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Forecasting the Impact of Information and Communication Technology on Gross Domestic Product in Iran

Sadr, Seyed Mohammad Hossein[1] Gudarzi Farahani, Yazdan[2 *]

1. Ph.D student in Management Information Technology, Department of Management and accounting, University of Allame Tabataba'I (ATU), Tehran, Iran.
2. M.A. student in Economics, University of Tehran, Faculty of economics, shomali Kargar, Tehran, Iran.

* E-mail of the corresponding author: yazdan.farahani@gmail.com.

Abstract

ICT has been considered as one of the factors that has affected productivity growth in the literature on economic growth for less than two decades. The ICT capital conveys the features of knowledge capital, so it can influence productivity growth both through capital deepening and its spillover effects. There have been many studies in the literature on the effect of ICT on GDP; however, the effect of ICT on GDP growth in the international context is less known. This study examines the relationship between ICT spillovers and GDP growth using a time series data method for Iran during 1980-2008.The result of this comparison showed that using a system approach can significantly increase the prediction accuracy. Finally, using the selected patterns, the impact of ICT on GDP for the period 2009 to 2020 is predicted. And result indicated that the impact of ICT on GDP will be increase to 2% in 2020.

Keyword: Information and communication technology, gross Domestic Production, time series model, VAR

1. Introduction

Generally Information & Communication Technology (ICT) consists of all the advanced technologies of communication and transformation of data in telecommunication systems. This system can be a telecommunication network, a number of communicated computers and connected to a telecommunication network and also programs used in them.

ICT focuses on important place of information, information storage and process devices and devices of transformation and acquiring information. It's obvious that in this way, apart from communicational potentials, other media, like radio and television would be also in the list of communicational devices (information distribution and publication channel). Relaying the structure of ICT prerequisites an informational laying structure in which all communicational devices and equipments like telecommunication equipments, radio and television would be involved.

Evaluation of the impact if ICT on economical work of countries have been a subject of attention since 1990. One of the most important variables in question is traffic profiting. ICT can affect the economic growth in three ways:

In this article forecasting the impact of ICT on gross domestic product in Iran is the subject of study. Organization of the article is as follows: after the introduction, background of the subject (theoretical and experimental) is discussed. The second part is sativa of description of the model. After that, derivatives and data resources are elaborated, followed by evaluation of the model and experimental results that are presented. An abstract of the results would shape the ending of this article.

2. Impact of ICT on economy of countries

The new economic conditions in the country that has emerged at different levels of organizational, national and international has been in a way that has made a revision in applying ICT guidelines inevitable. From organizational point of view, lots of criticisms of industrial activities and lots of solutions for their improvement has been presented that can cause a major alteration in structure of these industries. The probability of assurance of this alteration can by forecasted by many experts. Information technology, as guideline instrument, is of great help to organizations to be able to control such changes.

At national level, different organizations of different countries are constantly on the way of different growth levels; this fact states their economic reflection. At international level, with industries becoming global, economic conditions has gone through basic alterations and as a result, using information technology is inevitable. Different economic conditions of different industries are changing enormously from international angle, and this fact induces a suitable situation for imparting information technology potentials. Assurance of numerous alterations that can be designed beforehand by information technology could be subject of forecast. In business opportunities and new markets that are presented in this way, technology can play an important part to guarantee success.

Impact of information technology in structure and levels of and organization states inevitable entrance of that organization in information technology century. At the beginning of this century, using data processing is confined only to data processing sections and to certain operations on numbers. Organizations that use IT in a more advanced way use a wide range of software and hardware technologies by different groups and for different purposes and different activities.

In author's opinion different groups are at work in using IT in the country's economy. These groups are: government, using policies and regulations, business users with presenting requirements at request levels, manufacturers of IT with presenting the technology and stating acceptable levels, providers with networking and regular gatherings, expenditures with their requests and actions. Versatility of these applicants from one angle may probably show the acceptance of IT in industry, and on the other way, may be considered as an obstacle on the way of reaching a vaster application of IT. The role of these applicants in government schematizations in the field of using IT is very significant. It may be that a section through business pressures induced by this schematization and organization internal directions or with approaches of economic policy makers are forced to use IT. It is also possible that centered government schematizations and approaches be a lever to support the ongoing mutations in an industry that uses the very speeding process.

