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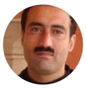
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ECONOMETRIC ANALYSIS OF THE IMPACT OF ICT ON ECONOMIC GROWTH FOR QATAR IN GLOBALIZATION CONTEXT

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Abstract. In recent years, advancement in information and communication technology (ICT) has caused many international structural changes. The world as developed, emerging and developing communities started extremely to harness ICT for sustainable development and advance creative and innovative knowledge societies in globalization context. The significant role of ICT is stemmed from empowering humans, governments and organizations to renovate information into knowledge as a forceful driver in progressing lasting change in the globalization of economy and society. Given the significance of ICT development and innovation as a key cause in increasing productivity, growth rates, economic development and advancement in all expanses, the developed countries have given great importance to adopt ICT drivers, tools and techniques to achieve continuous technology development, so as followed by developing countries to be accommodated with international changes. Economists forecast that economic growth is motivated by investments in ICT. The determination of this investigation is to examine the effects of ICT capital and labour stocks on economic growth for Qatar covering the period from 1995 to 2013, as ICT is an important driver for the globalization process. The outcomes show that there is a positive and significant association between the GDP per capita and the ICT index. The information density that consists of network and skills sub-indices is used as an indicator of ICT, where this ICT index has interpreted the impact on GDP per capita.

Keywords: Information and communication technology (ICT), Economic growth, Qatar

JEL Classification: C33, E22, O4

1. Introduction

The past few decades proved that technology was the driving force for growth and development (Kuzmenko, Maitah, Malec, & Hndi, 2014) (Macák, Maitah, & Selby, 2014) (Maitah, Hayat, Malec, & Eldeeb, 2014). Despite the different objectives of the various countries of the world, it seems that these countries agreed on that science and technology are the most effective tool for pushing ahead growth and development. Most industrially developed countries harness the bulk of their interest in the technological sphere focusing on various fields such as the technology used in sugar production (Maitah, Saleem, Malec, & Gouda, 2015) (Maitah, M; Smutka, L, 2016) (Maitah, Rezbova, Smutka, & Tomsik, 2016)

(Smutka, Zhuravleva, Pulkrabek, Benesova, & Maitah, 2016). The developing countries focus their greatest attention in the field of science and technology to determine the particular needed quantity and quality that may contribute more effectively than others to meet their development needs. Information and communication technologies (ICTs) are considered as the core components for technology deployment nowadays and as an enabling tools and techniques for exploiting the advances in technology and science.

The ever increasing value of ICTs in economic and social development arisen dramatically with an impressive rate since the mid-nineties which mark the starting period of rapid growth of these technologies and their markets. The world as developed, emerging and developing communities started enormously to harness ICT for sustainable development while advancing creative and innovative knowledge societies (Dedrick, Gurbaxani, & Kraemer, 2003). The important role of ICT stems from enabling humans, governments and organizations to transform information into knowledge as a robust driver in evolving lasting change in the economy and society (Conole & Dyke, 2004) (Lyon, 2013) (Toth, Maitah, & Stefkova, 2014). Given the importance of ICT development and innovation as a key factor in increasing productivity, growth rates, economic development and progress in all areas, the developed countries have given great importance to adopt ICT drivers, tools and techniques to achieve continuous technology development, so as followed by developing countries.

2. Related Work

The important role of ICT as an enabling technology that efficiently contributes in production cost reduction and productivity enhancement of various business sectors and so as for all country sectors, which will be reflected positively on economic growth attracted the concerns of many parties such as researchers, international organizations and governments. In what follows we will discuss several research studies talking about the impact of ICT on economic growth using various models such as Cobb-Douglas model, extreme bound analysis, vector autocorrelation and others. The quantified part of ICT involved different measures such as ICT capital and investment, and indices such as info-states by ORBICOM, opportunity index by ITU and others.

