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The Impact of ICT on Economic Growth Using ICT Development Index A Case Study of Selected Countries

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Abstract
The present study was to investigation the impact of information and communication technology (ICT) by using the ICT Development Index (IDI) and other economic policy variables on economic growth of the selected countries including some MENA group and some other countries in the region for the period 2010-2017 using a panel-GMM type of growth model. The results extracted from the integrated econometric model showed that elasticity in ICT section, it was estimated to be 0.175 and statistically significant. This means that one percent increase in ICT Development Index (IDI) caused economic growth to increase by 0.175 percent, respectively. Moreover, the impact of variables such as GDP per capita in the past period and exogenous rate of growth of the labor force were negative and the impact of the explanatory variables such as Gross Fixed Capital Formation, Educational Development Index and ICT Development Index were positive on the economic growth of the countries. All elasticities were statistically significant and close to theoretical expectations. Also by decomposing IDI into sub-indexes and estimation the models, the elasticities were estimated for IDI access sub-index (0.204), for IDI use sub-index (0.030) and for IDI skills sub-index (-0.093) and statistically significant.

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1. Introduction

The digital economy was first introduced in 1995 as the name of Canadian economist "Don Tapscott" book. This book was the first work to predict network-based economics in the information age. Since then, this meaning has been widely circulated around the world and discussions have begun about it (E Turban et al., 2002& 2009).

The ICT affects economic growth in general and productivity in particular in various ways. There are basically two types of impacts of ICT on productivity: direct and indirect effects. ICT is a part of produced goods (such as computer, network infrastructures) and services (such as information storages, communications). Technological progress and productivity growth in ICT-producing sectors have a direct impact on the economic productivity in proportion to the size of the ICT sector (Jorgenson et al., 2002). ICT also affects productivity in the sectors used.

After Robert Solow (1987) remarked the relationship between information technology and growth, the literature review reveals that the majority of researchers agree on the importance of ICT for the economic growth resurgence since the mid-1990s (Jorgenson et al., 2002; Oliner and Sichel, 2002; Daveri, 2003; Van Ark et al., 2008; Jalava. J., & Pohjola. M., 2008; Papaioannou and Dimelis, 2007).

According to Measuring the Information Society Report (ITU, 2015), the ICT Development Index (IDI) is a composite index that combines 11 indicators into one benchmark measure that can be used to monitor and compare developments in information and communication technology (ICT) between countries and over time. The IDI was developed by ITU in 2008 in response to requests from ITU Member States to develop an overall ICT index, was first presented in the 2009 edition of the Measuring the Information Society Report (ITU, 2015), and has been published with a biennial lag since then. The IDI framework form based on three dimensions – ICT access, ICT use and ICT skills.

The main objectives of the IDI are to measure (ITU, 2015):

- The level and evolution over time of ICT developments within countries and the experience of those countries relative to others;
- Progress in ICT development in both developed and developing countries;
- The digital divide, i.e. differences between countries in terms of their levels of ICT development; and
- The development potential of ICTs and the extent to which countries can make use of them to enhance growth and development in the context of available capabilities and skills.

The main objective of this study was to investigate the application of the ICT Development Index (IDI) to determine the impact of ICT parameters and other economic policy variables on economic growth in selected countries. Based on previous economic growth theories and available researches, a model of economic growth with emphasis on ICT parameters (IDI) and other economic policy variables in these countries identified, estimated and tested using the panel data method and GMM estimator from 2010 to 2017.

The framework of this paper is organized as follows: section 2 provides the related literature review in the world and Iran; the third section presented data and empirical model; the econometric analysis of the model and empirical results thus obtained are discussed in the section 4; and Section 5 concludes the paper with suitable policy implications.

2. Literature review

Following a book review by Robert Solow, which was published in the New York

Times in July 1987, the role of information and communication technology in productivity and economic growth was gained public attention. This article included the statement "[We] see the computer age everywhere..."(Solow, 1987), was raised up the discussion about the impact of ICT on productivity and growth and led to much effort to measure the economic impact of ICT. Since the 1980s, several studies have examined this issue.