The prevalent thought demanding complete draining in technological endeavors and the thought that it will solve all the problems of this level is not that logical. But also, it can be hoped that the problems of induced by lake of regulations between different sections of an industry are resolved by expansion of technology.

The last or maybe the most important point about the lake of complete acceptance of using IT in industries is that, information is still considered as an element which needs to be used by technology. One of the most important differences between “Information technology” and “data processing” is the need of “information technology” for management. The important managing elements in using IT consist: the support of high ranked managers of the organization, the amount of knowledge of managers about IT and the amount of investing in IT. In industrial section, lake of managing sophistications and shortage of attention up-to-date and technical information has made application of IT troublesome. The solution to this problem is training existing managers, not employing and training of new personnel.

But in the end, and in the science-based atmosphere of today economy, the ability to taking profound and effective use of information on the way of maximization of profiting is very important. Today the economic competition is more based on the ability to transform the vast amount of information into useable knowledge and applying them on the way of economic institutions aims and as result the economy of countries.

It's due to this fact that today knowledge management is a basic need for lots of economic institutions, because with correct and effective transformation of information into knowledge, growth of economic would be escalated and economic competition between them in markets would be eased.

One of the most obvious points that can be mentioned about network effects of applying ICT is easing the discovery of existing knowledge in organizations and institutions; this means discovering an instrument to find the hidden treasure lied in soil of institutions. Using ICT has resulted that different systems and arrangements are produced with single aim that is gathering information and transforming it into wisdom applicable in the institutions. There are various elements in the circle of knowledge management. The part that is the center of attention for economists may be the discovery resulted by knowledge of organizations as a main loop of this circle.

Easy access to physical deep-structures is without any doubt important, but because of the fact that, due to new approaches in management, labor work is considered as a capital, this fact would become one of companies pivotal owning.

The result is that, institutions access to trained and professional personnel in their field is inevitable; this means providing human capital before establishing capital and its proof is the growing demand of professional personnel and familiar to crafts of ICT in these years.

3. Conceptual framework and theoretical basics

In a whole view, in time series models instead of focusing on theoretical basics for studying economic variables behaviors, the main idea is that variable behavior should be investigated and resulted from inside the observations themselves.

Time series models are a group of models which consist of two main model of single-variable and multi-variable. Auto-regressive (AR) model, motive average (MA) model, auto-regressive integrated moving average (ARIMA) model, auto-regressive distributed lag (ARDL) model and vector auto-regressive (VAR) model are among the multi-variable models.

In single-variable time series models, future behavior of variables are considered as their past behavior so that for forecasting variable behavior there won't be any need for rather than those already existing in the series.

As a result, contrary to contrastive models, in which the depended variable Y is explained using explanatory variables $(X_1,\dots,X_n)$, in this model Y is explained using its past amounts and disruptions sentence.

In other words, existing information about distribution probably is a series of $(Y_1, Y_2,\dots,Y_n)$ that is a base for understanding the Y_{n+1} happening. Multi-derivational time Series models contain a group of methods that it is theorized in them that a variable cannot be explained merely on its history and other information that affecting the behavior of variable.

Generally Multi-variable time series patterns have three main patterns which are ARDL patterns, VAR patterns and Vertical error correction patterns. Each of these patterns introduces a certain behavior of variables and pictures the relation between them in a certain way.

Success of time series patterns in forecasting economical derivates like price and value of inflation, made them a common device in forecasting economical variables and they are used mainly in formulization of variable behaviors

and forecasting their future amount. In this study, the main effort is that, through a systematic process, logical method choosing the appropriate time series pattern to be used as forecasting device in apply studies be presented. In eyes of economical theories, ICT can be effecting in total profiting through; external effects of the network; advancement of compliments with accepting ICT; and providing better access to the knowledge. Experimental studies are done with growth accounting approach and focus on important impact of ICT on growth of profiting in developed countries and some developing countries.

