Studying the Effect of ICT Variables on the Economic Growth of Iran

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INTRODUCTION

Finding effective factors in growth and development of countries is among the topics that have received a considerable attention from policymakers and economists since a long time ago. The advances in ICT in last two decades and noticeable developments in its applications, have created a new age of mutual relations among people, institutions, companies and governments [1]. By the advent of information era, a new section in economy has appeared which is called ICT. The results of this technological revolution, in company with other scientific advances, have created new gaps. The gap between technology and knowledge has resulted in a world that part of it is progressing quickly while the other part is lagging behind [2].

ICT is affecting the globe in both supply and demand. On the supply side, it affects the economic behavior of the consumer by desirability function and wellbeing of consumer. On the side of demand, ICT enters the production function as a capital element in company of other supplementary factors (Business Management, Legislations, Economic Structure, Government’s Policies, and Human Capital) and leads to improvements in production process by capital deepening, technological advances, and more efficient labor force. The result will be added value in enterprises, different sectors and the whole country; therefore, the efficiency of labor force, and total efficiency will increase and economic growth will happen [3].

The current study aims at studying effects of ICT on Iran’s economic growth by using VECM. For this purpose, theoretical background and literature review are presented. Then, the general framework and used variables are discussed and conclusion and suggestions are offered in the last section.

Keywords: ICT, Economic Growth, Vecm, Johansen Integrated Test

ABSTRACT

ICT undoubtedly have massive transformation in all social and economic filed for humanity and its impact on human societies that define today’s world is becoming an information society rapidly. A society where knowledge, access and useful access of knowledge have central and decisive role, many economists who are studying in productivity, know information and communication technology as the core of the present technical changes and have attempted to quantify its effect and expand access to information and communication technology, cause to build capacity in unprecedented disseminating knowledge and information. At present, information and communication technology is the main component of the most developed economies. The technology is effective in various economic processes so that these technologies, in terms of economic and production factors, leading to a reduction in production costs and increase productivity and ultimately increase in economic growth in developing countries. And followed with a slight delay, this effect has been observed in some developing countries. Hence, this study examines the impact of ICT variables with the use of Vector Error Correction Model (VECM) for the period 1389 to 1358 in Iran. The results suggest that the ICT have significant role in economic growth in Iran. The vector error correction model estimation and Johansson test results proved long-term relationship between economic growth information and communication technology in Iran.
Theoretical Background:

A new economic phenomenon that is titled as “Knowledge Economy”, “Digital Economy”, “Electronic Economy”, “Virtual Economy” or “Network Economy” is the economy based on ICT industry. According to Pohjola [4], the modern economy is the result of two factors namely business globalization and ICT revolution. Some define the modern economy as efficiency advantages, decrease in rates of unemployment and the relative balance of inflation in industrialized countries in late 1990s which were resulted by technology, globalization and increasing competitive pressures. This definition is representative of the modern economy literature.


Kahn et al., mention the advantages created by using ICT and refer to ICT as a new tool that influences economic activities significantly. The balanced view would state that while main economic relations have changed, the traditional economic forces still exist. Kelly [9] mentions increasing returns and side effects of networking as the influential factors in changing business competitions and their reciprocal effects. Katz and Kruger [10] mention the end of scarcity, transmission and increasing return scale as the signs of the modern economy. Nakamura [11] considers creativity as the main force in the new economy. Delong believes that age of information technology has reduced the relative importance of traditional economic definitions. In company with other production factors, ICT leads to improvements in production process, capital deepening, advances in technology and quality of working force. The result is the added value in enterprises, different sectors, and the whole country and finally the economic growth and consumers’ wellbeing.

In the recent decade, a number of economists tried to present the new technology and knowledge as the reason for the economic growth. The one done by Quah (2001, 2003) is among the most significant studies in this area. Since a long time ago, the effect of technology on growth has been discussed and this effect can fall in three categories. In the classic definitions, technology is the reflection of knowledge in tools and means of production. From a point of view, influence of technology is analyzed in terms of realized goods, which has resulted in better capital productivity. In the second category, technology increases the labor force productivity. In the third category, technology increases the overall productivity while it does not necessarily increase the labor force or capital productivity and this mode is called Hicks Neutral Technology. Solo is one of the pioneers in this field. Many tried to explain technology as an influential endogenous factor in production and economic growth by endogenous growth pattern. These patterns introduced the effects of technology in different ways including human capital, improving production quality and increasing the range of production in the model [12].

