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Consideration the Causality between Information Communications Technology and Economic Growth in Iran

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Abstract

In this paper, we examine the Iran the causal relationship between information and communications technology (ICT) development and economic growth in. The Granger causality test is performed following the cointegration approach to reveal the direction of causality between ICT development and economic growth. Test results indicate that there is a long-run equilibrium relationship that runs from ICT development to economic growth in Iran; and a one-way directional causality of growth-led ICT development for Iran is evidenced. A discussion follows based on the empirical findings.

Keywords: Information and communications technology, economic growth, Granger causality.

1. Introduction

Economic growth theories predict that economic growth is driven on investment in Information and Communication Technology (ICT). However, empirical studies of this prediction have produced mixed results, depending on the research methodology employed and the geographical configuration considered. 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).

Early macro level studies, going back to late 1980s and early 1990s, indicated that ICT's share in productivity and economic growth was very small (Oliner and Sichel, 1994). However, later macroeconomic studies showed that investments in ICT had a considerable effect on the productivity of labor force and on economic growth (Oliner and Sichel, 2002). Gordon (2000) attributes productivity growth of the 1995-2000 period to business cycles. Results sometimes diverge due to different methodologies employed (Wan Lee Jung, 2011).

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 (Wan Lee Jung, 2011).

To date, results of the causal relationship between ICT development and economic growth have been mixed. As a matter of fact, research results for the relationship between ICT development and economic growth are inconclusive.

This study thus examines a causal relationship between ICT development and economic growth in Iran. This study aims to answer the following two questions: First, is there a long-run equilibrium relationship between ICT development and economic growth? Second, what is the direction of causality between the two variables in the short-run? This study aims to contribute to the literature testing the ICT-led economic growth hypothesis. This study employs cointegration tests to investigate a long-run equilibrium and Granger causality tests to investigate directional causality in the short-run between ICT development and economic growth.

Since the results of previous studies of the causal relationship between ICT development and economic growth have been mixed, this study suggests that the causal relationship between ICT development and economic growth may not be independent of the level of economic growth and ICT development of countries. Therefore generalizing from the study of one country to other countries should be a significant contribution to the body of literature in this domain. The empirical application of this paper uses the Iran, based on data availability and compatibility to test for the validity of the theoretical findings. Accordingly, the following hypotheses are considered:

Hypothesis 1: There is a long-run equilibrium relationship between ICT development and economic growth.

Hypothesis 2: ICT development leads to economic growth.

Hypothesis 3: Economic growth leads to ICT development.

In this paper, we intend to examine the relationship ICT and economic growth for Asian countries according to Wan Lee Jung (2011) article.

The paper is organized as follows: Section 2 present the estimation method and data and reports the results. Section 3 summarizes and brings the paper to its conclusions.

2- Methodology and Data

2.1. 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 they are universally 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 (Wan Lee. Jung, 2011).

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:

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

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.

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

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

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))

$$\Pi = \sum A_i - I_t \quad \text{that } \Gamma_i = -\sum A_j \quad (4)$$

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.

Therefore, this study concludes that;

Hypothesis 1 "There is a long-run equilibrium relationship between ICT development and economic growth" is supported. In other words, there exists a long-run equilibrium between the two variables for the Iran. In this case the Granger causality test method by an unrestricted VAR model is the best option for testing directional causality of short-run dynamics.

2.4. Granger causality test

Engle and Granger (1981), note that if two time-series variables are not cointegrated there may be unidirectional or bidirectional Granger causality in the short-run. Short-run causality is determined by test on the joint significance of the lagged explanatory variables, using an F-test or Wald test. The traditional practice in testing the direction of causation between two variables has been to use the standard Granger causality test (i.e. pair wise Granger causality tests for bivariate time-series). As an alternative, the short-run Granger causality can be tested by the Wald test.