One of the earliest studies has done by Oliner and Sichel (1994), they examined the impact of ICT capital on labor productivity in the period 1970-1992 for data collected of the United States. Because of the low level of ICT capital at that time, they estimated a small share of the ICT capital in labor productivity. The ratio of IT investment to total investment was small enough to have no significant economic impact. The share of IT capital in US capital investment was 3.5 percent in 1980 and nine percent in 1990, the share of IT capital increased to 22 percent in the 1990s.

Jorgenson and Stiroh (1995) supplemented the study of Oliner and Sichel (1994). They argue that the sharp decline in computer prices in the 1980s and 1990s led to a systematic underestimation of IT capital. Therefore they used a constant-quality price index for computing equipment and compensated the effect of the price decline. Their studies showed that the impact of information technology on US production is higher but not major. They found IT investments caused 0.5 percent incremental economic growth in the period 1985-1992.

Van Ark et al. (2008) examined the contribution of ICT capital and TFP on labor productivity growth in the EU for period 1973-2006. In their study, they claimed that the average annual growth of hourly labor productivity in the EU for period 1973-2006 was 2.4 percent over the period 1973-1995, which was twice as high as that rate in the U.S over the same period. This trend revolved in the next period. For period 1995-2006 in the U.S, the average annual growth rate was 2.3 percent, while in the EU it was only 1.5 percent.

In addition to previous mentioned studies on the selection of EU countries by Van Ark and others (2008), there was also a number of studies for OECD countries. They used growth accounting method almost. As one of the first studies, the role of ICT investment in productivity growth in the G7 countries (as an OECD subset) during the period 1996-1996 was examined by Schreyer (2000). He showed that ICT investment significantly explained productivity growth in all seven countries, although this varies across countries.

Colecchia and Schreyer (2002) examined the role of ICT investment in economic growth in nine OECD countries during the period 2000-2000. They found that in the early 1990s, ICT contributed 20-50% to economic growth. This contribution increased to 30-90% in the late 1990s, although contribution rates was differ between the countries. They found that rates were high for Australia, Finland and Canada and low for Germany, Italy and Japan.

Studies with large data samples show differences in ICT's contribution to productivity and economic growth in countries with different development status. Studies by Dewan and Kraemer (2000) for pre-1995 period showed the IT capital have positive and substantial returns in developed countries, but no substantial returns for developing countries. They suggested that this gap was due to low IT capital stock (relative to GDP) in developing countries and to the lack of complementary assets such as infrastructure and human capital. Pohjola (2002) didn’t found significant relationship between ICT and GDP growth in the two subgroups of developing and developing countries.

The above-mentioned studies carried out between countries use the growth accounting approach. But post-1995 studies were almost all based on estimates of production functions. These studies also lead to different conclusions. Papaioannou and Dimelis (2007) found the positive effects of ICT growth in developing and developed countries; the impact of ICT was higher in developed countries. Yousefi (2011) found a major role of ICT in the growth of high and upper middle income countries compared to low income countries in the period 2006-2006.

Among of the above mentioned authors, Yousefi (2011) has the largest data sample with 62 countries. The Becchetti and Adriani (2005) study has an even larger sample (up to 92 countries). The authors used other ICT components (such as the number of telephone lines and internet servers) as aproxy for ICT Instead of measuring ICT in terms of capital investment. These components are available for a wide range of developing countries and a large period.

Jalava. J, Pohjola. M (2008) showed that the share of ICT in Finland's GDP for 1990-2004 period was three times higher than the share of electricity between 1920 and 1938.

Orbicom's (2005) study over the period 2003–1995 in 153 countries showed a strong relationship between ICT development and economic growth. One percent increase in information sector index caused increasing 0.3 percent in GDP Per capita over this period.

Dividing 50 countries into six groups based on economic conditions by Khuong (2004) for examining the impact of ICT on economic growth, showed that ICT's contribution to overall output growth ranged from 6.4% for the period 1990-1995 to 11.8% for the period 1995-2000. It also had a positive impact on economic growth, with a 10% increase in ICT investment caused a 0.4% increase in output.

According to Nour (2002) studies in Egypt and some Arab countries of the Persian Gulf, ICT expenditures in most of these countries was positively correlated with economic growth. This indicated that the increase in these expenditures has had a positive effect on GDP in these countries during the period 1992-2000, but the size of this effect was not estimated.