One part of world, due to many reasons managed to create structures, basics and capacities needed for technology and science and develop constantly, in a way that have provided the main share in production and technology markets, and also have a good capability in absorbing these developments in solving their problems and expanding their potentials and capacities. At whole, ICT effects both demand and providence.

On demand side through desirability and welfare function impacts on economic behavior of consumers and results in developing production process, deepening of capital, advancement in technology and labor. Consequences of this impact are growth of interest in institutions, sections and countries and in the end, economic growth, profiting and welfare of consumers.

In the past recent years, numerous studies have been performed on impact of ICT in different economic variables. For example, Magres (1999) believed that in information based economy basic regulations and theories about structure of market and other regulations do not change, but works based on relative importance of each.

Advocates of new economy hold that we have entered a century in which production is high, unemployment is low and inflation is down either; because useful technological shocks have resulted in an increased profiting and decreased expenses on production side, but in fact, both in theoretical and practical point of views amount of evidence is low. Following chart investigates the effective channels of ICT on GDP in a graphic fashion (Figure 1).

In the end, with investigations taken place, following notifications worth mentioning:

1) Applying ICT decreases the cost of researches and impediments of entering exposition chain and shortens its way. These characteristics help efficiency (or proficiency) and expansion of interest margin and decreasing natural price of unemployment.

   In a way that today, this belief is widely accepted that investment in ICT has a positive effect on proficiency and on that part of advancement of proficiency that exists in information economics of new economy.

2) In investigating positive effects of ICT in business on exposition side, this point should be subject of attention that changes that are made on demand side of economy made by exposition side may have effect on levels of production and change the price of production elements. Because one of potential impacts of the internet may be growth of stock prices which may result in an increase in demand induced by the effect of wealth.

   On the other side activities related to structural transformation which is usually along with increase competition in the market, usually results in a sense of carrier insecurity and threatens consuming, while this impact is related to demand, the real path of interest rate (short-term) is affected.

3) Another idea is that, it is advancement in ICT or the internet as an extracting device that network impacts and structural transformations of the market can be main definitive. For example, the effect of electronic

transactions is relatively based on number of sellers and purchasers and also the nature of transactions. In markets that the number of sellers is more than the number of purchasers, usually the main result is pressuring price downward, but were the number of purchasers is more than sellers the effect of electronic network is to pressure the price upward. These swings in price effect production scale and applying production organizations in institutions.

Fomby (1998) believes that this identification should be based on character of time series and the kind of relation between them. On this method, following levels must be followed systematically. A) On the first level, variables which may have impact on each other must be identified. This task usually takes place using economic theories and experimental studies. For example amount of consuming goods, price of goods, income of consumers are variables which can affect each other in a way, so this variables could be considered as candidates of forecasting the consumption on production. B) In second level candidate variables are investigated on their statistical characters like stance and having common base. This investigation is usually taken place using examinations like Dicky Fuller so that their amplitude is specified. The result of this test can lead to two conditions. First is at least two of series related to models are filed with order one, and the second is that the series is filled with order zero. In other words, it has static level. At least *n-1*observation of first condition and possibility of having a long term relation (convergence of variables) is suggested that should be examined.

If existence of such a relation is cleared, the error correction model used to clear the behavior of the variable and to forecast its future amounts is appropriate and should be used.

If existence of a long term relation is not maintained, causal test must be done, so that existence of non-existence of a cause-and-effect relation between variables is maintained. But if results of the test stated the stativity of variables studied, again the kind of causal relation between variables of the model must be cleared and on its base the appropriate model is chosen. Investigating the cause here can be taken place using Grengy causal exam. Based on this exam, if there is a two way causal relation between investigated variables VECM is appropriate, because in this model all the variables are inborn toward each other and this fact is in coordinance with two way cause.

