic		Prob.	
Group rho-Statistic	5.567620		1.0000	
Group PP-Statistic	5.960530**		0.0000	
Group ADF-Statistic	-5.268434**		0.0000	

** denote significance at 1%.

Table 2 shows the Pedroni cointegration test results for the GDPP model. From the results, it could be seen that most of the statistics in the GDPP model rejected the null hypothesis of no cointegration. This indicated that all independent variables such as e-commerce, research and development (R&D), government size, and health expenditure had a long run relationship with the GDP per capita based on the purchasing power parity. This was the same result obtained by such previous studies as (Hansen and King, 1996; Blomqvist & Carter 1997).

3.3.3. Regression method

GLS was first described by Alexander Aitken in 1934. Assumptions in GLS regression include (Hojjat et.al 2010): (1) regression coefficients are linearly related, (2) all predictors must have a constant variance, (3) residuals shall not correlate with each other (serial correlation), (4) residuals have a constant variance, (5) no predictor variable is perfectly correlated with one another (to avoid multi-collinearity), and (6) residuals are normally distributed. To estimate the model, we assume that the width of the source is different for different countries (fixed or random effects).

To see if the width of the source for all sections is the same or not, we tested F and statistics of F as follows:

$$F = \frac{(SSR_{pool} - SSR_{Fixed}) / N - K}{SSR_{Fixed} /(NT - (N + K))} \tag{6}$$

Based on those data, we have NT-(N+K), N-K. If the denominator in which SSR_{pool} is the total square error in estimating the width of the same origin and SSR_{fixed}, the sum of squared error in the estimation method is proven to work; also, N, K, T, respectively, during this period, refer to the number of independent-variables and the number of sections. To experiment the theory of H_0 and compare its compatibility with those estimations that have accidental or inadvertent effects in front of H_1 as the incompatibility of accidental statistics, we can use this formula:

$$h = X^2(k) = \left[b - \hat{\beta}\right]' \sum^{-1} \left[b - \hat{\beta}\right] \tag{7}$$

,where by

$$\sum = Var\left[b - \hat{\beta}\right] = Var[b] - Var\left[\hat{\beta}\right] \tag{8}$$

And b is representative of Fixed-Effects estimation of the methods, their effects on β̂ estimation of the methods could be taken as random effects, and computational statistics for the test and the test of Human are shown in Table 3 below.

Table3.

The Fixed effects and Hausman test

	Static	d.f.	Prob
Fixed Effects Tests	137.334572	(20,163)	0.0000**
Hausman Test	28.907288	4	0.0000**

According to Table 1, we can come to the conclusion that the model should be estimated by using fixed effects. We now know that in the previous time series data, before calculating the respective Model, we should ensure the sustainability and stability of the variables. The ensuing results, as assembled as by "Model-estimation" and in accordance with the Fixed-effects test, are shown on Table 4.

Table 4.

The result of regressive estimation

Variables	Coefficients value	t-test value	p-value	Residual error
C	-1.75E+11	-3.289810	0.0012**	5.32E+10
EC	7.98E+08	4.866572	0.0000**	1.64E+08
R&D	1.68E+10	3.233674	0.0015 **	5.20E+09
GS	5.800631	14.48399	0.0000**	0.400486
HE	9447917	3.297148	0.0012**	2865481
		F-test value	2702.064	
		R^2 value	0.997523	

** refer to 1% levels of significance. Estimating the fixed effects-model

In this section, the GLS method was used to estimate the parameters of the proposed model, as shown in Eq.1. Table 4 shows the regression results. As can be seen, all results were significant and the signs of all coefficients were according to theoretical expectations. The corresponding correlation coefficient (R_2) was 0.9975, showing a high estimate of the signal-strength, which could be regarded as further evidence for the high strength of the explanations derived from the model as well as to delete fluctuations in consistency; we used estimation by means of weight. Coefficient of the e-commerce was equal to 7.98, implying that with an increase in e-commerce, 7.98 unit of GDP per capita was added. The coefficient of the R&D expenditure was equal to 1.68, showing that a rise in R&D expenditure would lead to 0.0168 percent increase in the GDP per capita. In addition, with one unit increase in government size, GDP per capita could be increased by 5.8 unit; finally, health expenditure could affect GDP per capita significantly. According to F-test, E.q. 1. was at a significance level of 0.0000.

4. Conclusion

This study investigated the impact of the e-commerce and R&D, health expenditure and government size on the GDP per capita in twenty one selected countries, namely, Austria, Belgium, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Luxembourg, Netherlands, Norway, Poland, Portugal, Slovak Republic, Slovenia, Spain, Sweden, and United Kingdom. The panel model with GLS method was used to investigate the period of 2005-2013. The results showed that the explanatory variables in the selected countries played a significant role in the per capita income. In other words, it was revealed that e-commerce and R&D expenditure with GDP per capita had a long run impact based on the cointegration test results; also, both e-commerce and R&D expenditure were found to have a positive impact on GDP per capita, but e-commerce had a stronger development-enhancing effect. In addition, other variables such as government size and health expenditure also had a positive influence on GDP per capita. According to these findings, the level of government activity has led to a growing interest in the positive analysis of the size of government (Borcherding, 1977; Brunner, 1978; Frey, 1982; Meltzer & Richard, 1978, 1981; Peltzman, 1980; Fratianni & Spinelli, 1982), such that the present paper could be regarded as a contribution to that analysis.

Therefore, the policy this study recommends is that because of the importance of e-commerce in economic development and social welfare, governments should adopt appropriate policies and provide the necessary conditions

for the development and promotion of ICT. For this purpose, according to the findings of empirical research, it is recommended that the government pay further attention to economic planning in order to improve e-commerce indicators, so that the total government measurements could eventually lead to economic development in the country. Our empirical results provided a good reference for other developing countries. In the future, we hope to further discuss the decomposition of e-commerce transactions into sales and procurement (e-sales or e-procurement), along with the relationship between knowledge variables, when more detailed data would become available. It would also be interesting to distinguish between different channels (reduction of the transaction cost between buyers and sellers or strong efficiency improvement in the production and supply of chain processes) through which e-commerce can raise GDP and employment.

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