The study entitled "ICT Investment and Economic Growth in the 1990s" compared the impact of ICT investment on economic growth in 9 OECD countries[1]. The study results showed that ICT capital investment contributed between 0.2 and 0.5% points per year to economic growth according to the country. For the period from 1995-2000, ICT contributed higher percentage from the preceding period ranging from 0.3 to 0.9% points per year. Results showed that the United States was not the only country that gained benefits from the positive impacts of ICT capital build up on economic growth. Impacts have obviously been biggest in the United States, and then in Australia, Canada, and Finland, but Germany, Japan, Italy, and France recorded the bottommost contribution of ICT investment impact on economic growth among the nine studied countries. One of the most influential drivers of growth as ICT investment in the study case is preparing appropriate ICT framework conditions and not essentially in ICT sectors itself (Colecchia & Schreyer, 2002).

[1] These countries include Australia, Canada, Finland, France, Germany, Italy, Japan, the United Kingdom and the United States

(Becchetti, Andres londono Bedoya, & Pagane, 2003) investigate the effect of investment in telecommunications and software on the productivity of Italian firms. They found that telecommunications positively impacts the formation of new products and practices, while software rises the request for skilled laborers for advancing firms' productivity.

The researchers (Jorgenson, Stiroh, Gordon, & Sichel, 2000) found that there is positive and significant impact of ICT on production in the United States in 1990s. In addition, a study by (Inklaar, O'Mahony, & Timmer, 2005) form the year 1979 to 2000 found that there is a significant contribution of ICT to economic growth for the United States and European countries including Germany, France, Netherlands and the UK, but the study found that the United States outperformed the four European countries (included in the study) in ICT influences on economy. Also several cross country studies discovered the positive impact of ICT on labor output and indicating country differences regarding ICT impacts in developed economies (Van Ark, O'Mahony, & Timmer, 2008). The result of positive influence of ICT on economic growth disagree with a research conducted by (Dewan & Kraemer, 2000) from the year 1985 to 1993. This panel conducted study (includes fourteen developing countries and twenty two developed economies) found that ICT impact on economic growth was found positive for developed countries. The panel study was held on 36 countries for the period from 1985–1993. They also found insignificant impact of ICT in developing countries referring this to low level of ICT investment, the deficiency of appropriate environment such as infrastructure and government policies.

3. Methodology and Data

Nowadays ICTs have a great impact in every aspect of our life, as an economic and social actuality. There is a difference between its consumptive and productive functions. As the economic theory states that the standard living of the people is subjected to consumption, but over time we must challenge the difficulty of increasing the production competences of a country in a sustainable approach, and so the economic growth can be advanced and extended to economic development (Maitah, Kuzmenko, & Smutka, 2016) (Soukup, Maitah, & Svoboda, 2015). The nature of ICT is twofold: the productive side (info-density) and the consumptive one (info-use). Info-density denotes to the portion of a country's whole capital and labor stocks related to ICT and represent the productive side. Info-use denotes to the ICTs consumption side. In principle, the two can be combined to represent the amount of a country's info-state. The difference in info-states among economies can relatively measure the Digital Divide.

ORBICOM model is provided by specialized institution as ORBCOMM network which is the "Global Network of UNESCO Chairs communications Telecommunications and the International Telecommunication Union", the model, based on one explained variable that is information density and technical progress. Info-density is the compound of all ICT factors of capital and labor. The productive capacity is fixed at any particular argument in time, as the pooled factors: stocks, and technology are fixed, but they can expand as time passes. ICT capital consists of network infrastructure, and ICT machinery and equipment. ICT labor is accounted as the stock of the ICT skills. Output production will be an accumulative function of ICT factors of various arrangements which comprise capital and labor (Jensen & Mahan, 2007).

