Iranian Economic Review, Vol.16, No.32, Spring 2012

The Role of Infrastructure in Promoting Economic Growth in Iran

Sakineh Sojoodi*
Fakhri Mohseni Zonuzi**
Nasim Mehin Aslani Nia***

Received: 2011/05/06 Accepted:2012/02/08

Abstract

Lack of infrastructure continues to be a key obstacle to growth and development in most of low-income countries. In recent years, however, the role of infrastructure has received increased attention. The goal of this paper is to provide an empirical evaluation of the role of infrastructure on economic growth of Iran over the period of 1985 to 2008. To do this, we have employed the autoregressive distributed lag (ARDL) framework and introduced Infrastructure capital as an input into aggregate production, because it comes at the cost of reduced investment in other types of capital. Our findings indicate that transportation facilities distinctively length of railway and roadway, also telecommunication infrastructure (fixed phone line) have positive and significant impact on economic growth of Iran but electricity production capacity doesn't have significant impact on per capita output growth.
Keywords: Infrastructure, Railway, Roadway, Telephone Line Density, Electricity Production, Economic growth.

1- Introduction

The lack of infrastructure is hindering the economic growth in many developing countries. According to studies infrastructure is indispensable to achieve economic growth and the role of infrastructure has received increased attention. A rapidly growing literature – starting with the seminal work of Aschauer (1989) – has sought to quantify the contribution of

* Ph.D. Candidate in Economics, University of Tabriz, (Corresponding Author).
** Master of Economics.
*** Ph.D. Candidate in Economics, University of Tabriz.

infrastructure to income and growth. This debate is reviewed in the World Bank's World Development Report (1994) which finds a large range of empirical results on the importance of infrastructure for economic growth, with estimates ranging from no effect, to rates of return in excess of 100% per annum.

The goal of this paper is to provide an empirical evaluation of the role of infrastructure on economic growth of Iran. To do this, In this study we have employed the autoregressive distributed lag (ARDL) framework developed by Pesaran and Shin (1995, 1999), Pesaran et al. (1996) and Pesaran (1997) to model the impact of Infrastructure capital investment on Iranian's economic growth over the period of 1985 to 2008. This framework has several advantages compared to the conventional cointegration methods such as Johansen (1998) and Johansen and Juselius (1990). The conventional approaches estimate long run relationships between a dependent and its regressors within the context of equations system. The ARDL however employs only a single reduced form equation (Pesaran and Shin, 1995). The ARDL can be employed regardless of whether the underlying regressors are purely I (0) or I (1), or mutually cointegrated. ARDL also avoids the larger number of specification to be made in the standard cointegration test, which include decisions regarding the number of endogenous and exogenous variables to be included, the treatment of deterministic elements, and the optimal lags to be specified (Duasa, 2007). We will introduce Infrastructure capital as an input into aggregate production, because it comes at the cost of reduced investment in other types of capital.

According statistics, Iran's economic infrastructure has been improving steadily over the past decades but that is relatively poor and inadequate. Part of this stems from the fact that the vast country was never fully developed, but it also experienced considerable setbacks during the Iran-Iraq war of the 1980s, and restoration since then has been slow. This problem seeks more notice from scholars and politicians to the infrastructures and their role in economic growth.

This paper is organized as follows: Review of literature on infrastructure impact on economic growth, methodology, data, empirical results and policy implication and conclusion.

2- Review of literature

Infrastructure accumulation may promote growth is hardly news for developing-country policy makers. In the macroeconomic literature, a number of studies have found empirical support for a positive impact of infrastructure on aggregate output (Table 1). In a seminal paper, Aschauer (1989) finds that the stock of public infrastructure capital is a significant determinant of aggregate TFP. However, the economic significance of his results was deemed implausibly large, and found not to be robust to the use of more sophisticated econometric techniques (Holtz-Eakin, 1994; Cashin, 1995; Baltagi and Pinnoi, 1995). Gramlich (1994) provides an overview of this literature. Kocherlakota and Yi (1996, 1997) investigate the relationship between shocks to public capital and subsequent changes in GDP in the United States and the United Kingdom over the last 100 years and finds positive and significant effect from infrastructure provision to GDP.

A more recent empirical literature, mostly in a cross-country panel data context, has confirmed the significant output contribution of infrastructure. Such result is reported, for example, by Canning (1999) using panel data for a large number of countries and by Demetriades and Mamuneas (2000) using OECD data. Roller and Waverman (2001) also find large output effects of telecommunications infrastructure in industrial countries, in a framework that controls for the possible endogeneity of infrastructure accumulation[1]. Similar results for road are reported by Fernald (1999) using industry data for the U.S. Calderń and Servén (2003a) present a similar empirical analysis with a focus on Latin America. Using GMM estimates of a Cobb-Douglas production technology obtained from a large cross-country panel data set, they find positive and significant output contributions of three types of infrastructure assets – telecommunications, transport and power.