But if there is a one way causal relation between variables, transportation models are more appropriate for forecasting.

In the end, if there is no meaningful causal relation between variables, mono-variable time series models give an appropriate forecast of variable behavior. Going through aforementioned levelslead us to choose a fitting model to determine behavior of variables studied that forecasting based on which have the most power.

But as mentioned earlier, the first level after determining variables is static test of them. Dicky Fuller test is the expanded version of one of the most reliable tests for investigating time series static condition. Numerous methods are introduced to investigate the causal relation between variables and one of the easiest of them is Granger cause test. Based on Granger method for causal relation between variables of X and Y, it's needed that meaningfulness of

different coefficients of a variable (X) in explanation of another variable (Y) is investigated. In case of meaningfulness of this coefficient, (X) is the causal of (Y). Contrary to this situation is also binding. For convergence exam of multiply variables usually two methods of Engle-Granger and Johansson is applied. But, Johansson method is able to identify the existence of a long-term relation (if it is existed) between variables and in this way it is superior to Engle-Granger method which lacks this character. In this method which is based on the relation between rank of matrix and signifying methods of them, using two statistics of impact and maximum special amount the number of long term relations is judged. Estimating models and forecasting based on them consist of four level of identification, estimation, evaluation and forecasting. These levels are a bit different for mono variable models and multi variable ones. In order to identify the appropriate model from among mono variable models this method is applied: first a comprehensive ARIMA model is formed in this way:

$$\emptyset_p(L^p)PC_t = \theta_q(L^q)\varepsilon_t \qquad (1)$$

That in it L is operator of halt and $(L)\emptyset_p$ and $(L)\emptyset_q$ are phrases of polynomial L in order with powers of p and q that p is the power of auto-correlated part of model, and q is the power of model's average moving part. $\varepsilon_t \sim iid(0,\sigma^2)$ and PC_t is the required time series which in this study is ICT.

Second, regarding the behaviour of average moving part and auto-regressive using auto-correlative function (ACF) and partial auto-correlative function (PACF) kind of final model is specified.

Identification of multi-variable models which consist of auto-regressive models with distribution halt and vector auto-regressive model and vector error correction models, have variable specification of models and also specification of appropriate halt number specification in them.

Choosing the first variables which should be entered in these models is inspired by economical theories and experimental studies.

For estimating kinds of ARIMA models, method of minimal ordinary squares OLS and methods of maximum linear ML are used. Vector auto-regressive model is also used for estimation in conditions where error sentences of model have steady variance and lake lasting coordination, using OLS method and with separation of each of functions in system.

After estimating the model, in order to study the ARIMA model, models with higher ranks are also estimated and compared with basic models and the fitting model is specified based on (AIC) scale and (SBC) scales and random sentences remaining estimation. Lastly, model's forecasting power –which is one of the most important scales in specifying the final model, is studied using Mean Absolute Error (MAE), Mean Absolute Percent Error (MAPE) and Root of Mean Square error.

4. Explanation of variables and sources of data

In this article, based on research background, variables used are divided in two main groups: main variables (consisting different indexes of ICT and human recourses) and an index indicating massive structure of a country's economy consisting economy capital and labor employment and percentage of changes in price of oil and liquidity.

Capital of ICT: capital of ICT which the element of production plays a role production of different goods and services. Separation of whole ITC capital from non-ICT has been subject of attention since 90s. ICT capital has a high outcome and it is expected that with deepening the capital, proficiency is helped.

Theoretical and practical studies show that growth of general proficiency in ICT industries is more than other sections. In this article ICT capital has been investigated from different angles. Advancement of deep-structures of ICT can lead to growth of proficiency in this section resulting in general proficiency. On this basis, variables of telephone impact coefficient and network index is applied. Also Aggregation of ICT shows that how changing funding from non-ICT to ICT can affect on growth of proficiency. To evaluate this effect, proportion of ICT capital supply to general capital proportion is used. ICT is used in economical activates in large scales and in order to evaluate these variables of internet influence coefficient and index of information application is used. Some experimental researches consider costs of ICT to be of internal overflow of ICT that to evaluate this ICT cost proportion variable to GDP is applied. Human capital: human capital consists of deployed specialties in length with programs of childhood, primary school, guidance school, high school, and university and in-work trainings for adults which emerge in each person. These capitals appear in different fields of knowledge and capabilities of the individual. Human capital, along with physical capital expands potentials of country in production of goods and services. Lucas insists on human capital deployment for constant development.