Romer & Lucas emphasized the economy of ideas and human capital. Aghion & Hiwt [13] emphasized improving the production quality as a sign of new technology. New technology is in turn a factor which makes manufacturers using old technologies leave the game. Helpman & Grossman suggested the endogenous growth pattern using the same idea.

Literature Review:

Keheuma Lanjmia studied the role of ICT in Africa and mentioned the internet as an influential positive and negative factor in economic growth. He also considered seeking help from researchers in the field of ICT and making changes in lives of African people, an important dimension for the growth of Africa.

William et al, studied the role of ICT in economic opportunities and counted ICT as an influential sector in directing needs and desires of low-income populations in developing countries. Nguyen did a comparative analysis among developing and developed countries in order to identify four categories of GCIOS leading solutions and ways for improving them in the developing countries. Alisalman emphasized the role of media in his study and suggested that new media (internet) can be influential in economic growth of countries. In a paper titled as “studying the effects of ICT on increasing the total factor productivity”, Rahmani and Hayati [14] concluded that ICT capital has the characteristics of knowledge capital and can, therefore, affect the productivity by capital deepening and its spillover effects. This research, studied the relation between ICT spillover and increase in total factor productivity by using panel data for 69 countries in the time period of 1993-2003. The results show that national investment in ICT and international ICT spillovers have a meaningful and positive effect on increasing TFP in both developed and developing countries. However, the effect of ICT on increasing TFP is more significant in developed countries than it is in developing countries. Based on the findings, one can state that appropriate infrastructures like skilled labor force and free business can assist countries in attracting benefits resulted from ICT.

Mahmoudzadeh & Asadi [12], in a paper titled as “effects of ICT on increasing productivity of labor force in Iran’s economy”, concluded that total productivity and non-ICT capital have the highest effect on labor force productivity in Iran’s economy. The effect of human capital and ICT capital on labor force productivity is positive and significant but they are less effective compared with other variables. The results of this study match
the ones suggested by empirical studies done in developing countries. Komijani and Mahmoudzade [15] in a research titled as “effect of infrastructure, application and spillovers of ICT on economic growth of developing countries”, concluded that physical capital, phone penetration rate, network index, internet and openness have positive effect on economic growth while increase in population and inflation leave negative effects. The effect of human capital on growth is not sustainable and convergence of developing countries is confirmed and ICT affects economic growth positively in three ways: First, by using ICT infrastructures which is stated as an industry and plays an important role in revealing consequences of ICT, second, by ICT applications which are visible in all social and economic aspects and third, by ICT spillover effects in all economic sectors which use ICT as an influential element.

Komeijani & Mahmoudzade [16] in a research titled as “Role of ICT in Iran’s Economic Growth”, studied the effects of ICT in the economic growth of Iran. The results show that non-ICT capital has the dominant role in the economy and explains 50% of Iran’s economic growth. The share of employment from economy is 30-38% and total productivity is 7-10%. ICT production potential is 7% which is meaningful and its share in Iran’s economic growth between 1994-2004 was 7%. This share is the minimum amount and effects of factors such as quality adjustment, application, spillovers and technology are not included. In addition, the causality relation applies between ICT capital and short-term, and long-term production. Also, there is constant return to scale in Iran’s economy. Improving supplementary factors, ICT infrastructures and developing them can contribute to the bigger share of ICT in Iran’s economic growth. Aghaii & Hoseininasab, in a study titled as “Effect of ICT on Economic Growth” concluded that economic growth theories are created by investment in ICT. While empirical studies have led to integrated results, these results have been chosen by selective searching methods and geographical combinations. Estimations have revealed the significant effect of economic growth caused by investing in ICT in members of OPEC. Results show that if these countries are willing to increase their economic growth, they have implement strategies that facilitate investing in ICT.

**MATERIALS AND METHODS**

**General Framework of VECM:**

In the articles published by Philips, he introduced the VECM to the world for the first time. This model was later applied by Hendry in analysis related to monetary supply and demand and is considered as a dynamic model. The statistical base for using VECMs is the cointegration existing among economic variables. The dynamic VECMs make determining long-term relations among endogenous variables possible. Also, they show how lack of balance in equilibrium long-term relations of variables affects their short-term dynamic changes. These unique properties of VECMs distinguish them from other structural and non-structural models of econometrics and have led to fast evolution of these models since 1990s.