Under the Wald test, the maximum likelihood estimate of the parameters of interest is compared with the proposed value, with the assumption that the difference between the two will be approximately normal. Typically the square of the difference is compared to a chi-squared distribution. The Block Exogeneity Wald test in the VAR system provides chi-squared statistics of coefficients on the lagged endogenous variables, which are used to interpret the statistical significance of coefficients of the regressors. In this way, Wald test statistics can be used to find out the Granger causal effect on the dependent variable. In the VAR system, Granger causality is done to glimpse the short-run causality running from independent variables to a dependent variable, using asymptotic t-statistics that follow chi-squared distribution instead of F distribution. The hypothesis in this test is that the lagged endogenous variable does not Granger causes the dependent variable. For Iran, to answer the question regarding the direction of causation in the short-run, the Granger causality tests by unrestricted VAR models are performed.

Engle and Granger (1981) and Granger (1988) note that if two variables are cointegrated there always exists a corresponding error correction representation in which the short-run dynamics of the variables in the system are influenced by the deviation from equilibrium. For the Iran, the existence of a long-run equilibrium relationship between ICT development and economic growth implies that the two variables are causally related, at least in one direction. The VECM implies that changes in one variable are a function of the level of disequilibrium in the cointegrating relationship, as well as changes in the other explanatory variable. The VECM is a technique that facilitates to capture both the dynamic and interdependent relationships of the said variables and is a special type of restricted VAR to correct a disequilibrium that may shock the whole system.

The long-run causality is implied through the significance of the t-statistics of the lagged error correction terms. In this case, it estimates the asymptotic variance of the estimator, and then the t-statistics will have asymptotically the standard normal distribution. Therefore, asymptotic t-statistics in this test can be interpreted in the same way as t-statistics, which are used to interpret the statistical significance of coefficients of the lagged error correction terms, which contain the long-run information because it is derived from the long-run cointegrating relationship. The short-run Granger causality can be tested by the Wald test. The Block Exogeneity Wald test in the VECM system provides chi-squared statistics of coefficient on the lagged endogenous variables, which are used to interpret the statistical significance of coefficients of the regressors. In this way, Wald test statistics can be used to find the Granger causal effect on the dependent variable. The hypothesis in this test is that the lagged endogenous variable does not Granger causes the dependent variable.

Table 3 displays the results of Granger causality tests with annual data. The null hypothesis regarding no causation leading from ICT development to economic growth in the short-run cannot be rejected for the country. The null hypothesis regarding no causation leading from economic growth to ICT development in the short-run can be rejected only for Iran at the 5% significance level. The results are consistent with different lag selections, but the numeric values of the results of different lag selections are not reported in this study. Considering the results of the Granger causality test in Table 3, this study concludes that Hypothesis 2 “ICT development leads to economic growth” is supported for this country in this study. Hypothesis 3 “Economic growth leads to ICT development” is supported for Iran. In other words, due to the presence of one-way directional causal relationship from economic growth to ICT development for Iran this finding suggests that economic growth leads to ICT development in Iran.

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.

In sum, the results of the causality test can help the government set priorities regarding where and how to use limited resources for national economic growth. 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. To detect the causal relationship, this study performed Granger causality tests following the cointegration approach, which has been the typical method favored in studies of this kind. 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. First, the simple bivariate VAR and VECM models were used in this study. The important and critical roles that other microeconomic factors play in model specifications were not fully considered. This can be improved by adopting an approach of using multivariate Granger causality tests to include important variables such as foreign direct investment, exports. Second, the limitations of this study may be related to data availability. Instead of using a series of mobile and fixed-line telephone subscribers (per 100 people) information, the more accurate measure of ICT development generated from economic impact data, so called credible instruments, will produce more precise causal relations.

References

Cheung, Y.W. & Lai, K.S. (1993), “Finite-sample sizes of Johansen's likelihood ratio tests for cointegration”, Oxford Bulletin of Economics and Statistics, 55, 313–328.

Dickey, D.A. & Fuller, W.A. (1981), “Likelihood ratio statistics for autoregressive time series with a unit root,” Econometrica, 49, 1057–1071.

Enders, W. (2004), Applied econometric time series (2nd Ed.). New York: Wiley.