On effective elements on general proficiency, impact of landline telephone influence coefficient variable, internet influence variable, information aggregation, information application, network index, openness of economy and saving rate is evaluated.

First we investigate the degree of permanency of variables used to show that how permanent our variables are.

Variables used in this article:

GDP: Gross Domestic product – World Bank (2011)

M: Liquidity (Money) - World Bank (2011)

L: labor – World Bank (2011)

K: Capital – World Bank (2011)

ICT: internet users, landline telephone, cell-phone and PC users (in each 100 person) – World Bank (2011)

4.1. ADF 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:

$$\Delta Y_t = \beta_0 + \beta_1 . trend + \rho Y_{t-1} + \sum_{i=0}^{\infty} \varphi_i \Delta y_{t-i} + \varepsilon_t \qquad (2)$$

Where Δ is the first-difference operator, ε_t is a stationary random error (Chang, at all, 2001).

In order to stop false regressions in research, first the stationary of variables are evaluated and to this end expanded Dicky Fuller exam is chosen. Applying expanded Dicky Fuller exam shows us weather inflation rate time series are stationary processes (with zero accumulation rank) or divergent (with non-zero accumulation rank).
Results in table (1) shows that to 0/5 and /10 meaningful level, statistic of Dicky Fuller for GDP and labour and ICT in absolute form in more than critical amounts and with two times of deduction becomes permanent, as a result, H0 theory believing in existence of a single root is voided. Statistic of Dicky Fuller for capital and percentage of oil price changes in absolute form is more than critical amount and with one time deduction becomes permanent, as a result, H0 theory believing in existence of a single root is voided, which leads to the fact that GDP time series and labour and accumulated ICT are from second rank, and capital and percentage of oil price changes are from first rank and 0.5 and 0.10 are permanent (Table 1).

In this section before estimating model, we investigate the accuracy of existence of a long term relation between GDP and ICT and economic capital in Iran using Johansson examination.

4.2. Tests of Cointegration

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

$$y_t = \theta_1 y_{t-1} + \cdots + \theta_p y_{t-p} + \vartheta X_t + \varepsilon_t \qquad (3)$$

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. (4)):

$$\Delta_{y_t} - \prod_{y_{t-1}} + \sum_{i=0}^{\infty} \Gamma_i \Delta_{y_{t-i}} + \beta_{xt} + u_t \quad (4)$$

Where (Eq. (5))

$$\Pi - \sum A_i - I_t \quad that\ \Gamma_i - -\sum A_j \quad (5)$$

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 (Yin and Xu, 2003; Aktaş, Cengiz and Yılmaz, Veysel, 2008). Based on this test, it becomes clear that on secure level of 0/95, three accumulation vectors exists between GDP and capital and labor and liquidation and ICT and percentage of oil price change. Results of Johansson exam which does not void a long term relation between variables, asserts the theory stating the impact of ICT on GDP.

In order to investigate the impact of ICT of GDP compiled data model in all the time period of 1980-2008 is studded and then, time period fitting with statistics at hand is chosen to estimate. Based on stated data and all the methods of economy evaluation, we have attempted here to evaluate our model using OLS method to show the impact of each of variables specially ICT on GDP. Supposing that our production function is in Cab-Daglas form, we used algorithms to make variables linear so that coefficients of each variable state its absorption toward production.

