



Reviewing the Effect of Infrastructural Investment on Economic Growth in Iran from 1983 to 2013

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ABSTRACT

Objective: Introduction: investment is one of the most important components of today's modern society. The key role that investment plays in the formation of the economic structure of a society has made it a main focus in most of the economic discussions about the role of infrastructural investment. Direct investments on infrastructures paves the way for production facilities, stimulates economic activities and also improves competitiveness by reduction the costs of business and transportations. However, over the past few years, since the developed countries have undergone some technological advancements and evolutions in fields such as new methods of production and storage, electronic business and since these countries have paid special attention to the external effects of this infrastructure especially in the environment, a new view has been developed which is based on the decrease in the effectiveness of the relationship between investing in this infrastructure and economic growth among economists. However, in developing countries, this view doesn't hold true because this infrastructure has not been sufficiently developed in these countries. **Methodology:** the present study aims to review the effect of infrastructural investment on Iran's economic growth. In this respect, the production function economic growth model has been expressed and infrastructural investment has been reviewed as an important infrastructure as an overall variable. **Results:** In order to identify the effect of the infrastructures on Iran's economic growth, two variables have been used, i.e. physical infrastructures and Information and Communication Technology. In order to estimate the aforementioned model, the autoregressive disturbed lag method in the time span of 1983 to 2013. **Conclusion:** The findings of this research have shown that in this specific time period, the reviewed infrastructures including Information and Communication Technology and physical infrastructure have had a positive and significant impact on Iran's economic growth.

1. Introduction

Economic development requires investment in various economic sectors and activities and infrastructural investment is considered to be the key to the economic growth of any country. In most countries, especially in the developing ones, the public sector is accounted for infrastructural investment. In contrast, developed countries want to enrich the country's economy, employment and achievement of sustainable economic growth and development but they are in the face of the problem of shortage of investment resources. Shortage of revenues obtained from exports and the unfair rate of exchanges which are often not in favor of those who export goods and evolving raw materials and a large population and high consumption are factors that limit the savings resources that can be turn into productive investment in this kind of countries to a large extent. Compensating for setbacks and reaching sustainable development require some investments that are used for exploiting potential economic infrastructures. Without infrastructural and structural investments, we cannot expect a development in economic welfare, employment, or production (AKBARIAN & GHAEDI, 2011).

1.1 Research objectives:

determination of the impact of physical infrastructure and Information and Communication Technology (ICT) on Iran's economic growth.

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1.2 Secondary objectives of the research:

1. Determination of the impact of ICT capital inventory on the economic growth in Iran.
2. Determination of the impact of the index of physical infrastructures on the economic growth in Iran.

1.3 Research hypotheses

1. The impact of ICT inventory on the economic growth in Iran in the long-term and the short-term is positive and significant.
2. The impact of physical infrastructures on the economic growth in Iran in the long-term and the short-term is positive and significant.

2. Materials and methods

Each study has a special method of conduction; in such a way that researches in different areas of various sciences use special tools and means in order to fulfil the goals of the research and they conduct their studies using the special methodology of that specific field. Empirical economic researches also consider the theoretic principles of economy and use modern econometric methods (Safdari & Mehrizi, 2011).

In the present study, the effect of physical infrastructures as an overall variable on economic growth has been reviewed. By relying on the theoretical principles and by taking into consideration the previous studies, the developed Cobb-Douglas production function has been used in order to review the impact of these infrastructures on economic growth (Herranz-Loncán, 2007). The present study aims to evaluate how and to which extent the physical infrastructures affect the economic growth of Iran. The production function with constant returns to the production scale has been used as the basis of the model used in this section. In this research, by using the Solo growth model and by getting inspired by the works of Khan and Reinhardt, we have aimed to design a growth model for Iran's economy so that it could be used in order to study the effect of public investments in transportation on the long-term growth of Iran's economy. For this purpose, public investment in transportation can be considered as a production factor in the production function (Mottaleb, 2007). In the growth model, the total production function associates the entire production with the production factors and also a variable which is usually called total factor productivity:

$$y = AF(K, L, Z) \quad (1)$$

In this equation, Y is indicative of the total production, A is indicative of the factor productivity, K is indicative of the capital inventory, L is indicative of the workforce, Z is indicative of the other factors that affect growth. With the differentiation of the equation above and with the algebraic equations, we can present the following equation:

