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The Impact of Information and Communication Technology Use on Economic Growth

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Abstract: This paper studies the impact of Information and Communication Technology (ICT) use on economic growth in different countries and regions of the world. The results indicate that there is a positive relationship between growth rate of real GDP per capita and ICT use index (as measured by the number of internet users, fixed broadband internet subscribers and the number of mobile subscription per 100 inhabitants) for 159 countries over the world. This study also finds that ICT use in the high income group has a higher effect on economic growth than other groups. This implies that if these countries seek to enhance their economic growth, they need to implement specific policies that facilitate ICT use.

Keywords: Economic growth, Information and Communication Technology use.

1. Introduction

At the present time, ICT has become a serious part of economy. Almost all firms and consumers use computers and Internet connection for economic purposes, such as providing consumers with a more diversified and customized products, improving product quality, and selling goods and services. However, country data on computer, cell phone, and Internet users illustrate different ICT diffusion rates across countries and between regions, even among those with the same levels of economic development. In fact, ICT is the combination of electronics, telecommunications, software, networks, and decentralized computer work stations, and the integration of information media (Granville et al. 2000), all of which impact firms, industries, and the economy as a whole. ICT is comprised of a variety of "communication equipment" which includes radio, TV, and communication equipment and software. Therefore, ICT investment includes "investments in both computer and telecommunications, as well as related hardware, software and services" (Dedrick et al. 2003).

In this article, we would like to examine the relationship between ICT use and growth rate of GDP per capita in 159 countries. Although many researchers have provided empirical evidences for the correlation between ICT investment and economic growth, study on the impact of ICT use on economic growth is still an unexplored area. Therefore, this article would fill the literature gap on the effect of ICT use. We deployed panel data analysis for the sample of 159 countries over the period 2000-2009.

The organization of the paper is as follows: The next section is a review of relevant studies on the impact ICT on Economic growth. Section 3 presents the data and methodological framework. Section 4 shows the empirical findings and discussion on the possible imitations. Finally, Section 5 concludes the article with a few issues on policy implications.

2. Literature Review

The high growth performance of the United States over the 1990s has attracted the attention of economists to the sources of growth in economy. Some studies (Scarpetta et al. 2000; Gust & Marquez 2000) have shown that there is no single factor that affects on the growth performance, over the past few years. ICT plays two basic roles in this process, first through capital deepening which is the result of increasing the

overall investment, second by contributing to Total Factor Productivity growth. Many empirical studies (e.g. Colecchia & Schreyer 2001; Jorgenson 2001; Van Ark et al. 2002) confirmed the effect of ICT investment on growth performance. The ICT investment is commonly associated with rapid technological progress and competition in the production of ICT goods and services, which have contributed to a steep fall in ICT prices and encourage investment in ICT.

On the other hand, there is some optimistic view which suggests that developing countries may have an advantage over advanced countries with respect to ICT diffusion. Antonelli (1991) mention that switching from the predominant technology paradigm to a new "ICT-oriented paradigm" imposed significant costs to developed countries which can effectively lock these countries into those paradigms and simultaneously, important opportunities open up for less-industrialized countries to catch up and even "leapfrog" beyond the industrialized countries because they have relatively lower switching costs (Seo & Lee 2006).

Another study that concentrates on the telecommunication development is Lam and Shiu (2010). They use the number of fixed-line and mobile phone subscribers per 100 persons as an index of telecommunication development and indicate that there is a bi-directional relationship between real GDP and telecommunications development for European and high income countries. Their studies show that countries with competition and privatization in telecommunications have achieved a higher TFP growth than those without competition and privatization. While there have been numerous studies on the effect of ICT investment on economic growth, very few is done about the impact of ICT use on economic growth. The main hypothesis of this paper is that the effects of ICT use (as measured by the number of internet users, fixed broadband internet subscribers and the number of mobile subscription per 100 inhabitants) on economic growth is positive and significant. We present results based on the Generalized Method of Moments (GMM) estimator. Combining data for the 159 countries, we find that ICT use has a positive impact on output growth.

