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DOES INFORMATION AND COMMUNICATION TECHNOLOGY DEVELOPMENT CONTRIBUTES TO ECONOMIC GROWTH?

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ABSTRACT

This paper studies the impact of Information and Communication Technology (ICT) development on economic growth in different countries and regions of the world. The results indicate that there is a positive relationship between real GDP growth and ICT development (as measured by the ICT Development Index) for 153 countries over the world. This study also finds that ICT development in the upper-middle income group has a higher effect on economic growth than other countries. This implies that if these countries seek to enhance their economic growth, they need to implement specific policies that facilitate ICT development.

Keywords: *Economic growth, Information and Communication Technology development, ICT*

1. INTRODUCTION

At the present time, Information and Communication Technology 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 [1], 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" [2].

In this article, we would like to examine the relationship between development in ICT and GDP growth in 153 countries. Although many researchers have provided empirical evidences for the correlation between ICT investment and economic growth, study on the impact of ICT development on economic growth is still an unexplored area. Therefore, this article would fill the literature gap on the effect of ICT development. We deployed panel data analysis for the sample of 153 countries in 2002, 2007 and 2008.

The organization of the paper is as follows: The next section is a review of relevant studies on the impact ICT on Economic growth. Methodological framework and data will be presented in Section three. The empirical findings and discussion are in section four. Finally, section five concludes the article with a few issues on policy implications.

2. REVIEW OF LITERATURE

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 [3-4] 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. [5-7]) confirmed the effect of ICT

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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 [8] 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 [9].The only study which concentrates on the telecommunication development is Lam and Shiu [10]. They indicate that there is a bi-directional relationship between real GDP and telecommunications development as measured by teledensity for European and high income countries. Their studies show that countries with competition and privatization in telecommunications have achieved a higher Total Factor Productivity (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 development on economic growth. The main hypothesis of the paper is that the effect of ICT development as measured by the IDI on economic growth is positive and significant. We present results based on the Generalized Method of Moments (GMM) estimator. Combining data for the 153 countries, we find that ICT has a positive impact on output growth.

3. METHODOLOGY AND DATA

3.1. Conceptual Form

This study uses a dynamic panel data model [11] to investigate the impact of ICT development 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 development indicator, respectively, and m indicate the level of lags for these two variables. *i* and *t* represent countries and time period, respectively. μ_i is the unobserved country-specific effects, 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 [12] is used for the estimation. In this method lags of the dependent and independent variables are used as instruments. In this study, we encounter data limitation for IDI and consider lags only up to one period. The dynamic panel data model is then applied to the complete panel dataset and to the sub-groups based on income level.

3.2. Data

GDP per capita in constant 2000 prices in US dollar has directly obtained from World Development Indicators [13]. The extracted from two reports presented by International Telecommunication Union (ITU), measuring the information society in 2009 and 2010, [14-15]. The Index captures the level of advancement of ICTs in more than 150 countries worldwide. This composite index consists of ICT readiness, referring to infrastructure and access, ICT use and intensity of use and ICT impact capturing ICT capability or skills.

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. They are complemented by data capturing literacy and enrolment, sourced from UNESCO. By combining multiple indicators into a single value, the IDI will provide a holistic picture on the state of ICT development within a country. For more detail and background to the creation of IDI index, one can refer to the ICT reports.

4. FINDING AND DISCUSSION

Our estimated results based on the GMM-dynamic panel data- are summarized in Table 1. Broadly, the results confirm the expected

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relationship between the real GDP per capita and ICT development. 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 [16]. 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 [17]. 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.

Table 1. Estimation Results using GMM Estimator

Variable	**Coefficient**
IDI	0.153 (3.66)***
IDI(-1)	0.004 (0.41)
GDP(-1)	0.099 (6.29)***
J-statistic	48.94***
Total panel Observations	153
Instrument rank	4

Note:

T-statistic in parentheses;

***, ** and * denotes statistically significant at 1%, 5% and 10%, respectively.

The dependent variable is the first-difference of the Ln(GDP) and all variables are in Logarithm.

GDP (-1) and IDI (-1) are lagged variables of GDP and respectively.

The coefficient of ICT development is positive and statistically meaningful at the probability level of 99%. Since all variables are in logarithm, the value of coefficients represents their elasticity. For example the IDI coefficient 0.15 implying that a 1% increases in ICT development would lead to 15% economic growth in these countries. The statistics presented by the World Bank and other international organizations indicate an increasing trend of IDI 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 has a significant growth generating effect. The sign of first lagged of IDI coefficient is positive but not significant. Since the first lagged coefficient of GDP is 0.099 and statistically significant at a high level that implies the positive effect of this variable on economic growth.