For info-use the readiness of ICT goods is crucial for the consumption of ICT services that would fulfil eventual needs, and constructing 'consumptive capacity' is a requirement to generate ingesting drifts. There is a difference between ICT uptake and ICT intensity of use, where uptake refers to ICT goods and intensity of use to ICT services. Uptake and intensity of use are subject to the level of classification according to obtainability of statistical data, such as investigating measures and analysis according to sectors, where industries can be divided by size or type, and governments by level such as local, regional, national, and type of organization. Also, clusters of individuals can be distinguished by gender, metropolitan and rural positions, level of education which are significant for the investigating of digital divides core to an economy (Sciadas, From the digital divide to digital opportunities, 2005).

The aggregate production function that encounters the relationship between the economic growth as output and the degree of ICT practices as input which can be represented by the production part of ICT (networks and skills) is complex. In an introductory effort to estimate the strength of this connection, we inspect the effect of info-density on GDP per capita as info-density captures the ICT per capita stock of capital and labor skills, and GDP per capita measures the cumulative per capita output as a representation for growth. The per capita conversion of networks and skills in the calculation of the info-density index is not identical to the per capita transformation of GDP. In the info-density index the capital stock is measured per 100 persons in some cases and per household in other cases. In the GDP per capita calculation, GDP is divided by the population. A subsequent and more detailed examination of the relationship between info-density and GDP per capita might perfectly explore the sensitivity of the results to these data differences (Sciadas, Monitoring the Digital Divide... and Beyond, 2003).

The relationship between GDP per capita and info-density is linear, and there is a strong correlation between them, that is, over time as info-density increases, GDP per capita increases. This model can be expressed as follows:

$$\text{Log}\,(GDP_{i,t}) = \log\,(A) + \alpha_1 \,\text{Log}\,(ID_{i,t}) + \varepsilon_{i,t} \qquad (1)$$

Where ($GDP_{i,t}$) represents GDP per capita for country (i) over time (t), ($ID_{i,t}$) represents info-density for country (i) over time (t) in annual sequence, (α_1) represents the elasticity of info-density of GDP per capita and (ε_t) represents the random factor. The model can be estimated using the panel regression using least squares, fixed effects and random effects approaches. The model can be used to estimate the sensitivity of per capita GDP to variations in info-density for each individual country within the study sample.

The calculations of info-density according to ORBICOM (Sciadas, From the digital divide to digital opportunities, 2005) is as follows:

$$\text{ID} = \sqrt[k]{\prod_{i=1}^{k} I_{n,t}^{i,j(c)}}\sqrt[k]{\prod_{i=1}^{k} I_{n,t}^{i,j(c)}} \qquad (2)$$

The notation Π represents product and n the number of each component's individual indices. *I* represents the guide value and i represents the used indices. In 2001, for networks n=5 (fixed, mobile, cable, Internet and bandwidth), for skills n=2 (literacy and gross enrolment) and for uptake n=4 (television, residential lines, PCs and Internet users). With k=2, Networks and skills are united into the ID index.

$$\text{ID} = \sqrt[2]{networks * skills}\sqrt[2]{networks * skills} \tag{3}$$

$$\text{Networks}= \sqrt[3]{fixed/100\ inhabitants * mobile/100\ inhabitants * bandwidth(b/s)/internet\ user} \tag{4}$$

$$I^{gross\ enrolment} I^{gross\ enrolment} = (\text{primary} + 2 \text{ x secondary} + 3 \text{ x tertiary})/6 \tag{5}$$

$$\text{Skills} = \sqrt[2]{literate\ rate * I^{grossenrolment}}\sqrt[2]{literate\ rate * I^{grossenrolment}} \tag{6}$$

The data sources of independent control variables and dependent variable of GDP per capita are from the World Bank database[2]. the Info-density index data for the years from 1995-2003 are from ORBICOM study , the index for the years 2004-2013 was calculated depending on the data from ITU, World Bank and UNESCO bulletins, in addition to using information from Qatar Ministry of Development Planning Statistics[3].

4. Results and Discussion

The estimated results measuring the impact of ICT represented by info-density on economic growth for Qatar represented by GDP per capita are shown in table1.