3. Methodology and Data

3.1. The Conceptual Form

This study uses a dynamic panel data model (see Shiu &Lam, 2008) to investigate the impact of ICT use on economic growth. The model is shown as follows:

$$GDP_{it} = \alpha_1 + \sum_{m=1}^{M} \beta_m ICT_{i,t-m} + \sum_{m=1}^{M} \gamma_m GDP_{i,t-m} + \mu_i + \eta_t + \upsilon_{it}$$

GDP and ICT refer to logged real GDP per capita and logged ICT use indicator, respectively, and *m* indicate the level of lags for these two variables. *i* and *t* represent the countries in the sample, and the time periods. μ_i is the unobserved country-specific effect, and η_t is the time period dummy. The error term is represented by υ_{it} . After first-differencing, we have:

$$GDP_{it} - GDP_{i,t-1} = \sum_{m=1}^{M} \beta_m (ICT_{i,t-m} - ICT_{i,t-m-1}) + \sum_{m=1}^{M} \gamma_m (GDP_{i,t-m} - GDP_{i,t-m-1}) + (\upsilon_{it} - \upsilon_{i,t-1})$$

In this equation there is correlation between the new error term and the differenced lagged-dependent variable, therefore, the estimation still yields biased results. In order to solve this problem, the GMM estimator suggested in Arellano and Bond (1991) is used for the estimation. In this method lags of the dependent and independent variables are used as instruments. In this study, we consider lags up to four years and the dynamic panel data model is then applied to the complete panel dataset.

3.2. The Data

GDP per capita in US dollars at constant 2005 prices, using the purchasing power parity (PPP) exchange rates has directly obtained from World Development Indicators (WDI). This study calculates the ICT use index following the two reports -measuring the information society in 2009 and 2010- presented by International Telecommunication Union (ITU). The ICT use index includes three indicators, Internet user penetration, fixed broadband penetration, and mobile broadband penetration and captures the level of ICT use in more than 150 countries worldwide. The ICT data presented in the reports and used to construct the

index are all collected by ITU, mostly through its annual questionnaire sent to governments. For more detail and background to the creation of ICT use index, one can refer to the ICT reports.

4. Findings and Discussion

Our estimated results based on the GMM -dynamic panel data- are summarized in Table 1. Broadly, the results confirm the expected relationship between the real GDP per capita and ICT use index. As table 1 show, all variables have signs that are consistent with theory predictions. In the context of GMM, the over-identifying restrictions may be tested via the commonly employed J-statistic of Hansen (1982). The J statistic is distributed as $\chi 2$ with degrees of freedom equal to the number of over-identifying restrictions (L – K). L is the number of instrumental variables and K is the number of explanatory variables. J is the most common diagnostic test in GMM estimation to analyze the appropriateness of the model. A rejection of the null hypothesis shows that the instruments are not properly chosen. This may be either because they are not truly exogenous, or because they are being incorrectly excluded from the regression (Baum et al. 2003). In this paper the J-statistic rejects the null hypothesis of correlation between residuals and instrumental variables. Therefore, the credibility of the results for interpretation is verified and the results can be interpreted in a high level of confidence.

The coefficient of ICT use index is positive and statistically meaningful at 1% significance level. It means that the more a country use ICT, the greater is its economic growth. The statistics presented by the ITU and other international organizations indicate an increasing trend of ICT use indicators in most of these countries, it means that these countries recognized the important effect of ICT on their economic growth. They also verify the hypothesis of this paper that ICT use has a significant growth generating effect. The signs of the first lagged of ICT use index and GDP per capita coefficient are positive and highly significant that implies the positive effect of these variables on economic growth. Moreover the second, third and forth lagged of ICT and GDP are negative and mostly insignificant.