For further analysis of the impact of ICT development on economic growth, we categorized the sample of 153 countries by different income levels. The results based on the Two Stage Least Squares (TSLS) method are summarizes in Table 2. In all the income groups ICT development has a positive and significant effect on economic growth which is in line with this paper hypothesis. Moreover, the IDI coefficient for the upper-middle income group is 0.75, which is the highest among the four income groups while, this coefficient for the low-income group is just 0.20. These empirical results are consistent with the findings of Lam and Shiu [10].

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

Variable	Coefficient			
Income level	**High**	**Upper middle**	**Lower middle**	**Low income**
IDI	0.61 (6.32)***	0.75 (7.54)***	0.53 (6.24)***	0.20 (1.69)**
IDI(-1)	-0.58 (-31.90)***	-0.74 (-7.99)***	-0.56 (-6.04)***	-0.16 (-1.62)*
GDP(-1)	0.99 (60.21)***	0.99 (25.36)***	0.99 (15.50)***	1.00 (22.53)***
Adjusted R-squared	0.97	0.99	0.94	0.96
Durbin -Watson stat.	1.80	1.78	1.95	1.95

- T-statistic in parentheses;
- ***, ** and * denotes statistically significant at 1%, 5% and 10%, respectively.
- The dependent variable is the Ln(GDP) and all variables are in Logarithm.
- GDP (-1) and IDI (-1) are lagged variables of GDP and IDI respectively.
- Number of High income countries are 46, Upper-middle income 37, Lower-middle income 38 and Low income 32.

In addition, we perform cross sectional estimation for GDP per capita as a dependent variable and IDI as an independent variable to explore the effect of IDI on GDP growth in each year. The estimation results are in table 3. Since the IDI coefficients are very close in 2002, 2007 and 2008; it can suggest a similar trend in these three years.

Table 3. Cross Sectional Estimation using TSLS

Variable	Coefficient		
Year	**2002**	**2007**	**2008**
C	5.84 (70.9)***	5.35 (54.2)***	5.21 (48.8)***
IDI	2.52 (28.7)***	2.46 (29.8)***	2.44 (28.9)***
Adjusted R-squared	0.84	0.85	0.84
Durbin -Watson stat.	2.20	2.16	2.14

- T-statistic in parentheses;
- ***, ** and * denotes statistically significant at 1%, 5% and 10%, respectively.
- The dependent variable is the Ln(GDP) and all variables are in Logarithm.

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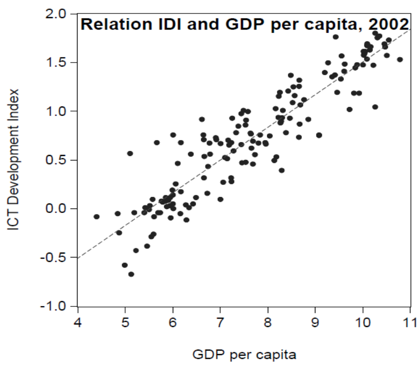
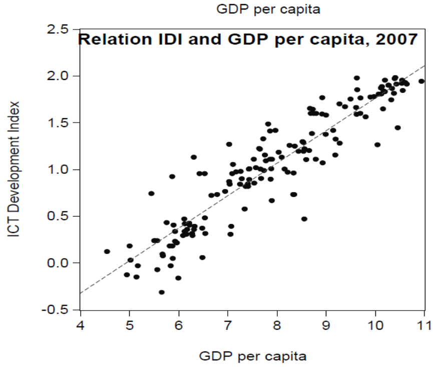
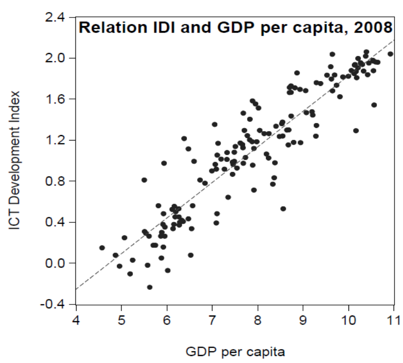
The Following graphs also indicate the strong correlation between IDI and real GDP per capita in 2002, 2007 and 2008 separately. The logarithmic model presented in those charts provides a good fit for the data, with a correlation coefficient of 0.49, 0.68 and 0.71 in 2002, 2007 and 2008 respectively.







5. CONCLUSION AND IMPLICATIONS

This paper concentrated on exploring the effect of ICT development on economic growth. The results show that ICT development has a significant effect on the economic growth of these countries. The coefficient measuring the effect of the ICT development on economic growth was positive, indicating that ICT affect economic growth of the 153 sample countries in a positive way. 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 development and economic growth.

Consequently, ICT plays a vital role as a mean for economic growth. Therefore, it seems necessary for all countries to increase their IDI in order to boost economic growth. It is essential for the governments to provide the society with information, up-to-date structures and educated people in order to access and use ICT efficiently.

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