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Impact of economic development indicators, information and communication technology on economic growth in Iran with ARDL approach

Enayati, Morteza [*] , Mohammad Ali Bakhshizadeh[**] and Yazdan Gudarzi Farahani[***]

[*] MA from Economics ,University of Tehran, Alborz compus, Tehran, Iran.
[**]MA in Information Technology Management, Payam e Noor University, Tehran, Iran.
[***] Ph.D. student in Economics, Department of Economics, University of Tehran, Shomali Kargar, Tehran, Iran.

Abstract

Investigation the indicators such as economic development and sustainable growth and human development and information and communication technology (ICT) and ITIL indicators has an important role in economic development. This article examines the impact of economic development indicators on Iran's economic growth in the period 1370-1390 using the ARDL approach. We use autoregressive distributed lag approach to estimate the cointegration relationship and short term dynamics. In this model the coefficient of error correction term equal -0.70 which that is found to be negative and statistically significant suggesting a rapidly adjustment of error correction factor that reflects the increasing rate is adjusted. The results of estimating the pattern of growth with an emphasis on purchasing power parity, stable income, per capita income, human development and information and communication technology in Iran using the ARDL models show that ICT and ITIL indicators has a significant effect on economic growth. We find that the coefficient of ICT, equal 0.12 which shows that a unit of increase in ICT, lead to 0.12 percent increase in economic growth. Impact of other variables such as stable income on economic growth equal to 3.87 and purchasing power parity index coefficient equal to 2.28 and the impact of per capita income on economic growth equal to 4.48 .

Keywords: information and communication technology, economic growth, ARDL model, error correction model.

JEL Classification: C22, E23, O40, O30

1. Introduction

Economic growth theories predict that economic growth is driven on investment in Information and Communication Technology (ICT). One of the most notable economic developments in the last decade has been the rapid increase in the ICT1 sector's share of investment activity and of the economy. The use of ICT has revolutionised the structure of management and the nature of competition in the emerging global economy.

Thus, ICT adoption is now a central part of strategic planning by organisations seeking into engages in the emerging digital economy. Over the past decade, the development of information and communications technology and the investment in the ICT sector has been increasing rapidly in many countries. The fast growth of ICT infrastructure can be explained by a number of factors, such as advancements in ICT related technologies and services and market demand. In particular, over the past decade, many countries have seen explosive growth in mobile communications. Mobile communications are experiencing accelerated growth rates in both developing countries and developed countries in recent years. The diffusion of mobile ICT services has not only facilitated market competition but also attracted a lot of domestic and foreign investment into the ICT sector. During the past decade, world economic output has also been growing at a fast rate, and in particular (Wan Lee. Jung, 2011).

The growth in IT exports observed over the last decade has created much euphoria and unprecedented media attention. In this context, it is only appropriate that we go beyond casual observations, and attempt to place the IT sector in its rightful place, a prerequisite for making informed policy-decisions. This calls for an understanding of the real contribution of this sector to the economy as a whole (Karagöl and Erdil, 2012).

The macroeconomic implications of the IT export boom may be viewed in a more precise way from two angles—its implications on the product market and on the labour market. We have the 'Dutch disease' models in trade theory, which can be used as an analytical tool to reflect on both of these implications in the short run. The central argument of these models is that windfall booms of external income can cause problems. They may result in an unexpected de-industrialization of the economy. The literature on Dutch disease and the 'resource curse thesis' underline such backwash effects of a primary commodity boom (Corden 1984 and Van Wijnbergen 1984).