In which, Y is an indicator of total real production in economy, A is an indicator of total production technology, L is an indicator of the workforce, K is an indicator of a total of capital inventory and Z is an indicator of other factors that will affect economic growth. In this function, t shows different years. The model presented in this section is a neoclassical growth model which works as follows (Pradhan & Bagchi, 2013).

With total differentiation of both sides of this equation, the following equation would be obtained:

$$dY_t = F.dA_t + A_t \cdot \frac{\partial F}{\partial L_t} \cdot dL_t + A_t \cdot \frac{\partial F}{\partial K_t} \cdot dK_t + A_t \cdot \frac{\partial F}{\partial Z_t} \cdot dZ_t \quad (2)$$

By dividing the sides of the equation by (Y_t), we will have:

$$\frac{dY_t}{Y_t} = \frac{F}{Y_t} \cdot dA_t + \frac{\partial F \cdot A_t}{\partial L_t} \cdot \frac{dL_t}{Y_t} + \frac{\partial F \cdot A_t}{\partial K_t} \cdot \frac{dK_t}{Y_t} + \frac{\partial F \cdot A_t}{\partial Z_t} \cdot \frac{dZ_t}{Y_t} \quad (3)$$

Because $A_t = \frac{Y_t}{F}$ in the equation above, we have:

$$\frac{dY_t}{Y_t} = \frac{dA_t}{A_t} + \frac{\partial Y_t}{\partial L_t} \cdot \frac{L_t}{Y_t} \cdot \frac{dL_t}{L_t} + \frac{\partial Y_t}{\partial K_t} \times \frac{K_t}{Y_t} + \frac{\partial Y_t}{\partial Z_t} \cdot \frac{Z_t}{Y_t} \cdot \frac{dZ_t}{Z_t} \quad (4)$$

Now, we can define the following variables and rewrite the equation:

Growth domestic production per capita growth,

$$\frac{dY_t}{Y_t} = \dot{Y} \quad (5)$$

Technological advancement

$$\frac{dA_t}{A_t} = A^\circ \quad (6)$$

Percentage of change in GDP in the effect of change in the active population

$$\frac{\partial Y_t}{\partial L_t} \cdot \frac{L_t}{Y_t} = \delta \quad (7)$$

Growth of the active production in the country

$$\frac{dL_t}{L_t} = L^\circ \quad (8)$$

Marginal productivity of capital = change in the production for change in capital

$$\frac{\partial Y_t}{\partial K_t} = \quad (9)$$

Ratio of investment to gross production

$$\frac{dK_t}{Y_t} = \frac{K_t - K_{t-1}}{Y_t} = \frac{I_t}{Y_t} \quad (10)$$

The elasticity of production of other factors

$$\frac{\partial Y_t}{\partial Z_t} \cdot \frac{Z_t}{Y_t} = \gamma \quad (11)$$

Growth of the variable Z (other factors affecting growth)

$$\frac{dZ_t}{Z_t} = Z_t^\circ \quad (12)$$

By taking into consideration what was mentioned above, the equation can be rewritten as follows:

$$Y_t^\circ = A_t^\circ + \beta \frac{I_t}{Y_t} + \delta L_t^\circ + \gamma Z_t^\circ \quad (13)$$

Thus, given the aforementioned equations, the designed model is as follows:

$$y_t = f(l_t, ict_t, infra_t, t, dum) \quad (14)$$

In which, Y is an indicator of gross domestic production, l_t is an indicator of workforce, ict_t is an indicator of information and communication technology inventory, t is an indicator of the process variable and dum is an indicator of the dummy variable.