The results of Dewan and Kraemer (2000) study on the effect of ICT capital return on development in developed and developing countries indicated that it is positive and significant for developed countries and not significant for developing countries. These results by using of the random effects method showed that the elasticity of production to ICT capital, non-ICT capital and labor force in developed countries were 0.057, 0.16 and 0.85, respectively, and for developing countries, respectively these were -0.59, -0.12 and 0.28, which were not significant.

3. Theoretical and empirical model

Information and Communication Technologies (ICTs) impact on economic growth by creating an economic infrastructure different from other high-performance economic infrastructures, both directly and indirectly. Due to simultaneous Connection and use for all users and world wide web, the efficiency of this infrastructure is higher than other economic infrastructures and thus for the expansion of ICT infrastructures, it has a positive impact on economic development in all countries. It is to be expected and the high impact of this infrastructure is on dissemination of information and organizational efficiency (Hardy, 1980). However, some economists also believe that ICT is a prerequisite for exploiting other infrastructural developments (such as transportation, education, etc.) that are essential for economic growth (Koutroumpis, 2009).

The research approach in this study was to measure the contribution of ICT infrastructures to long-term economic growth in the context of cross-country growth analysis over the period 2010-2017. To this end, we incorporated and extended the ICT segment variables in the usual regression model of Mankiw, Romer and Weil (1992), hereafter denoted as M.R.W, which augments the growth model of Solow (1956) by additionally considering human capital accumulation. M.R.W model for measuring long-term growth in different countries has modified greatly since its emergence in 1992. These modifications were related to the structure of the model or usage of different methods and approaches to solve the model. Extensions of model have been conducted by several authors, e.g. Knowles and Owen (1995), by adding health sector capital, Ram (2007) using IQ measurements or Aixala and Fabro (2007) with institutional indicators have given. The purpose of these modifications were often to increase the explanatory power of the model.

Effective usage of information and communication technology can improve knowledge-based activities in societies and caused economic growth. The process of the ICT impact on the development and growth of countries can be illustrated in Fig. 1. In this process the quality and quantity of outcomes depend on efficiency and effectively ICT use.

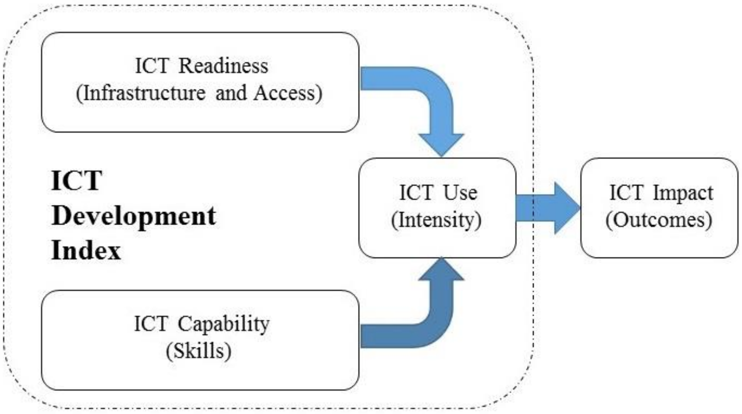

Figure 1: The process of ICT impact. (IUT, 2015).

The standard Solow growth model is Cobb-Douglas production function with constant return to scale. M.R.W (1992) modified the model by adding human capital as further production input. The modified production function is as follows:

$$\mathrm{Y}_{\mathrm{i,t}} = \mathrm{A}_{\mathrm{i,t}}.K^{\psi}{}_{i,t}.H^{\eta}{}_{i,t}.L^{1-\psi-\eta}{}_{i,t} \qquad (1)$$

Whereas Yit, Kit, Hit, and Lit represent real production, physical capital, human capital, and labor, respectively, Also Ait represents technical progress in the period t and ψ, and the coefficients of production elasticity to physical capital and human capital are measured. In this model, the constant exponential rates for labor and technology is assumed:

$$\mathrm{L}_{\mathrm{i,t}} = \mathrm{L}_{\mathrm{i,0}}.e^{\mathrm{n_i}t} \qquad (2)$$

$$\mathrm{A}_{\mathrm{i,t}} = \mathrm{A}_{\mathrm{t}} = \mathrm{A}_0.e^{\mathrm{g}t} \qquad (3)$$