Economic growth is the increasing ability of a nation to produce more goods and services. The use of ICT can enable the production of goods in a short amount of time and services are also provided more efficiently and rapidly. Growth can occur in many different ways, for example, the increased use of land, labor, capital and business resources and increased productivity of existing resources use by using ICT. ICT investment can also increase economic growth in many ways. ICT networks provide the framework for the delivery of different services, improves communications between firms, spreads to other industries and contributes to their profits affecting overall economic growth. The increased economic importance of ICT raises new questions for governments regarding the best policy frameworks to adopt for encouraging both ICT investment and ICT-led growth. The rapid diffusion of ICT in the past decades also introduces new policy issues for consideration, such as the effect of ICT on the distribution of economic activity and the influence of ICT on productions. Does the development of ICT infrastructure lead the increase of economic growth? Or does the increase of economic growth lead the development of ICT infrastructure? It is a vital question to explicitly disentangle the effect of ICT development and investment on economic growth. For this reason, the causal relationship between ICT development and economic growth has long been a subject of interest for empirical investigation. To date, a large number of studies have focused on explaining the economic impact of ICT development on economic growth and the issue has ranked among the active research fields since the issue has received considerable regulatory and public policy attention in many countries. ICT-led economic growth tends to occur when ICT demonstrates a stimulating influence across the overall economy. Although many studies find ICT development is one of the factors that affect economic growth, its contribution to the overall economy has varied between countries at different stages of development.

The purpose of this paper is, therefore, to investigate the relatiopnship between ICT, ITIL and economic growth, and to obtain policy implications from the results. The paper is organized in the following fashion. Section 2, describe the fundamentals of economic growth and ITIL. Section 3 presents data and empirical study. Final section contains the conclusions.

2. Fundamentals of economic growth and ITIL

2.1 Information Technology Infrastructure Library (ITIL)

A collection of thoughts and techniques for managing IT infrastructure, implement and use them.

ITIL is published as a collection of books, each book covers the topics of IT management.

ITIL thinking in the 1980s, there was a time when the British government found that the quality of IT services in a country that is provided is sufficient and acceptable.

In the 90s the big companies and government agencies in Europe very quickly began using the platform built using ITIL in government agencies and nongovernmental organizations to rapidly growing institution. In 2000, Microsoft's core products as the basis of ITIL MOF (Microsoft Operations Framework) can be used.

In 2001, the second version of ITIL was released.The short duration of ITIL, as the best and most widely known method for IT service management.(Majid Iqbal and Michael Nieves, 2007).

The current version of ITIL is used, is the third version that has the following five main sections:

1- Service Strategy

2- Service Design

3- Service Transition

4- Service Operation

5- Continual Service Improvement

2.2 Benefits of ITIL

The benefits of ITIL for IT service providers

-Increased customer satisfaction from IT services

-Reducing the risk of being faced with needs that had not been identified

-Reduce Costs

-Better communication and data transfer between customer and IT service provider

-There are standards for IT service Arayhdhndhgan

-Ability to produce more and better use of skills and experiences

-A method for quality IT services

2.3 Relationship between macroeconomic variables and ICT economic growth

The effect of Information and communication technology (ICT) on economic growth through the more effective is the first investment in information and communication technology (ICT), the high working capital and this is causing them to increase productivity and reductions in capital goods and increased in investment and increase national production is the result. The development of information and communication technology (ICT) to organize the distribution of goods and services resulting in new production methods and products and create new markets and economic growth provides. And improved efficiency and increased competition in markets shows that both these factors have a positive influence on economic growth. (Lan-Ii Yi, Lan Zheng, Qiang Yan and YunLi, 2010)

3- Methodology and Data

3.1. Data

Though various indicators of world ICT development are reported periodically by International Telecommunication Union, the periodic instability among the most commonly used measurements deter the need to rely on a single superior measure. Moreover, as good as the indicators may appear, the paucity of data in the ICT development in many developing countries poses a serious problem for the adoption of many of the indicators due to limited data availability and comparability. In this reason, different researchers have employed different indicators in their measurement of ICT development. Therefore, the accuracy of a proxy has not been subject to careful statistical scrutiny. Despite these facts, mobile and fixed-line subscribers (per 100 people), were used as a proxy of ICT development for the Iran in this study because this universally indicator measured and a consistent index collected by the international agencies and also, their longitudinal data availability corresponds well with that of real Gross Domestic Product (GDP). The data on real GDP, real exchange rates relative to the US dollar, are used as a proxy of economic growth for the Iran in this study. The information of GDP and mobile and fixed-line telephone subscribers (per 100 people) has been obtained from the world development indicators of the World Bank (http://data.worldbank.org/) and has been reported on an annual basis. The yearly time-series of the information were available from 1980 to 2010.