The logarithmic production function is as follows

$$\ln y = \beta_0 + \beta_2 \ln l_t + \beta_4 \ln ict_t + \beta_5 \ln infra_t + \beta_6 t + \beta_7 dum_t + \varepsilon_t \quad (15)$$

3. Discussion and results

3.1 Testing the stationarity or non-stationarity of variables

In this study, the Augmented Dicky-Fuller test has been used in order to measure the stationarity or non-stationarity of the variables. The model below shows the unit root test known as Augmented Dicky-Fuller (ADF) test. For this purpose, we have used the Dicky-Fuller test which is the most commonly used method for testing the stationarity of time series. The results of testing the convergence of dynamic model of the function production showed that

$$\Delta Y_t = \mu + \lambda t + \theta Y_{t-1} + \sum_{i=1}^p \alpha_i \Delta Y_{t-i} + u_t \quad (16)$$

This test is only valid when u_t is a random variable with the relevant assumptions, especially, u_t must not be autocorrelated. In the equation above, μ is the intercept and λt is a process component which enters the model as an outsourcing variable based on the nature and the type of the variable. The sensitivity regarding the accurate selection of the outsourcing input variable is because of the fact that if any mistake is made in determining this variable can present a stationary series as a biased non-stationary series (Holtz-Eakin & Schwartz, 1995).

The stationarity test (Augmented Dicky-Fuller) has been done for all of the research variables which is a model without intercept and process. Therefore, the test equation is as follows:

$$\Delta Y_t = \theta Y_{t-1} + \sum_{i=1}^p \alpha_i \Delta Y_{t-i} + u_t \quad (17)$$

In the test, the statistical hypotheses are as follows:

H_0 : variables are non-stationary.

H_1 : variables are stationary.

Here, the Eviews software is used in order to determine the stationarity or non-stationarity of the variables of the model. The results obtained from the Augmented Dicky-Fuller test regarding the variables of the model with intercept and process have been presented in (Table 1).

Table 1. Results of the unit root ADF test for the time series variables of the model
(the critical values have been considered to be equal to -2.96 at a 5-percent level)

Variable	Symbol of the variable	ADF Statistics regarding the level of variables	ADF Statistics regarding the difference of the first level of variables	ADF Statistics regarding the difference of the second level of variables	Degree of cointegration
Workforce logarithm	$\ln l_t$	-2.42	-4.605	-	I(1)
Information and communication technology inventory logarithm	$\ln ict_t$	-2.308		-	I(0)

Gross domestic production logarithm	LN y	2.764	-5.373		I(1)
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Source: software calculations of the research

3.2 Long-term ARDL test and the results obtained from it

In the current regression model, it is estimated that given the low sample volume, one of the regressions would be selected based on the Schwarz-Bayesian Criterion. However, before discussing the long-term relationship, the cointegration test must be implemented on the ARDL model (Canning & Pedroni, 2004). In addition, in order to test whether or not the dynamic short-term relationship tends to become long-term, the total of the coefficients must be lower than one. It seems that based on the Schwarz-Bayesian criterion (SBC), two interruptions have been considered for the gross domestic production logarithm variable (Esfahani & Ramirez, 2003). Moreover, one interruption has been selected by this criterion for the variable gross domestic production growth rate (LDPG). For other variables, no interruption has been considered. Here, the value of the calculation statistic based on this method is equal to:

$$t = \frac{\sum_{i=1}^p \hat{\phi}_i - 1}{\sum_{i=1}^p S_{\hat{\phi}_i}} \Rightarrow t = \frac{0/1797 - 1}{0/1789} = -4/5852 \quad (18)$$