The validity of the estimated model can be proved through statistical evaluation method as follows:

- F-test (Fisher test): The significance for the model as a whole is explained as the calculated F-statistics (471.21) is greater than the tabular one (F= 4.45), so the alternative hypothesis is accepted and the whole model is significant. Also the level of Fisher significance is zero (Prop (F-statistic) =0.0).
- Significance of model parameters: The t-test value for log (info-density) is 21.70 which is more than the tabular one which is 2.11at 5% confidence level so as for the constant with t-statistic equal 90.09 greater than tabular value, so the parameters are significant.
- Confidence interval: significance of info-density parameter can be assured by the confidence interval α ϵ [0.469303-2.11*0.021620, 0.469303+2.11*0.021620] = [0.424, 0.515], we see that zero doesn't belong to the confidence interval. Significance of constant parameter can be assured by the confidence interval α ϵ [4.029014-2.11*0.021620, 4.029014+2.11*0.021620] = [3.983, 4.075], where zero doesn't belong to the confidence interval.
- Determination coefficient: the value of R-square is 96.5% which means that ICT explains 96.5% of the changes that occur in the dependent variable.

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[2]http://databank.worldbank.org/ddp/home.do.

[3]http://www.qsa.gov.qa/eng/index.htm

- Durbin Watson (DW): As the DW statistic value 1.483 is more than the DW tabular value 1.401 at 5% confidence level, then we accept the null hypothesis and conclude that there is no positive autocorrelation between the residuals.
- Normality test: The results of this test are shown in figure 1, this test depends on Jarque-Bera statistic that is calculated from skewness and kurtosis statistics, where n is the number of observations and k is the number of input variables in the regression equation. The hypothesis of this test are as follows: H_0: Errors are normally distributed and H_1: Errors are not normally distributed. The results show a low value of Jarque-Bera statistic (J-B=0.12) which is less than the critical value of chi-square χ^2 (2)=5.99, with the Jarque-Bera probability (94.03 %) that is higher than 5 %; then, the null hypothesis is not rejected implying that there is non-normality problem and the error is common.

Table 1: Results of estimated model for the impact of ICT on GDP per capita for Qatar

Dependent Variable: LOG_GDP_C
Method: Least Squares
Date: 10/19/15 Time: 23:07
Sample: 1 19
Included observations: 19

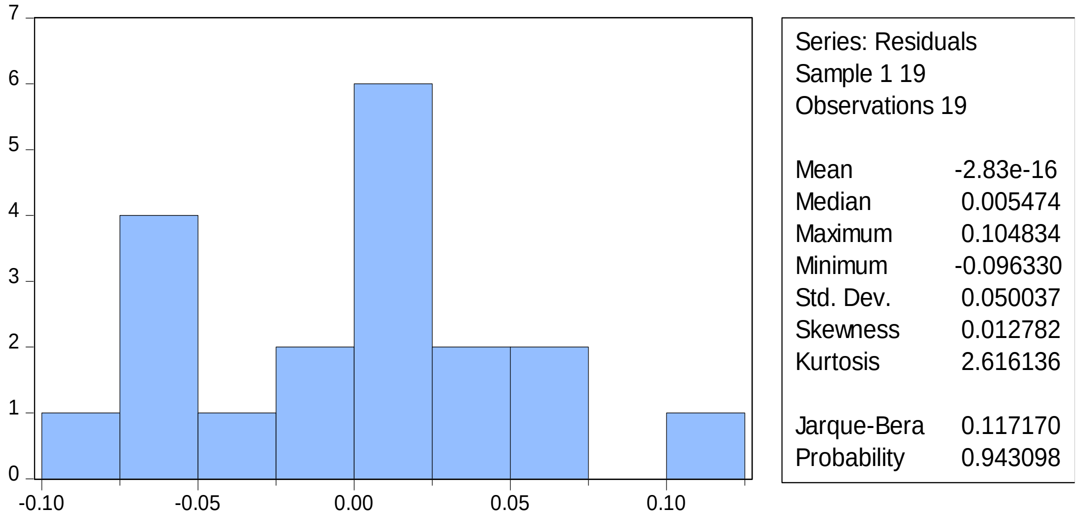
Variable	Coefficient	Std. Error	t-Statistic	Prob.
LOG_ID_	0.469303	0.021620	21.70731	0.0000
C	4.029014	0.044722	90.09065	0.0000
R-squared	0.965179	Mean dependent var		4.993396
Adjusted R-squared	0.963130	S.D. dependent var		0.116453
S.E. of regression	0.022361	Akaike info criterion		-4.663731
Sum squared resid	0.008500	Schwarz criterion		-4.564316
Log likelihood	46.30544	Hannan-Quinn criter.		-4.646906
F-statistic	471.2073	Durbin-Watson stat		1.482819
Prob(F-statistic)	0.000000			