The general form of VSEM is as the following:

\[
\Gamma_0 \Delta y_t = \alpha \beta' \Delta y_{t-1} + \Gamma_1 \Delta y_{t-1} + \ldots + \Gamma_{p-1} \Delta y_{t-p+1} + B_0 x_t + \ldots + B_q x_{t-q} + CD_t + u_t \tag{1}
\]

Where alpha is the k*r matrix of Loading Coefficients and shows the loading toward the long-term equilibrium. In fact, it shows what proportion of lack of balance is compensated in the current period. Beta is the k*r cointegration matrix which shows the long-term part of the pattern (model). - is the k*1 matrix of short-term endogenous coefficients and ut is the * vector with the mean of zero [17].

It was mentioned that existence of cointegration among economic variables is the statistical base for using VECM. Generally, using conventional econometrics methods to estimate time series models’ coefficients is based on the assumption that model’s variables are stationary. Yule and Frisch showed that there is a strong correlation between variables that have trends, even in cases that there is no meaningful economic relation between them. This, in fact, was the starting point for a concept now known as cointegration.

At first, in order to solve the problem of moving variables in the same direction and to avoid false regression between time series variables, T (a time series variable) was used to be placed among independent variables of model. Later, it became clear that this solution is only applicable when trend’s variables are stationary. If the variables of difference model are stationary, adding T time trend to the variables or removing certain trend from variables does not lead to the stationary state of these variables. In this situation, using conventional econometrics causes F and T tests not to have the needed validity and one is likely to make wrong interpretations about the strength of relation between variables. In variables for which trends are not stationary, variables difference is used in order to avoid false regression. However, using first-level difference of variables in regressions, leads to loss of valuable information about long-term relations of variables. Using cointegration method makes calculating the regression possible based on level of variables and without being worried about their falsity.
In VAR models, if variables are not stationary, making a difference is necessary. This will lead to loss of information regarding the level of variables to an extent that some researchers use non-stationary variables in order to keep the information about variables’ level. However, in VECM which is a cointegrated vector auto regression model, the concept of cointegration is used in order to make non-stationary variables stationary. In addition, information regarding the long-term relations between variables is kept in the model [18].

Therefore, a model consistent with Iran’s ICT variables is based on the VEC model. In the current study, variables including GDP, CPI, number of phone lines (nlphone) and phones penetration rate (zphone) are used. The VEC model can be presented in this general matrix format:

\[
\begin{bmatrix}
\Delta GDP_{it} \\
\Delta CPI_{it} \\
\Delta nlphone_{it} \\
\Delta zphone_{it}
\end{bmatrix}
= \alpha_{i1} + \sum_{j=1}^{p-1} \alpha_{i,j} \Delta u_{i,t-j} + \begin{bmatrix}
\Delta GDP_{i,t-1} \\
\Delta CPI_{i,t-1} \\
\Delta nlphone_{i,t-1} \\
\Delta zphone_{i,t-1}
\end{bmatrix} + \begin{bmatrix}
\alpha_{11} & \alpha_{12} & \alpha_{13} & \alpha_{14} \\
\alpha_{21} & \alpha_{22} & \alpha_{23} & \alpha_{24} \\
\alpha_{31} & \alpha_{32} & \alpha_{33} & \alpha_{34} \\
\alpha_{41} & \alpha_{42} & \alpha_{43} & \alpha_{44}
\end{bmatrix} \begin{bmatrix}
\Delta GDP_{i,t-1} \\
\Delta CPI_{i,t-1} \\
\Delta nlphone_{i,t-1} \\
\Delta zphone_{i,t-1}
\end{bmatrix} + \begin{bmatrix}
c_1 \\
c_2 \\
c_3 \\
c_4
\end{bmatrix} + \begin{bmatrix}
\hat{u}_{1t} \\
\hat{u}_{2t} \\
\hat{u}_{3t} \\
\hat{u}_{4t}
\end{bmatrix}
\]

(2)

In this equation, alpha matrix is the matrix of cointegration that shows the long-term part of model. Ai is the matrix of short-term coefficients and ui is the vector of * and cij is the matrix of predetermined variables coefficients. In this equation, the differential form of variables is presented in the format of VEC model.

RESULTS AND DISCUSSION

Stationary Test:

Stationary of variables time series is one of the subjects to be studied before estimating the subject model. In the current study, seasonal extended Dickey-Fuller Unit Root Test was used for the stationarity test. In the following table, the results of the test for the introduced variables are presented.