The absolute value of t is larger than the absolute value of the critical values presented by Banerjee, Dulaw and Master which is equal to -3.82; therefore, H_0 , indicative of lack of cointegration is rejected and the existence of a long-term relationship is accepted. The value presented by Banerjee, Dulaw and Master is equal to -3.28 at the confidence level of 95%. Since the absolute value of the calculation statistic is larger than the absolute value of the value of the statistic presented in the [table 1], the alternative hypothesis, which is indicative of the long-term relationship between variables, is confirmed. Thus, given the existence of the long-term relationship, as it was stated, the ARDL method has two advantages. Firstly, it is not necessary to pay attention to the non-stationarity of the variables (Mehra et al., 2010). In other words, the researches can use the aforementioned method without any concerns about the stationarity or non-stationarity of the variables. Secondly, when the sample volume is low, using other methods won't provide us with an unbiased estimation; while, the aforementioned method solves this problem because it takes into consideration the existing short-term dynamic reactions between the variables. Given that in the present study, not all of the variables are stationary and also the sample volume is small, thus, the aforementioned method seems to be the best way of estimation (Babazadeh et al., 2009). In other words, the short-term model moves towards the long-term model. Now, in order to answer the question of the speed of the movement of the dynamic model (short-term) towards the long-term model, we must turn to the error correction model. The results obtained from the estimation of the long-term model for the production function have been presented in [table 2]. By reviewing the results of the long-term test of the model, it becomes clear that in the long-term, the coefficients of the variables in [table 2] can indicate extension. The results obtained from the long-term ARDL test of the considered model can be seen in the present study. Their coefficients are indicative of extension. Coefficient of the physical infrastructures also show that with a one-percent increase in the value of the physical infrastructures, the logarithm of gross domestic production also undergoes a 0.4941-percent increase which then leads to an increase in the percentage of gross national production. The results regarding the workforce variable are in accordance with the macroeconomic theories and it can be said that they confirm the results obtained from the previous studies regarding the positive and significant impact of this variable on gross domestic production. The obtained results also showed that there is a strong, positive and significant relationship between workforce and gross domestic production; in that a one-percent increase in the value of the workforce variable leads to an increase in the value of the gross domestic production variable (Li & Liu, 2005). The research results are indicative of the positive and significant effect of information and communication technology (ICT) on gross domestic production. In this study, we aim to evaluate how and to which extent the physical infrastructures affect the economic growth of Iran. The determination coefficient (**R-squared**) of this estimation is equal to 98%. This coefficient shows that the independent variables in this model are able to explain 98% of the changes of the dependent variable. The estimated f-statistic (**F-Stat**) is higher than its critical value; thus, the H_0 which is indicative of the insignificance of the independent variable of the model is strongly rejected which means that the entire estimation model is significant (Démurger, 2001). The Durbin-Watson statistic (**DW-statistic**) of the model has also been calculated to be equal to 2.02.

Table 2. Reviewing the coefficients of the model in the long-term

Variables	Coefficients	Standard deviation	Statistic	Probability
LN _t	1.8286	0.1303	5.4015	0.001
LNict _t	0.011491	0.04517	1.1689	0.0073
LN Infra	0.4941	0.03867	3.1028	0.009
C	-38.1145	4.1417	-2.6778	0.002
T	-0.00617	0.573	-2.034	0.0026
DW – statistic = 2/02	F – Stat = 207/5		R ² = 0.98	

Sources: software calculations of the research – computer appendix

3.3 Testing error correction of the model

There is an error correction model (ECM) for each long-term relationship which associates the short-term changes of the variables to their long-term equilibrium values. The coefficient of the error correction in the present study has been calculated to equal to -0.64 which means that about 64% of the lack of equilibrium in a period will be moderated in the next one which means that the speed of the moderation in order to reach equilibrium is relatively slow. The error correction coefficient (ECM) shows the moderation for reaching equilibrium which is equal to -0.64 and it is indicative of a quick moderation from lack of equilibrium to long-term equilibrium. In other words, in each period, 64% of the existing lack of equilibrium would be moderated (Alavinasab, 2013).