Where n is the exogenous rate of labor force growth in the country and g is the exogenous rate of technology growth. The second assumption is that these rates are constant across countries. Therefore, it can be concluded that physical capital and human capital in effective units of labor are as follows:

$$\overline{k}_{it} = s_{ki}.y_{it} - (n_{it} + g_t + \delta_t).k_{it} \qquad (4)$$

$$\overline{h}_{it} = s_{hi}.y_{it} - (n_{it} + g_t + \delta_t).h_{it} \qquad (5)$$

$$k_{it} = \frac{K_{it}}{A_{it}.L_{it}}, \quad h_{it} = \frac{H_{it}}{A_{it}.L_{it}}, \quad y_{it} = \frac{Y_{it}}{A_{it}.L_{it}}$$

ski and shi represent the rate of accumulation of physical and human capital in country i, respectively. Additionally, the depreciation rate for both types of capital is δi and ψ + η <1. Under applying these initial conditions, capital converges to a steady state (k*i, h*i) given by the system of equations:

$$k^*_i = \left(\frac{s^{1-\eta}{}_{ki}.s^{\eta}{}_{hi}}{\mathrm{n_i}+g+\delta}\right)^{\frac{1}{1-\psi-\eta}} \qquad (6)$$

$$h^*_i = \left(\frac{s^{\psi}{}_{ki}.s^{1-\psi}{}_{hi}}{\mathrm{n_i}+g+\delta}\right)^{\frac{1}{1-\psi-\eta}} \qquad (7)$$

Substituting equations (6) and (7) into the production function and taking logs, Firstly, as a function of investments in human capital shi:

$$\ln(\frac{Y_{it}}{L_{it}}) = \ln A_0 + \mathrm{gt} - \frac{\psi+\eta}{1-\psi-\eta}.\ln(\mathrm{n_i} + g + \delta) + \frac{\psi}{1-\psi-\eta}.\ln s_{ki} + \frac{\eta}{1-\psi-\eta}.\ln s_{hi} \qquad (8)$$

Secondly, as a function of the human capital level:

$$\ln(\frac{Y_{it}}{L_{it}}) = \ln A_0 + \mathrm{gt} - \frac{\psi}{1-\psi}.\ln(\mathrm{n_i} + g + \delta) + \frac{\psi}{1-\psi}.\ln s_{ki} + \frac{\eta}{1-\psi}.\ln h^*_i \qquad (9)$$

According to Mankiw, Romer and Weil (1992), the selection between equation (8) and equation (9) for estimation depends on "whether the available data on human capital correspond more closely to the rate of accumulation [...] or to the level of human capital".

Short-run dynamics converge the income per effective labor to its steady-state value and we can show it by:

$$\ln(y_{it}) - \ln(y_{i0}) = \Theta\ln(y^*_i) - \Theta\ln(y_{i0}) \qquad (10)$$

Where $\Theta = (1 - e^{-\lambda_i t})$, and λi is the rate of convergence to long term. Equation (10) shows that the change of income per effective labor is a function of steady-state y* and initial level y_0 of income per effective labor. Substituting the y* in equation (10):

$$\ln(y_{it}) - \ln(y_{i0}) = \frac{\Theta\psi}{1-\psi-\eta}.\ln s_{ki} + \frac{\Theta\eta}{1-\psi-\eta}.\ln s_{hi} - \frac{\Theta(\psi+\eta)}{1-\psi-\eta}.\ln(\mathrm{n_i} + g + \delta) - \Theta\ln(y_{i0}) \qquad (11)$$

The equation (11) estimated by Mankiw, Romer and Weil (1992) for cross section of countries in the period 1965-1980.