Table 1. Estimation Results using GMM Estimator

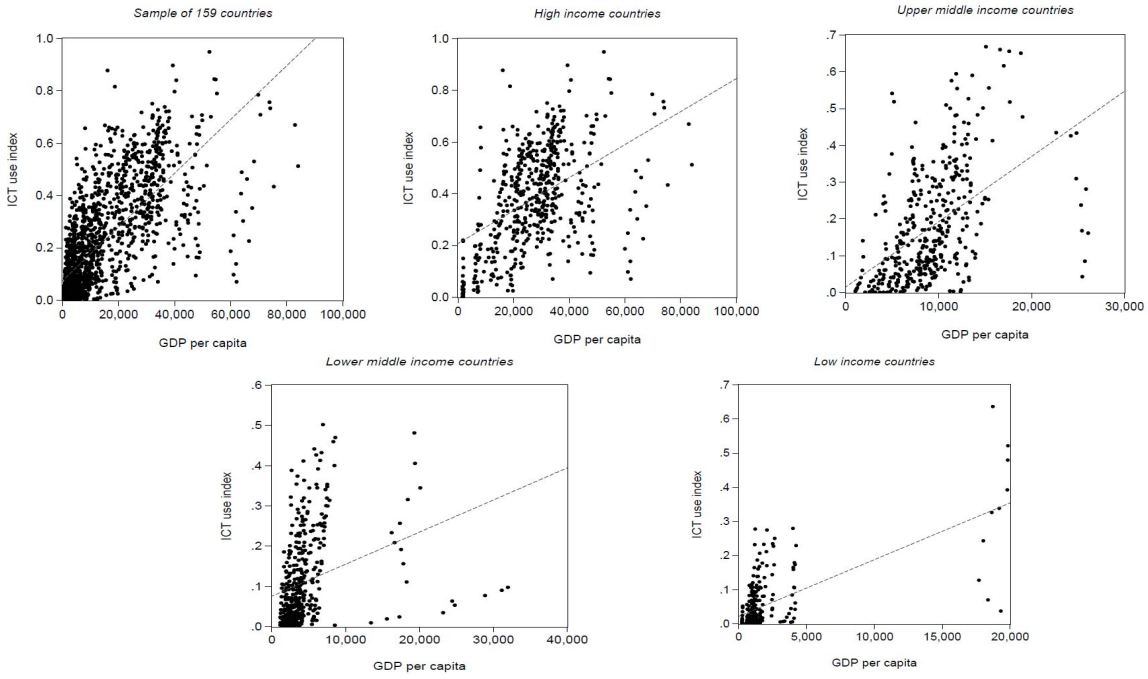
Variable	**Coefficient**	**T-statistic**
ICT	0.014	2.82***
ICT(-1)	0.023	2.59***
ICT(-2)	-0.004	-0.44
ICT(-3)	-0.001	-0.13
ICT(-4)	-0.001	-0.24
GDP(-1)	0.61	12.39***
GDP(-2)	-0.001	-0.04
GDP(-3)	-0.069	-1.72*
GDP(-4)	-0.080	-2.34**
J-statistic	26.05***	
Total panel Observations	629	
Instrument Rank	11	
***, ** and * denote statistically significant at 1%, 5% and 10%, respectively. The dependent variable is the first-difference of the Ln(GDP) per capita and all variables are in Logarithm. GDP (-t) and ICT (-t), t=1, 2, 3, 4 are lagged variables of GDP and ICT use index respectively.		

For further analysis of the impact of ICT use on economic growth, we categorized the sample of 159 countries by different income levels. The results based on GMM method are summarizes in Table 2. Based on the table, in all the groups except the low income group, ICT use index has a positive and significant effect on economic growth which is in line with this paper hypothesis. Moreover, the ICT coefficient for the high income group is 0.086, which is the highest among the four income groups while, this coefficient for the low income group is just 0.002 and not significant. Table 2 also shows that the first lagged of ICT use index for low income countries is positive and significant at 5% significance level. These empirical results are consistent with the findings of Lam and Shiu (2010).

Table 2. Estimation Results using GMM Estimator based on different income levels

Variable	**Coefficient**			
Income level	**High**	**Upper middle**	**Lower middle**	**Low income**
ICT	0.086 (3.09)***	0.047 (3.53)***	0.019 (3.81)***	0.002 (0.63)
ICT(-1)	0.008 (0.45)	0.037 (1.88)*	0.034 (2.53)**	0.010 (2.51)**
ICT(-2)	-0.016 (-0.47)	0.001 (0.06)	-0.022 (-1.79)*	-0.004 (-0.90)
ICT(-3)	-0.071 (-3.65)***	0.015 (0.69)	0.004 (0.28)	0.005 (1.34)
ICT(-4)	0.046 (2.09)**	-0.011 (-0.71)	-0.003 (-0.29)	0.000 (0.28)
GDP(-1)	0.742 (3.58)***	0.775 (4.00)***	0.270 (2.58)***	0.241 (1.83)*
GDP(-2)	-0.026 (-0.24)	-0.064 (-0.68)	-0.205 (-2.97)***	0.238 (1.47)
GDP(-3)	-0.067 (-0.41)	-0.215 (-4.43)***	0.341 (2.32)**	-0.015 (-0.36)
GDP(-4)	-0.312 (-3.39)***	-0.114 (-2.66)***	0.002 (0.03)	0.075 (1.25)
J-statistic Total panel Observations Instrument Rank	6.93 202 11	8.55 156 11	1.65 160 11	1.72 116 11
T-statistic in parentheses; ***, ** and * denote statistically significant at 1%, 5% and 10%, respectively. The dependent variable is the Ln(GDP) and all variables are in Logarithm. GDP (-t) and ICT (-t), t=1, 2, 3, 4 are lagged variables of GDP and ICT respectively. Number of High income countries are 51, Upper-middle income 39, Lower-middle income 40 and Low income 29.				