Table 3. Results of the error correction test

Variables	Coefficients	Standard deviation	Statistic	Probability
dLNL _t	0.2064	0.0443	1.6709	0.0055
dLNict _t	0.00061	0.03867	1.1409	0.005
dLN Infra	-21.106	7.1223	-4.1765	0.002
dC	-0.0495	0.0007	-2.112	0.001
dt	-0.6445	0.2207	-5.1309	0.001
DW – statistic = 2/02	F – Stat = 207/5		R ² = 0.98	

According to the information presented in [table 3], all of the coefficients are statistically significant at a 90% significance level. In the short-term, the variables have a positive and significant effect on economic growth. Just like in the long-term, the workforce has the most significant effect in the short-term. However, what is of importance when it comes to error correction is the ECM (-1) coefficient. In the aforementioned model, this coefficient was calculated to be equal to 0.6445 which is statistically significant and shows the speed of moderation of short-term equilibrium towards long-term equilibrium. The aforementioned result means that a time interval of shorter than 2 periods is needed for the short-term equilibrium error to be corrected and for the model to return to long-term equilibrium (Munnell, 1992). In general, the results of the ECM model show that when each of the explanatory variables of the model is shocked, it takes about one and a half year for gross domestic production to return to equilibrium. Briefly, the obtained results confirm the existence of a long-term relationship between the variables. In addition, all of the coefficients are statistically significant and have the expected signs and symptoms.

3.4 Stability test and diagnosis of classical assumptions

This test is usually used in cases when we are not sure of the time of the structural break in the reviewed time series.

One of the classical assumptions of the regression model is that the disturbing elements of U_i , which appear in the regression function of the population, have similar variances and if this assumption is falsified, these parameters will no longer be sufficient and have minimum variance, although they are linear and unbiased. Another of the stability tests is lack of a serial correlation between the disturbing elements which will then lead to heteroscedasticity (same). In the present study, the results of this test have been obtained as follows [table 4]. In addition, the following results were obtained by observing the diagnostic statistics obtained from the estimation:

Table 4. Results of testing the classical assumptions

Test statistics	LM version	F version
Serial correlation	13.495 (0.009)	3.619 (0.021)
Functional form	15.120 (0.000)	20.022 (0.000)
Normality	0.066 (0.967)	Not applicable
Heteroscedasticity	0.351 (0.553)	0.334 (0.567)

Source: computer appendix

All of these tests are statistically significant and the coefficient of all of these tests are higher than 5%. Therefore, the following problems won't exist in the model: model expression, normality, heteroscedasticity and serial correlation.

4. Conclusion

- The results of the stationarity test, using the Dicky-Fuller test and Peron's structural break show that the logarithms of all variables are non-stationary.
- The obtained results confirmed the existence of a long-term and a short-term relationship between the variables.
- The coefficients are statistically significant; in that a one-percent increase in the value of the variable's workforce, physical infrastructures and ICT lead to a 0.49, 0.809 and 0.8286% in the value of the economic growth variable in the long-term. Among these variables, physical infrastructure is highly important.
- The coefficient of the logarithm of the physical capital inventory is positive and significant both in the short-term (0.0021) and the long-term (0.29). The important point is that the effect of capital inventory on production in the long-term is greater than its effect in the short-term and its significance in the long-term is stronger than that in the short-term.

- The coefficient of the logarithm of workforce is equal to 0.52 in the short-term and 0.82 in the long-term which means that this variable has significant impact on Iran's economic growth and production both in the short-term and the long-term. The effect of this variable is stronger and more significant in the long run.
- The highest extension for the workforce has been calculated to be between 1 and 1.8 which indicates that the human force plays a crucial role in the growth and development of the country.
- The highest extension calculated for economic growth regarding infrastructural investment shows the overall positive effects of the development of this infrastructure on the production of the country. However, one must not forget that the prerequisite for the investment in this infrastructure to affect economic growth and development is the preparation of the conditions that are needed for economic development.
- The coefficient of the logarithm of the physical infrastructures in the short-term has been equal to 0.0026 and the t-statistic associated with it has been calculated to be equal to 5.7 which means that it has a positive and significant impact on production. Moreover, the long-term results are indicative of an increase in the aforementioned coefficient.

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