Source: author using Eviews 9

- Parameter stability: As illustrated in table, the parameters are stable, where Ramsey's test is used for this issue with the null hypothesis that proposes the stability of the model coefficients if the probability is more than 5%. As shown in table 2 Log likelihood probability is 6.9%, then null hypothesis is accepted indicating that the model coefficients are stable. Also the probability associated with F-statistic 11.92%, which is more than 5 %, then we accept the null hypothesis and the model is well specified.
- Heteroscedasticity test: As illustrated in table 3. The two associated probabilities are more than 5 %, hence, we accept the null hypothesis of homoscedasticity of errors. Also the model is serial independent as clarified from table 2.

The positive and significant impact of ICT is obvious, where the result shows that ICT elasticity is 0.469, which means that any increase of domestic ICT by 10% leads to increase in GDP per capita by 4.69% where it is a positive with proportional impact.

Figure 1: *for Qatar Actual fitted graph*



Source: author using EVIEWS 9

As we recognize from table A.3 in Appendix 2, there are comparatively low GDP per capita growth together with high info-density growth rates. This might be due to incompetent investments, which may delay these developing Arab countries illustrated in this study from gaining the benefits of ICT contributions, so there is a need for adequate edge of info-density. Also this delay of benefiting from ICT externalities may be due to the extra time needed to accumulate ICT experience for these Arab countries. Other factors impede the economy from growing are various economic policies (financial policy, investment, trade, monetary policy and others), in addition to geopolitical issues and others.

Table 2: Ramsey and serial correlation test *for Qatar*

Ramsey RESET Test Equation: UNTITLED Specification: LGDPC LID C Omitted Variables: Squares of fitted values			
	Value	Df	Probability
t-statistic	1.703760	10	0.1192
F-statistic	2.902797	(1, 10)	0.1192
Likelihood ratio	3.313167	1	0.0687
Breusch-Godfrey Serial Correlation LM Test:			
F-statistic	0.279804	Prob. F(2,9)	0.7623
Obs*R-squared	0.761004	Prob. Chi-Square(2)	0.6835

Source: author using EVIEWS 9

Table 3: Heteroscedasticity test

Heteroscedasticity Test: Breusch-Pagan-Godfrey			
F-statistic	3.891482	Prob. F(1,17)	0.0650
Obs*R-squared	3.539153	Prob. Chi-Square(1)	0.0599
Scaled explained SS	2.289486	Prob. Chi-Square(1)	0.1303

Source: author using EVIEWS 9

5. Conclusion

This paper focused on the impact of ICT on economic growth for Qatar. ICT has a significant impact on economic growth and globalization of Qatar's economy which was the case of study of this paper. The econometric results show that the impact of ICT on economic growth for Qatar is positive and significant with 0.469 points. This positive impact will facilitate the globalization of Qatar economy as the usage of information and communication technology has a significant impact on connecting the various economic sectors in Qatar with other related sectors in the global context. The positive and significant impact of ICT on Qatar economy indicates that it is necessary to continue investing in ICT infrastructure and services which in turn would positively and significantly impact the advancement the economic growth.

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