Engle, R.F. & Granger, C.W.J. (1981), “Cointegration and error correction: representation, estimation and testing”, Econometrica, 55, 251–276.

Gordon, R. (2000), “Does the “new economy” measure up to the great inventions of the past?,” Journal of Economic Perspectives, 14, 49–74.

Granger, C.W. J. (1988), "Some recent developments in a concept of causality", Journal of Econometrics, 39, 199–211.

Johansen, S., & Juselius, K. (1990), "Maximum likelihood estimation and inference on co-integration with application to the demand for money", Oxford Bulletin of Economics and Statistics, 52, 169–221.

Johansen, S. (1991), "Estimation and hypothesis testing of cointegration vectors in Gaussian vector autoregressive models", Econometrica, 59, 1551–1580.

Mackinnon, J.G., Haug, A.A. & Michelis, L. (1999), "Numerical distribution functions of likelihood ratio tests for co-integration", Journal of Applied Econometrics, 14, 563-577.

Mackinnon, J.G. (1996), "Numerical distribution functions for unit root and co-integration tests", Journal of Applied Econometrics, 11, 601-618.

Newey, W. & West, K. (1994), "Automatic lag selection in covariance matrix estimation", Review of Economic Studies, 61, 631-653.

Phillips, P. & Perron, P. (1988), "Testing for a unit root in time series regression", Biometrica, 75, 335–346.

Oliner, S.D. & Sichel, D. (1999), "The resurgence of growth in the late 1990s: Is information technology the story?," Journal of Economic Perspectives, 14, 3–22.

Oliner, S.D. and D.E. Sichel (2002), "Information Technology and Productivity: Where Are We Now and Where Are We Going?", Federal Reserve Bank of Atlanta Economic Review, 3, 15-44.

Wan Lee. Jung. (2011), "Empirical evidence of causality between information communication technology and economic growth in China, Japan and Korea", The 11th International DSI and the 16th APDSI Joint Meeting, Taipei, Taiwan, July 12 – 16.

World Bank, 2011. World Development Indicators 2011, CD ROM version. Washington, DC.

Note:

Note 1. ln denotes the natural logarithm of the variable under consideration. Δ denotes the first difference of the variable under consideration. The test equations were tested by the method of least squares. The Augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) test equations include an intercept but no time trend. For both the ADF and PP t-statistics, the probability value for rejection of the null hypothesis of a unit root are employed at the 0.05 level (p-value < 0.05) based on MacKinnon (1996) one-sided p-values.

Note 2. The test equations were tested by the method of least squares. For the Johansen cointegration test, the assumptions of cointegration test allow for leaner deterministic trend in data include an intercept but no time trend and test VAR. For the both trace and maximum eigenvalue test statistics, the probability value for rejection of the null hypothesis of no cointegration is employed at the 0.05 level based on the MacKinnon-Haug-Michelis (1999) p-values.

Note 3. The coefficients of regressors have been estimated by VAR or VECM. Numbers in the cells of the independent variable ("X") are chi-square statistics and numbers in the cells of ECT are asymptotic t-statistics, which are used to interpret the statistical significance of the parameters. The probability value for rejection of the null hypothesis is employed at the 5% significant level.

Table 1. Results of unit root test

	ADF t-statistic (lag length)		PP t-statistic (bandwidth)	
	Δln GDP	Δln ICT	Δln GDP	Δln ICT
Iran Data	-3.97(2)	-4.36(0)	-3.74(5)	-4.38(2)

Table 2. Results of the Johansen cointegration test

	Trace test		Maximum Eigenvalue test	
	$r = 0$	$r \leq 1$	$r = 0$	$r \leq 1$
Iran Data	15.69	2.21	14.64	2.21

Table 3. Results of Granger causality tests (Block Exogeneity Wald tests)

	"Y"	Δln GDP		Δln ICT	
	Method "X"	Δln ICT(H2)	ECT	Δln GDP(H3)	ECT
Iran Data	VECM	0.56	3.53	0.81	1.23