<table>
<thead>
<tr>
<th>Variables</th>
<th>Statistic</th>
<th>Statistic</th>
<th>Statistic</th>
<th>Statistic</th>
</tr>
</thead>
<tbody>
<tr>
<td>GDP_log</td>
<td>-1.95</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CPI_log</td>
<td>-1.88</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>enophln_log</td>
<td>-1.02</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>zphone_log</td>
<td>-0.035</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>GDP_log_d1</td>
<td>-8.15</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CPI_log_d1</td>
<td>-9.03</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>enophln_log_d1</td>
<td>-2.57</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>zphone_log_d1</td>
<td>-4.24</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The extent of test’s statistic in critical levels based on the study done by Davidson and Mcinon (1993)

Fixed Parameter, Virtual Seasonal Variables and Linear Trend %10: (-3.13) %5: (-3.41) %1: (-3.96)

Fixed Parameter and Virtual Seasonal Variables

As it can be seen from results presented in Table (1), all level variables are non-stationary in the 90% significance level but become stationary once a difference is made in this significance level.

Cointegration Test:

Several tests exist in order to study the convergence among which Johansen Cointegration Test can be mentioned. In the current study, Johansen Test is used. In case the cointegration among variables is determined, a long-term and equilibrium relationship can be said to exist among subject variables. Doing this test and Likelihood Ratio Testing and then comparing the results with critical values of table in 1%, 5% and 10% levels prove cointegration and equilibrium relationship among model variables. Based on the results shown in Table (2), two and three long-term relationships exist in the model in 99% and 95% significance levels, respectively.

<table>
<thead>
<tr>
<th>Null Hypothesis</th>
<th>LR</th>
<th>P value</th>
<th>%90</th>
<th>%95</th>
<th>%99</th>
</tr>
</thead>
<tbody>
<tr>
<td>r = 0</td>
<td>518.68</td>
<td>0.0000</td>
<td>60.00</td>
<td>63.66</td>
<td>70.91</td>
</tr>
<tr>
<td>r ≤ 1</td>
<td>110.86</td>
<td>0.0000</td>
<td>39.73</td>
<td>42.77</td>
<td>48.87</td>
</tr>
<tr>
<td>r ≤ 2</td>
<td>25.82</td>
<td>0.0487</td>
<td>23.32</td>
<td>25.73</td>
<td>30.67</td>
</tr>
<tr>
<td>r ≤ 3</td>
<td>6.27</td>
<td>0.4380</td>
<td>10.68</td>
<td>12.45</td>
<td>16.22</td>
</tr>
</tbody>
</table>

** Null Hypothesis is rejected in 10% significance level
*** Null Hypothesis is rejected in 1% significance level

Source: Research Calculations
Determining the optimum lag:
Determining the optimum lag is of a significant importance in reiteration of VEC model; therefore, AIC, SC, HQC and FPE are used. Based on these criteria in the model, optimum lags are determined as 1 and 2.

Diagnostic Tests:
In order to evaluate the optimal lag for estimating the required model, Portman test was used for recognizing the autocorrelation, Jurque-Bera test was used for recognizing normality and multi-variable ARCH-LM was used for recognizing Heteroskedasticity of residual error components. Results of these tests are presented in Table (3).

<table>
<thead>
<tr>
<th>Diagnostic Tests</th>
<th>Test For Nonnormality</th>
<th>Q</th>
<th>Test</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>465.87</td>
<td>245.33</td>
<td>100.34</td>
</tr>
<tr>
<td></td>
<td>0.0008</td>
<td>0.00</td>
<td>0.00</td>
</tr>
</tbody>
</table>

Diagnostic Based in the results shown in table (3), lag of 2 is selected as the optimal lag.

Impulse Response Function (IRF):
Graph (1) depicts GDP and CPI reaction to changes in number of phone lines and phone lines penetration rate using Hall’s approach (1992), in the significance level of 90% and number of bootstraps replications of 500 (number of fluctuations applied to shocks in model) in short-term, mid-term and long-term.
Fig. 1: Impulse Response Function

In line with the theoretical backgrounds and Based on the analysis of Reimers & Lutkephol, results of figure (1) show that positive shock of number of phone lines has a positive effect on GDP and a negative effect on the general level of prices in short-term, mid-term and long-term. Also, the results show that positive shock of penetration rate of phone lines has a positive effect on GDP and a negative effect on the general level of prices in short-term, mid-term and long-term.

Conclusion:

Technologic changes play a pivotal role in the process of economic growth. Technologic changes are in company with modifications in production methods that are resulted from modern innovations in means of production. Technological changes lead to increase in work productivity, capital return and other factors of production. The capacity of ICT in accelerating the economic growth and improving lives of people and also the pressure form the international community for p

REFERENCES