Coefficient of variables has the required sign. Core of findings about Iran in investigating impact of ICT on GDP, with appropriate estimation of model by auto-associated method with distribution halts showed that results of model evaluation states positive and meaningful impact of different indexes of ICT on GDP (at least with 90 percent accuracy), and also, growth rate of liquidity has meaningful and positive impact on GDP, this is while employment generally has positive impact on GDP but in all conditions the impact is not meaningful, on the other side, percentage of oil price change has a meaningful impact on GDP. Also, in these results, network effects in applying IT productions can be observed. In a way that, utilitarian of a person increases based on consumption of another person of that product. This states that coefficient amount of landline, installing PC and cell phone and application of internet has been large.

Elements which cause differences between new economy and classic economy could be categorized as follows:

1- High stable price, 2- proficiency with increasing scales (or advantage on scale on exposition side) 3- external network impacts (or advantages caused by scale on demand side)

Considering results of convergence exam and based on what stated in methodology, at this level the causal exam based on Granger causal examination was performed so that the next step towards choosing appropriate model is

taken.

Results of this test shows meaningful one-way and two-way causal relation between variables of both models, as a result, the most fitting model for forecasting impact of ICT on GDP are mono-variable models that its special kind should be asserted from among model series of ARIMA in next tests.

Specifying auto-regression halt part and rank of moving average part in ARIMA models related to ICT was taken place by method of drawing diagram of auto-converge graph and partial auto-convergence. Due to the fact that ACF diagram is figuratively decreasing and PACF diagram also decreases suddenly in first halt and gets close to zero, it can be estimated that ICT variable has first rank auto-regression model or it is ARIMA(1,0,0). It was chosen as the basic model and was analyzed by OLS method, but in next level and in order to investigate the candidate model, models with higher ranks were also analyzed. Among analyzed models, moving average auto-regressive model with one halt and auto-regressive of second rate ARIMA (2.0.1) which has the least error in forecasting and the least amount of AIC and SBC statistics was chosen.

Moving average auto-regressive model with one halt and rank of two was used for forecasting internal and external samples between years of 2009 to 2020 and the results are shown in table (5).

As it can be observed, this forecasting has fulfilling delicacy in a way that in forecasting external samples of this model amount of error is about 7 percent.

Estimating the model related to impact of ICT on GDP was done among ARIMA general model series like it was done before; that is, auto-converge and partial auto-converge of this variable at level was drown to specify the basic candidate model.

Considering the fact that in here ACF diagram showed a descending process and PACF diagram was cut during halts, rank one auto-regressive process ARIMA (1, 0, 0) was chosen as the basic candidate for specifying variable behavior of apple annual consumption and it was evaluated by OLS method.

For analyzing estimated model, other models with higher ranks were estimated also and were compared using scales of AIC, SBC for their forecasting power. Results of this comparison are shown in table 3. The best model that has the most power in forecasting and the least amount of AIC, SBC is our previously chosen model, vis-à-vis rank one auto-regressive model. It was observed that causal test does not certify existence of a meaningful causal relation between variables. Based on this fact, if a researcher pursuits the aforementioned approach, would not choose VAR model for forecasting, this is while due to the fact that this model does not need to separate indogenic and ectogenic variables and considers all of them to be indogenic in experimental researches possesses special utility and has been used numerously without going through stated levels and being appropriately tested. Now the question is that if this model was used in such a situation, how much would it affect the delicacy of forecasting? To answer this question, VAR model was also analyzed and the amount of impact for ICT on GDP was forecasted based on this model and Possibility of forecasting power comparison of this model (which with no regard to aforementioned levels for choosing the appropriate model is randomly chosen) with ARIMA models (which are the result of aforementioned levels) is at hand. Results comparing forecasting delicacy of VAR model with chosen model of ARIMA series in forecasting impact of ICT on GDP based on scales of MAPE, MAE and MSE are shown in table 6. As it can be observed, forecasting error of model selected through choosing process is a lot less than forecasting error of the model chosen randomly.

This result is important because, in lots of researches, scholars without going through levels stated, choose a time

series model randomly and use it to forecast amounts of variables at hand. This results in a kind of error in model clarification.