Additionally, the two time-series are seasonally unadjusted and, therefore, transformed into a natural log form to minimize any possible distortions of dynamic properties of the data and thus to remove a heteroskedasticity problem from the model initially.

2.2. Unit root test

Nelson and Plosser (1982) argue that almost all macroeconomic time series typically have a unit root. Thus, by taking first differences the null hypothesis of nonstationarity is rejected for most of the variables. Unit root tests are important in examining the stationarity of a time series because nonstationary regressors invalidates many standard empirical results and thus requires special treatment. Granger and Newbold (1974) have found by simulation that the F-statistic calculated from the regression involving the nonstationary time-series data does not follow the Standard distribution. This nonstandard distribution has a substantial rightward shift under the null hypothesis of no causality.

Thus the significance of the test is overstated and a spurious result is obtained. The presence of a stochastic trend is determined by testing the presence of unit roots in time series data. Non-stationarity or the presence of a unit root can be tested using the Dickey and Fuller (1981) tests.
The test is the t statistic on φ in the following regression:

$$\Delta Y_t = \beta_0 + \beta_1 . trend + \rho Y_{t-1} + \sum_{i=0}^{\infty} \varphi_i \Delta y_{t-i} + \varepsilon_t \qquad (1)$$

Where Δ is the first-difference operator, ε_t is a stationary random error.
If a time-series is found to be non-stationary, a filtering mechanism such as the first difference of the variable can be employed to induce stationarity for univariate model estimation. Augmented Dickey–Fuller (1981) and Phillips–Perron (1988) tests are carried to test the null hypothesis of a unit root in the level and the first difference of the two variables. As Enders (2004) indicated, the Augmented Dickey–Fuller (ADF) test assumes the errors to be independent and to have constant variance, while the Phillips–Perron (PP) test allows for fairly mild assumptions about the distribution of errors. Results of both ADF and PP tests for stationarity are reported in Table 1. The null hypothesis of a unit root cannot be rejected in the level of the variables, but all null hypothesis of a unit root is rejected in the first difference of the variables. The results in Table 1 unanimously confirm that all variables are integrated of order one *I(1).* The optimal lag in the ADF test is automatically selected based on the Schwarz Info Criterion (SIC) and the bandwidth for the PP test is selected based on the Newey-West estimator (1994) using the Bartlett kernel function, and the numeric values are reported in Table 1.

Table 1. Results of unit root test

variable	ADF t-statistic (lag length)	PP t-statistic (bandwidth)
ln GDP	-1,65	-3.81
Ln ICT	-2.21	-5.16
Ln HDI	-1.26	-4.25
Ln YP	-2.34	-2.84
Ln PPP	-2.69	-3.27
Ln GNA	1.62	-2,76

2.3. Cointegration test

The cointegration test is based in the methodology developed by Johansen (1991), and Johansen and Juselius (1993). Johansen's method is to test the restrictions imposed by cointegration on the unrestricted variance autoregressive, VAR, involving the series. The mathematical form of a VAR is

$$y_t = \theta_1 y_{t-1} + \cdots + \theta_p y_{t-p} + \vartheta X_t + \varepsilon_t \qquad (2)$$

where y_t is an *n*-vector of non-stationary *I(1)* variables, x_t is a d-vector of deterministic variables, $\theta_1, .., \theta_p$ and ϑ are matrices of coefficients to be estimated, and ε_t is a vector of innovations that may be contemporaneously correlated with each other but are uncorrelated with their own lagged values and other right-hand side variables. We can rewrite the VAR as (Eq. (3)):

$$\Delta_{y_t} = \prod_{y_{t-1}} + \sum_{i=0}^{\infty} \Gamma_i \Delta_{y_{t-i}} + \beta_{xt} + u_t \quad (3)$$