Ram (2007) used the M.R.W model with variables the average income of working-age persons, the working-age population, the rate of technical change and δ the depreciation rate of physical capital. The value of g + δ was usually assumed to be 0.05 and constant across the countries (see e.g, MRW 1992, Knowles and Owen 1995). Also in the study of MRW (1992), they used (I/GDP) as the average ratio of investment as proxy for physical capital investment (sk_i) and working-age population in secondary school as proxy for human capital investment (sh_i) over the period 1960-1985.

The model equation (8) can be written as:

$$\ln(\frac{y_{i,t}}{y_{i,t-1}}) = \beta_0 + \beta_1\ln y_{i,t-1} + \beta_2.\ln(\mathrm{n_i} + g + \delta) + \beta_3.\ln s_{ki} + \beta_4.\ln s_{hi} + u_i \qquad (12)$$

This model (12), shows the growth of per capita income depend on per capita income of the previous period and other variables of current period.

4. Data, Econometric analysis and empirical results

In this study, we estimated the model equation (12) with three changes. The first change is related to the observation period that we changed to the years 2010-2017. The second change relates to the sh_i variable, which wasn't available for all countries and we used the Human Development Index for sh_i variable. For sk_i variable, as in Ram (2007), we used the ratio of investment to GDP (I / GDP).

In the third and major change of this study, we used the Information Development Index (IDI), published by the World Telecommunication Union, as a proxy representing the ICT sector. ICT variables have been used by Nonneman and Vanhoudt (1996) as a technology variable. According to the definition of IDI index, this variable was introduced as representing ICT infrastructure, equipment, internet network, number of users and users ICT skill. Adding IDI into model, is meaningful extension of M.R.W (1992) model. By applying these changes, we have:

$$\ln\left(\frac{y_{i,t}}{y_{i,t-1}}\right) = \beta_0 + \beta_1 \ln y_{i,t-1} + \beta_2 \ln(\mathrm{n_i} + g + \delta) + \beta_3 \ln\left(\frac{I}{GDP}\right) + \beta_4 \ln(\mathrm{HC}) + \beta_5 \ln(\mathrm{IDI}) + u_i \quad (13)$$

We used Equation (13) in empirical analysis to evaluate the impact of information and communication technology on economic growth. In order to better results, we also used other known growth factors as control variables in the model, such as the degree of economic freedom. Therefore, we have final model (linear-logarithm model) is shown in Eq. (14) and was used to estimate the relations between the target variables of the present study:

$$\ln\left(\frac{y_{i,t}}{y_{i,t-1}}\right) = \beta_0 + \beta_1 \ln y_{i,t-1} + \beta_2 \ln\left(\mathrm{n_{i,t}} + g + \delta\right) + \beta_3 \ln\left(\mathrm{GFCF_{i,t}}\right) + \beta_4 \ln\left(\mathrm{EDI_{i,t}}\right) + \beta_5 \ln\left(\mathrm{EFREE_{i,t}}\right) + \beta_6 \ln\left(\mathrm{IDI_{i,t}}\right) + u_i \quad (14)$$

Where $y_{i.t}$ is GDP per capita, n is the exogenous rate of growth of the labor force, g + δ =0.05, GFCF is Gross Fixed Capital Formation, EDI is Educational Development Index, EFREE is Economic Freedom Index, IDI is ICT Development Index, i, t are country and time period and u_i is error term.

The GDP per capita considered non-oil GDP. IDI statistics were extracted from International Telecommunication Union (ITU) reports (ITU, 2015). The data of economic variables were also extracted from the World Bank website and economic freedom index extracted from Cato Institute, Fraser Institute, and the Friedrich Naumann Foundation for Freedom reports.

Countries selected from the Middle East and North Africa known as "MENA" and several other countries in the region. These country sample were Algeria, Bahrain, Egypt, Jordan, Lebanon, Morocco, Oman, Qatar, Saudi Arabia, Tunisia, United Arab Emirates, Turkey, Azerbaijan, Armenia, Georgia and Iran (16 countries in total).

This study was included 128 observations (16 countries, 8 Years). To estimation the model, we used Panel Generalized Method of Moment (GMM) and the results of the Sargan test indicated the suitability of the selected instrumental variables in the estimated model.

The estimation of equation (14) was done in four steps. In first step, the integrated model estimated with ICT Development Index (IDI). The estimation results of first step were summarized in Table (1).