As it can be observed, mono-variable models from ARIMA model series have more delicacy in forecasting amount of impact of ICT on GDP in Iran. This fact stats that impact of this element, more than becomes subject of impact from other variables, it is explained by its past behavior. In other words, amount of ICT in previous years contains enough information for forecasting its future behavior. This result in fact certifies results maintained from causal exam which stated existence of a meaningful causal relation between ICT and GDP. In other way VAR equation also can result in the fact that with growth of GDP investing in ICT section due to growth of influence of this part on industry and other section of the country in a way that a two-way causal effect between impact of ICT and GDP is maintained, but, error of ARIMA model was less and amounts of past investments in this section have a better explanation than GDP in growth of this section. In other words, introduced approach for selection of time series model can correctly specify the appropriate model of forecasting.

Regarding to high delicacy of selected model in forecasting impact of ICT on GDP, this model was applied in forecasting the impact of ICT on GDP between the years 2009 to 2020. Based on forecast shown in table 7, impact amount of ICT on GDP will have a rather good advancement and ICT impact on GDP reaches to %2 in year 2020.

5. Results and Discussions

As it was mentioned earlier, main aim of this study was presentation and explanation of a systematic approach to specify and select an appropriate time series model for forecasting behavior of economic variables that with modeling shows the impact of information and communication technology in the country. Comparing amount of forecasting error for maintained models presented to modeled forecast error (VAR) which is not maintained from this method showed that, if the selection is done based on statistical characters of variables and in the method explained in this paper, delicacy of forecast exceeds to a considerable point and more reliable results is maintained. In fact, randomly choosing a time series model and not considering the principles explained may cause unrealistic and mistaken forecasts in policy-makings and schematizations.

This article is dedicated to analyzing the impact of ICT on GDP and its growth in Iran. To this aim, after the introduction, theoretical basics and experimental studies practiced in this field were mentioned. Due to the fact that subjects concerning the impacts of ICT in today economics is new, informative basics and statistical requirements of this subject is yet to be identified and formed delicately and providers of these information are still at beginning levels of presenting them, based on experimental model estimated scale of impacting ICT on GDP is 0.02 which shows little but meaningful impact of ICT on GDP through exceeding proficiency of specialized labor of capital, based on which different classifications performed by international institutions and organizations about indexes of ICT to this date. In this research, the approved index of World Information Society Community in Jeniva conference (2005) was applied. This index consisted of four group of indexes in which statistics of all these indexes were not at hand for all countries in the world as a result, with short scanning of ICT indexes in Iran, criterion of selecting the analysis period about indexes of ICT and estimation of model using time series data was reachability of statistics related to explanatory variables of the model. At the beginning by performing exam, root of all the variables became permanent using deduction and results indicated positive and meaningful impact of information and communication technology on gross domestic product.

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Figure 1.