Where (Eq. (4))

$$\Pi = \sum A_i - I_t \quad that \;\; \Gamma_i = -\sum A_j \quad (4)$$

Granger's representation theorem asserts that if the coefficient matrix n has reduced rank r<n, then there exist n x r matrices α and β each with rank r such that $\pi = \alpha \beta'$ and $\beta' y_t$ is stationary. Here, r is the number of cointegrating relations and each column of β is a cointegrating vector. For n endogenous non-stationary variables, there can be from (0) to (n-1) linearly independent, cointegrating relations.

According to Granger (1988), cointegration means that the two non-stationary variables are integrated in the same order with the stationary of residuals. If the two variables are cointegrated, there exists a force that converges into a long-run equilibrium. In other words, if ICT development and economic growth are cointegrated, there is a force of equilibrium that keeps ICT development and economic growth together in the long-run. There are two test methods to identify the presence of a cointegrating relationship between two variables: (a) the Engle-Granger two-stage single equation method and (b) the Johansen-Juselius (1990) cointegration test. The Johansen method has two separate tests, the trace test and the maximum eigenvalue test. The Engle-Granger method obtains only one single cointegration relationship whereas it is possible to obtain more than one cointegration relationship with the Johansen method. Given this, the Engle-Granger method is Ordinary Least Squares (OLS) based test and the Johansen method is a maximum likelihood based test that requires a large sample. For the Engle-Granger two-stage single-equation method in this study, the Augmented Dickey-Fuller (ADF) test equation includes an intercept but no time trend. The test equations were tested by the method of least squares. The optimal lags are automatically selected for the ADF test based on the Schwarz Info Criterion (SIC). Based on the residual sequence of the ADF test, the null hypotheses of a unit root cannot be rejected for this country in the study, which has proven having one cointegrating relationship between ICT development and economic growth in the country. Numeric values of the results of cointegration test by the Engle-Granger method are not reported in this study due to space limitation.

Cheung and Lai (1993) reported that the Johansen approach is more efficient than the Engle-Granger method because the maximum likelihood procedure has significantly large and finite sample properties. The Johansen (1991), procedure uses two ratio tests: (a) a trace test and (b) a maximum eigenvalue test, to test for a number of cointegration relationships. Both can be used to determine the number of cointegrating vectors present, although they do not always indicate the same number of cointegrating vectors.

While doing the Johansen cointegration test, if there arises a different result between trace statistic and maximum eigenvalue statistic, the result of maximum eigenvalue test is preferred in this study due to the benefit of separate tests on each eigenvalue.

The results of the Johansen cointegration test in Table 2 show that the trace statistics and the maximum eigenvalue statistics are bigger than the critical values for Iran; therefore, the null hypothesis of no cointegration cannot be rejected at the 5 % significance level for this country.

The results indicate that there is one cointegration relationship between the two variables at the 0.05 level, which the trace statistic and the maximum eigenvalue statistic are greater than the critical values, the null hypothesis of no cointegration can be rejected at the 0.05 level. The results indicate the existence of one cointegrating equation between ICT development and economic growth in the country.

Table 2. Results of the Johansen cointegration test

Null Hypotheses	Alternative Hypotheses	Trace Statistic	Critical Value (5%)
H0	H1		
r=0	r=1	25.40	15.49
$r \leq 1$	r=2	8.58	3.84

The likelihood ratio tests show that the null hypothesis of absence of cointegrating relation (r = 0) can be rejected at 5% level of significance. Thus, we can conclude that ICT development and economic growth are cointegrated in the long run.