The result of first step in Table (1), indicate that the signs of the coefficients of the explanatory variables - GDP per capita in the past year (significant), exogenous rate of growth of the labor force (significant) and Economic Freedom Index (significant) were negative and the signs of the explanatory variables - Gross Fixed Capital Formation (significant), Educational Development Index (significant) and ICT Development Index (significant) were positive.

For second step, we used IDI access sub-index instead of IDI in model. The estimation results of second step were summarized in Table (2).

Table (1): Results of model estimation with ICT Development Index

Independent variable	Dependent variable log diff. GDP per capita, 2010-2017	
	Coefficients (βi)	**t-value**
C	4.273***	4.146
Ln (GDP per capita in the past year)	-0.392***	-5.202
Ln (n + g + δ)	-0.012***	-4.430
Ln (Gross Fixed Capital Formation)	0.364***	3.824
Ln (Educational Development Index)	0.410**	2.617
Ln (Economic Freedom Index)	-0.766***	-2.752
Ln (ICT Development Index)	0.175***	13.219
R-squared	0.684	
Adjusted R-squared	0.589	
J-statistic	13.300	
Prob. (J-statistic)	0.347	
Notes: * significant at 10%; ** significant at 5% and *** significant at 1%		

Table (2): Results of model estimation with IDI access sub-index

Independent variable	Dependent variable log diff. GDP per capita, 2010-2017	
	Coefficients (βi)	t-value
C	4.502***	4.221
Ln (GDP per capita in the past year)	-0.412***	-3.656
Ln (n + g + δ)	-0.024**	-2.521
Ln (Gross Fixed Capital Formation)	0.360***	4.175
Ln (Educational Development Index)	0.284	1.264
Ln (Economic Freedom Index)	-0.847***	-3.398
Ln (IDI access sub-index)	0.204***	2.190
R-squared	0.690	
Adjusted R-squared	0.596	
J-statistic	12.378	
Prob. (J-statistic)	0.415	
Notes: * significant at 10%; ** significant at 5% and *** significant at 1%		

The estimation results were summarized in Table (2), indicate that the signs of the coefficients of the explanatory variables - GDP per capita in the past year (significant), exogenous rate of growth of the labor force (significant) and Economic Freedom Index (significant) were negative and the signs of the explanatory variables - Gross Fixed Capital Formation (significant), Educational Development Index (insignificant) and IDI access sub-index (significant) were positive.

The estimation results of substituting IDI use sub-index instead of IDI for third step, were summarized in Table (3). These results indicate that the signs of the coefficients of the explanatory variables - GDP per capita in the past year (significant), exogenous rate of growth of the labor force (significant) and Economic Freedom Index (significant) were negative and the signs of the explanatory variables - Gross Fixed Capital Formation (significant), Educational Development

Index (significant) and IDI use sub-index (significant) were positive.

And in fourth step we used IDI skills sub-index instead of IDI in model. The estimation results of second step were summarized in Table (4). These results indicate that the signs of the coefficients of the explanatory variables - GDP per capita in the past year (significant), exogenous rate of growth of the labor force (significant) and Economic Freedom Index (significant) were negative and the signs of the explanatory variables - Gross Fixed Capital Formation (significant) and Educational Development Index (significant) were positive.

Unlike IDI access and use sub-indexes in previous steps, the sign of the coefficient of the IDI skills sub-index was negative, which means that the sub-index of the skill had negative effect on economic growth. In other words, few resources are allocated to the ICT skills section in these countries, and these skills didn't increase economic growth, and had a negative impact on economic growth because this sector had use part of countries resources without any efficiency and effectively.