The Following graphs also indicate the strong correlation between ICT use index and real GDP per capita in the sample of 159 countries, high, upper middle, lower middle and low income groups, respectively. The distribution around the trend line is fairly homogenous, especially for high and upper middle income countries.



5. Conclusions and Implications

This paper concentrated on exploring the effect of ICT use index on economic growth. The results show

that ICT use has a significant effect on the economic growth of these countries. The coefficient measuring the effect of the ICT use on economic growth was positive, indicating that ICT affect economic growth of the 159 sample countries in a positive way. Furthermore, in high income counties ICT use index has the strongest effect on real GDP per capita among the others and low income countries are affected by ICT use index after a one year delay. In other words, the performance of the low income group countries in the effect of ICT use index is somewhat lagging. Therefore these countries can improve their overall GDP growth with policies aimed at increasing ICT use.

Consequently, ICT plays a vital role as a mean for economic growth. Therefore, it seems necessary for all countries to increase their ICT use index through increasing the number of internet users, fixed broadband internet subscribers and the number of mobile subscription per 100 inhabitants in order to boost economic growth. It is also essential for the governments to provide the society with information, up-to-date structures and educate people in order to use ICT efficiently. The major research limitation of this study was the failure to collect data for a longer time period. Therefore future research for a longer time span would shed more light in the assessment of the relationship between ICT use and economic growth.

6. References

[1] Antonelli, C. 1991. The diffusion of advanced telecommunications in developing countries. Paris: Organization for Economic Co-operation and Development (OECD).

[2] Arellano, M. & Bond, S. 1991. Some tests of specification for panel data: Monte Carlo evidence and an application to employment equations. Review of Economic Studies 58: 277-297.

[3] Baum, C. F., Schaffer M. E., & Stillman, S. 2003. Instrumental Variables and GMM: Estimation and Testing. Boston College Working Paper 545.

[4] Colecchia, A. & Schreyer, P. 2001. ICT investment and economic growth in the 1990s: Is the United States a unique case? A comparative study of nine OECD Countries (STI Working Paper). Paris: Organisation for Economic Co-operation and Development.

[5] Dedrick, J., Gurbaxani, V. & Kraemer, K.L. 2003. Information technology and economic performance: A critical review of the empirical evidence. ACM Computing Surveys 35(1): 1-28.

[6] Granville, B., Leonard, C., & Manning, J. 2000. Information technology and developing countries: Potential and obstacles. Tokyo Club Meeting, Munich, Germany, 19-20.

[7] Gust, C. & Marquez, J. 2000. Productivity Developments Abroad. Federal Reserve Bulletin: 665-681.

[8] Hansen L.P. 1982. Large Sample Properties of Generalized Method of Moments Estimators. Econometrica 50(4): 1029-1054.

[9] International Telecommunication Union 2009. & 2010. Measuring the Information Society: The ICT Development Index, Place des Nations CH-1211 Geneva Switzerland

[10] Lam, P. L. & Shiu, A. 2010. Economic growth, telecommunications development and productivity growth of the telecommunications sector: evidence around the world. Telecomm. Policy, 34(4): 185-199.

[11] Jorgenson, D.W. 2001. Information Technology and the U.S. Economy. American Economic Review 91(1): 1-32.

[12] Scarpetta, S., Bassanini, A., Pilat, D. & Schreyer, P. 2000. Economic Growth in the OECD Area: Recent Trends at the Aggregate and Sectoral Levels, OECD Economics Department Working Papers, OECD, Paris.

[13] Seo, H. & Lee, Y. 2006. Contribution of information and communication technology to total factor productivity and externalities effects. Information Technology for Development 12(2): 159-173. Retrieved September 26, 2007 from Business Source Premier Database.

[14] Shiu, A. & Lam, P. L. 2008. Causal relationship between telecommunications and economic growth in China and its regions. Regional Studies, 42, 705–718.

[15] Van ark, B., Melka, J., Mulder, N., Timmer, M. & Ypma, G. 2002. ICT Investment and Growth Accounts for the European Union, 1980-2000. DGECFIN, European Commission, Brussels, September, www.eco.rug.nl/ggdc/homeggdc.html