In contrast with the relatively large literature on the output contribution of infrastructure, studies of the impact of infrastructure on long-term growth are much less abundant. In a study of the growth impact of government

1- A related result is that of Cronin et al. (1991), who find that telecommunications investment Granger-causes aggregate U.S. output.

spending, Easterly and Rebelo (1993) find that public expenditure on transport and communications significantly raises growth. Fay and Perotti (1994) find a positive effect of telephones on economic growth

Also, Sanchez (1998) finds a positive impact of roadway length and electricity generating capacity in explaining subsequent economic growth. Easterly (2001), reports that a measure of telephone density contributes significantly to explain the growth performance of developing countries over the last two decades. Esfahani and Ramirez (2002) report significant growth effects of infrastructure in a large panel data set in which the contribution of infrastructure is affected by institutional factors. Loayza, Fajnzylber and Calderń (2003) find that the same telecommunications indicator is robustly related to growth in a large panel data set including both industrial and developing countries. Lopez (2004), by using telephone density as the infrastructure indicator in a panel framework and controlling for possible reverse causation, finds that infrastructure raises growth and reduces income inequality. Canning and Pedron (2004) examined the long run consequences of infrastructure provision on per capita income growth in a panel of countries over the period of 1950-1992 and find that in the vast majority of cases infrastructure does induce long run growth effects. Kularatne (2006) found that Investment in economic infrastructure affects South Africa economic growth directly and indirectly via private investment.

In contrast, Hulten and Schwab (1991), Tatom (1991, 1993a, 1993b) and Holtz-Eakin (1994), Holtz-Eakin and Schwartz (1995) and Garcia-Mila, McGuire and Porter (1996) suggest that there is little evidence of an effect from infrastructure to income growth in a panel of U.S. state level data, particularly when fixed effects are included.

Akbarian and Ghaedi (1390) investigated the relation between per worker investment in infrastructure and non oil per worker gross domestic production of Iran during 1340 -1385, using Vector Auto Regressive. Their results indicate that investment in infrastructure has positive and significant effect on per worker GDP and there is no significant relation between non oil GDP growth and investment in infrastructure growth.

Table 1: Brief Review of Literature

Study	Aggregation Level	Data	Conclusion
Aschauer(1989)	US	Time Series, 1949-85	Strong and positive relationship between productivity and public investment
Ford & Poyet (1991)	US	Time Series, 1957-83	Public investment has a positive and significant effect on private output
Shah (1992)	Mexico	Time Series, 1970-87	Public infrastructure has positive multiplies effects on output
Toen-Goet & Jongeling (1994)	US	Time Series, 1960-2000	Public investment on infrastructure has a significant and positive influence on output
Ram (1996)	53 Developing Countries	Panel Data, 1973-80, 1980-85, 1985-90	Public investment appears more productive and private investment
Morrison and Schwartz (1996)	US	State-level data	Infrastructure investment provides a significant return to firms, and augments productivity growth.
Devarjan, Swaroop & Zou (1996)	43 Developing Countries	Time Series, 1970-90	Total government expenditure has a positive but statistically insignificant effect on growth.
Ramirez (1998)	Chile	Time Series, 1960-93	Public investment has a positive and highly significant effect on growth
Nourzad (2000)	12 Developing/ Developed Countries	Panel Data, 1976-89	Public capital exerts a positive and statistically significant effect on labor productivity
Shioji (2001)	US & Japanese Regions	Panel Data, 1958-78	Infrastructure capital has a significant positive effect on long run output in both countries
Kneller, Bleanery & Gemmel (2001)	22 OECD countries	Panel Data, 1970-95	An increase in productive expenditure significantly enhances growth
Rioja (2001)	7 Latin American Countries	Time Series	Infrastructure investment has sizeable positive effects on GDP and private investment
Dodonov, Hirschhausen & Sugolov(2002)	UKRAINE	Panel Data	Positive relation between infrastructure investments and growth.
Sugolov, Dodonov & Hirschhausen (2003)	15 East European Transition Countries	Panel Data, 1993-2000	positive relation between infrastructure policies and economic development and economic growth
Boopen (2006)	Africa	Panel Data, 1985-2000	Transport capital development has a important effect in fastening productivity and economic development
Marrocu & Paci (2007)	Italy	Panel Data, 1996-2003	public capital has a positive and significant effect on production
Rodriguez (2007)	121 developed countries	Time Series, 1960-2000	Infrastructure provision has a significant effect on productivity and growth.
Straub, Vellutini & Warlters (2008)	East Asia	Panel Data ,1975-2005	Significant and positive link between infrastructure, productivity and growth.
Ismihan & Metin-Özcan (2009)	Turkish	Time Series, 1960-2006	There is a positive effect of infrastructure on economic growth.
Banerjee, Duflo & Qian (2009)	China	Time Series, 1986-2003	Proximity to transportation networks have a large positive causal effect on per capita GDP growth rates.
Jayme, da Silva & Martins (2009)	Brazil	Panel Data, 1986-2003	public infrastructure expenditures in transport has a positive effect on growth