Table (3): Results of model estimation with IDI use sub-index

Independent variable	Dependent variable log diff. GDP per capita, 2010-2017	
	Coefficients (βi)	**t-value**
C	4.440***	4.166
Ln (GDP per capita in the past year)	-0.364***	-4.648
Ln $(n + g + \delta)$	-0.041***	-6.538
Ln (Gross Fixed Capital Formation)	0.347***	3.706
Ln (Educational Development Index)	0.576***	2.960
Ln (Economic Freedom Index)	-0.849***	-3.577
Ln (IDI use sub-index)	0.030***	6.693
R-squared	0.745	
Adjusted R-squared	0.667	
J-statistic	16.526	
Prob. (J-statistic)	0.168	
Notes: * significant at 10%; ** significant at 5% and *** significant at 1%		

Table (4): Results of model estimation with IDI skills sub-index

Independent variable	Dependent variable log diff. GDP per capita, 2010-2017	
	Coefficients (βi)	**t-value**
C	3.522***	3.509
Ln (GDP per capita in the past year)	-0.250***	-3.490
Ln $(n + g + \delta)$	-0.047***	-5.896
Ln (Gross Fixed Capital Formation)	0.317***	3.153
Ln (Educational Development Index)	0.430**	1.999
Ln (Economic Freedom Index)	-0.872***	-3.517
Ln (IDI use sub-index)	-0.093***	-2.137
R-squared	0.712	
Adjusted R-squared	0.625	
J-statistic	12.442	
Prob. (J-statistic)	0.331	
Notes: * significant at 10%; ** significant at 5% and *** significant at 1%		

5. Conclusion and policy implications

The results extracted from the integrated econometric model showed the significant and positive affect of ICT on economic growth, which was consistent with the findings of previous studies and showed that that elasticity in ICT section, it was estimated to be 0.175 and statistically significant. This means that one percent increase in ICT Development Index (IDI) caused labor forces productivity growth to increase by 0.175 percent, respectively. Moreover, the elasticity of variables such as labor force growth (-0.012), economic freedom index (-0.766), gross fixed capital formation (0.364) and education development index (0.410) on the economic growth of the countries.

The above results show that in the selected countries, the variables of gross fixed capital formation and human capital development had the greatest positive impact on economic growth for the period 2010-2017. Despite the widespread use of ICT in these countries, the lower positive impact of ICT on economic growth than mentioned variables, could be attributed to the non-economic use of ICT technologies for most internet subscribers and ICT users in these countries and it can be concluded that these countries have failed to use from ICT development significantly for their economies.

Sensitivity of economic growth due to a change in the economic freedom index of 1% resulted in a change in economic growth of -0.766%. This relation, despite the theoretical expectation, showed inverse effect of the economic freedom on economic growth, in contrast to most studies conducted for developed countries that reported this sign as being positive. The reason for this contrary result could be attributed to the large portion of GDP in the mostly selected countries from their huge windfall oil revenues as well as the extensive interference of governments in their economics such as support of governments from export or import goods. It cause to debilitation and destruction the private sector motivation in the economy.

Also by decomposing IDI into sub-indexes and estimation the models, the elasticities were estimated for IDI access sub-index (0.204), for IDI use sub-index (0.030) and for IDI skills sub-index (-0.093) and statistically significant.

Unlike IDI access and use sub-indexes, the sign of the coefficient of the IDI skills sub-index was negative, which means that the sub-index of the skills had negative effect on economic growth. In other words, few resources are allocated to the ICT skills section in these countries, and these skills didn't increase economic growth, and had a negative impact on economic growth because this sector had use part of countries resources without any efficiency and effectively.

According to the definition of the IDI index its calculation method, 40% of the weight of IDI (IDI access sub-index) is consist of Fixed-telephone subscriptions per 100 inhabitants, Mobile-cellular subscriptions per 100 inhabitants, International Internet bandwidth Bit/s per Internet user, percentage of households with computer and Percentage of households with Internet access. Also, 40% of the weight of the IDI (IDI use sub-index) is consist of Percentage of individuals using the Internet, Fixed (wired)-broadband subscriptions per 100 inhabitants and Wireless-broadband subscriptions per 100 inhabitants. The IDI skills sub-index is 20% of the weight of IDI and consist of Mean Years of schooling, Secondary enrolment ratio and Tertiary enrolment ratio. According to these definitions, to improve the effect of ICT on economic growth, it is suggested that done appropriate policies to increase the necessary infrastructure, including increasing the bandwidth of Internet access, the infrastructure of fixed telephone, mobile phones and the number of households. Regarding the IDI skills sub-index structure, despite the favorable level of this index in the selected countries, these result showed that these ICT skills are not used for improving production.

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