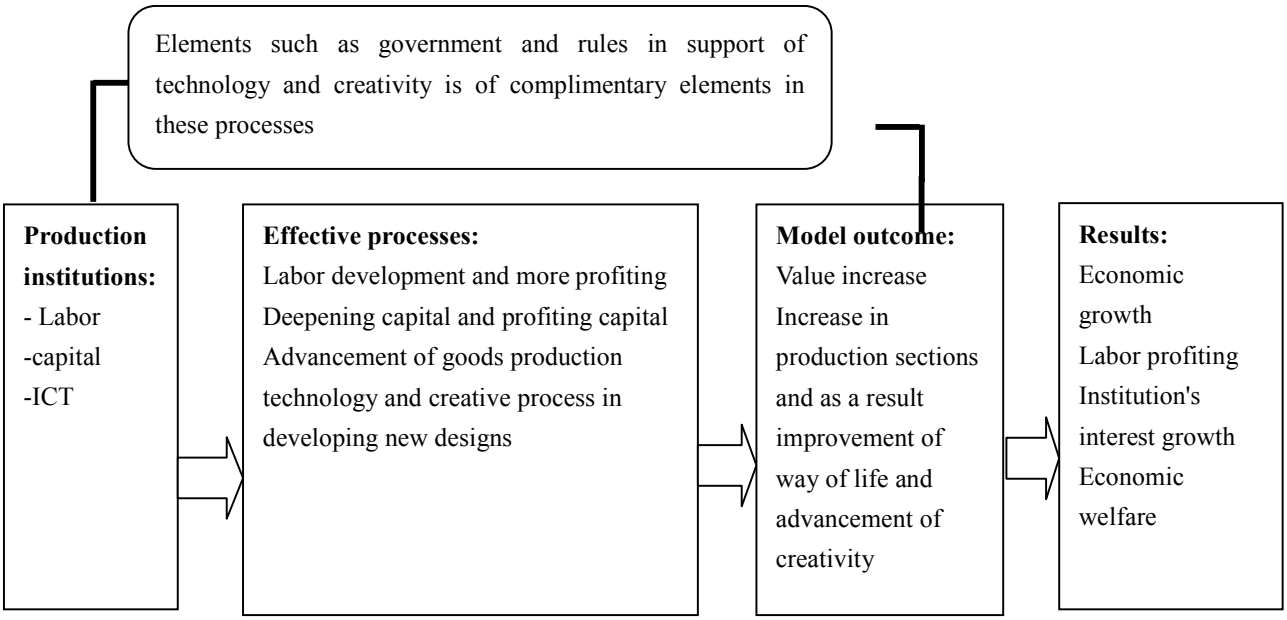

Table (1) - Results of ADF Test for Unit Roots

Variable	ADF statistic	Critical values	
		1%	5%
GDP	-4.92	-3.78	-3.01
L	-3.93	-3.78	-3.01
K	-5.20	-3.78	-3.01
M	-0.91	-3.80	-3.02
ICT	-5.15	-3.72	-2.98
OIL	-4.38	-3.75	-2.99

Table (2) - Results of Johansen's Cointegration Test

Null Hypotheses	Alternative Hypotheses	Trace Statistic	Critical Value (5%)
H0	H1		
r=0	r=1	9.40	15.49
$r \leq 1$	r=2	3.58	3.84

Table (3) - results of model estimation

Variable	Coefficient	statistic t	p-value
C	38.71	13.73	0.00
L	32.25	-5.54	0.00
K	48.36	4.71	0.00
M	8.24	-3.18	0.00
ICT	0.02	4.23	0.00
OIL	7.28	4.45	0.00
R^2=0.83	DW=1.79	F statistic=0000	

Table (4) - results of ARIMA model related to impact of ICT on GDP

Type of model	Q statistic	AIC	SBC	Forcasting error square average root (RMSE)
ARIMA(0,0,1)	32.45	-2.89	-2.79	2.31
ARIMA(1,0,1)	33.39	-2.62	-2.54	1.21
ARIMA(1,0,2)	32.76	-2.47	-2.31	1.41

Table (5) - results related to delicacy of forecasting of ARIMA model in relation with impact of ICT on GDP

Scale of error evaluation	Mean square error (RMSE)	Mean absolute Error (MAE)	Mean absolute percentage error (MAPE)
Forecasting internal samples of	0.88	0.76	5.41
Forecasting external samples of	1.17	1.03	7.21

Table (6) - comparison of different models forecasting power

Type of model	Mean square error (RMSE)	Mean absolute Error (MAE)	Mean absolute percentage error (MAPE)
ARIMA	1.14	1.02	7.43
VAR	2.37	2.15	9.59

Table (7) - forecasted amount of investment in ICT section and its impact on GDP

Year	Investment in ICT section (billon Riall)	Impact on GDP
2009	0.867	0.02
2010	0.910	0.023
2011	0.923	0.032
2012	0.946	0.036
2013	0.957	0.039
2014	0.972	0.043
2015	0.983	0.05
2016	0.996	0.058
2017	1.022	0.08
2018	1.051	1.2
2019	1.083	1.5
2020	1.101	1.8