The ARDL modelling approach was originally introduced by Pesaran and Shin (1999) and later extended by Pesaran et al. (2001).

$$\Delta lnY_t = \delta_0 + \sum_{i=1}^{n} \delta_{1i} \Delta Ln\, Y_{t-i} + \sum_{i=0}^{n} \delta_{2i} \Delta Ln\, ICT_{t-i} + \sum_{i=0}^{n} \delta_{3i} \Delta Ln\, HDI_{t-i} + \sum_{i=0}^{n} \delta_{3i} \Delta Ln\, YP_{t-i} + \sum_{i=0}^{n} \delta_{5i} \Delta Ln\, PPP_{t-i} + \sum_{i=0}^{n} \delta_{6i} \Delta Ln\, GNA_{t-i} + \delta_7 Ln\, Y_{t-1} + \delta_8 Ln\, ICT_{t-1} + \delta_9 Ln\, HDI_{t-1} + \delta_{10} Ln\, YP_{t-1} + \delta_{11} Ln\, YP_{t-1} + \delta_{12} Ln\, PPP_{t-1} + \delta_{13} Ln\, GNA_{t-1} + \mu_t \quad (5)$$

The bounds testing procedure is based on the joint F-statistic (or Wald statistic) for cointegration analysis. The asymptotic distribution of the F- statistic is non-standard under the null hypothesis of no cointegration between examined variables. Pesaran and Pesaran (1997) and Pesaran et al. (2001) report two sets of critical values for a given significance level. One set of critical values assumes that all variables included in the ARDL model are I(0), while the other is calculated on the assumption that the variables are I(1). If the computed test statistic exceeds the upper critical bounds value, then the Ho hypothesis is rejected. If the F-statistic falls into the bounds then the cointegration test becomes inconclusive. If the F-statistic is lower than the lower bounds value, then the null hypothesis of no cointegration cannot be rejected.

If the series of two variables are non-stationary and the linear combination of these two variables is stationary, then the error correction modeling rather than the standard Granger causality test should be employed. Therefore, an ECM was set up to investigate both short-run and long-run causality. In the ECM, first difference of each endogenous variable (GDP and ICT) was regressed on a period lag of the cointegrating equation and lagged first differences of all the endogenous variables in the system. The Result of long run coefficent are presented in Table 4.

Table 4. The Result of long run coefficent

variable	coefficent	Prob
$LICT$	0,12	0.00
LHDI	0,17	0.00
$LGNA$	3,87	0.00
$LPPP$	2,28	0.00
LYP	4,48	0.00
C	14,34	0.00

Notes: The lag lengths are chosen by using AIC information criterion. * Denotes the rejection of the null hypothesis at 5% level of significance.

3. Conclusion

Unlike the empirical findings of the previous studies, the Granger causality test in this study does not support the hypothesis of ICT-led economic growth in the short-run for Iran in this study. The results of this study also find a one-way causal relationship from economic growth to ICT development for Iran. Some of the possible reasons why the growth-led ICT development hypothesis is true for Iran are that economic development would be beneficial for ICT development in Iran and ICT development is strongly affected by growth of the Iranian economy in such conditions.

Therefore, a careful empirical analysis is desirable for any country that may want to focus on the ICT industry as part of its national economic development strategy. The analysis will verify if the common notion that the ICT-led growth is in fact applicable to that particular country. Based on the results of this study, decisions on the

ICT-led economic growth strategy can be adjusted or altered for such factors as the overall ICT investments and ICT infrastructure budget, approval of private or governmental ICT projects, and so forth.
If empirical results support the ICT-led growth hypothesis in the short-run, more resources should be allocated to the nation's ICT industry as a priority rather than to other sectors. The current study discovered mixed results between ICT development and economic growth in this country. The mixed results indicate that the direction of causality between ICT development and economic growth may be determined by various factors of the country. In conclusion, factors for this country such as the degree of dependence on the ICT industry, the usage of ICT and the level of economic development may each be considered individually as important determinants. The mixed results of this study further point to several research directions for the future.

Suggestions for future studies

- Consideration the relationship between ICT investment and economic growth in developing countries.
- The effect of ITIL on economic growth with Panel approach.
- The effect of Economic decentralization from large cities and economic growth.

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