Source: Summery of reviewed existing literature

3- A Growth Model with Infrastructure Capital and Methodology

The aim of this section is to suggest a simple model that links the provision of infrastructure capital in an economy to growth. Our model is adapted from Barro (1990). Aggregate output Y, at time t, is produced using public infrastructure capital (G), private capital (K), and labor (L) such that

$$Y_t = A_t L_t^{1-\alpha-\beta} K_t^{\alpha} G_t^{\beta} \qquad (1)$$

Where, A is total factor productivity at time t. For simplicity we assume it is constant. Dividing both sides by L and taking the natural ***logarithm*** of each ***side gives:***

$$Log(py_t) = \alpha_0 + \alpha_1 Log(pk_t) + \alpha_2 Log(pg_t)$$

Were py, pk and pg refer to per (each worker's output) worker output, private capital and public infrastructure capital. In this study we have employed the autoregressive distributed lag (ARDL) framework, basically, the error correction (EC) representation of the ARDL cointegration for equation (3) is as follows:

$$\Delta Log(py_t) = b_1 + \lambda_1 Log(y_{t-1}) + \lambda_2 Log(pk_{t-1}) + \lambda_3 Log(pg_{t-1})$$
$$+ \sum_{i=1}^{p-1} \gamma_{1,i} \Delta Log(py_{t-i}) + \sum_{j=0}^{q-1} \gamma_{2,j} \Delta Log(pk_{t-j}) + \sum_{k=0}^{r-1} \gamma_{3,i} \Delta Log(pg_{t-k}) + \varepsilon_{1t} \qquad (3)$$

In order to test the existence of a long run relationship between the dependent and independent variables, the F-test is used. There should be a long run relationship; the F-test will indicate which variable should be normalized. The null hypotheses of no cointegration amongst the variables are as follows:

$$H_0 : \lambda_1 = \lambda_2 = \lambda_3 = 0$$
$$H_1 : \lambda_1 \neq \lambda_2 \neq \lambda_3 \neq 0$$

The F-test has a non-standard distribution that depends upon two major factors. First, the distribution depends on whether the variables included in the ARDL model are I (0) or I (1). Second, the non-standard distribution also depends on the number of regressors and whether the ARDL model contains an intercept and/or a trend. Two sets of critical values (CVs) were reported by Pesaran and Pesaran (1997) and Pesaran et al. (2001). Since these two sets of critical values provide critical values bounds for all classification of the regressors into purely I (1), purely I (0) or mutually cointegrated- the ARDL approach is also referred to as a bounds testing procedure (Pesaran et al., 2001). If the computed F statistics falls outside the critical bounds, a conclusive decision can be made regarding cointegration without the need for knowing the order of integration of the regressors. For instance, if the empirical analysis shows that the estimated F statistic is higher than the upper bound of the CV, then the null hypothesis of no cointegration is rejected. In case that the computed F statistics falls inside the upper and lower bounds, a conclusive inference cannot be made without further tests.

The orders of the lags in the ARDL model can be selected by either the Akaike Information criterion (AIC) or the Schwartz Bayesian criterion (SBC), before the selected model is estimated by ordinary least squares. For annual dataset, Pesaran and Shin (1999) recommended choosing a maximum of 2 lags. From this, the lag length that minimizes SBC is selected. Optimal lag length selection approach shows that if one model stands out among the others in term of the goodness of fit or the parsimonious specification, it must be the best-fitted model. In other words, it is the optimal model. In order to choose the best ARDL (p,q,r), ARDL with different combinations of p,q,r= 1,2,3 will be used. The ARDL with the larges SBC will be chosen as the optimal model. Once the optimal ARDL model has been chosen, the next step would be to conduct several diagnostic analyses on the model specified in this study. This involves testing if the residuals follow standard regularity conditions (hemoskedasticity, no serial correlation and follows normal distribution). Further, stability tests (CUSUM and CUSUMSQ test) will also be conducted to ensure that the estimated model is statistically robust.

4- The Data

It is perhaps helpful from the outset to clarify what is being considered as “infrastructure” in the context of this study. World Bank(1994) defines infrastructure as public services (electric energy, water facilities), public works (roads) and other transportation (harbors and airports), then the definition adopted here focuses on the services provided by the physical networks or “infrastructure systems” associated with energy (electricity production capacity), transport (roadway and railway length, air transport), also in this paper according with Fay and Perotti (1994), Easterly (2001) and Lopez (2004) telecommunications (Fixed phone line density) used as infrastructure capital in growth equation. The paper used annual data from SCI, Statistics Central of Iran and CBI, Central Bank of Iran over the period 1985–2008[1] and World Development Indicators (WDI). We should notify that because of nonexistence of stock capital series in privet sector, the gross privet investing data constant in 1997 US dollar is used, instead.

5- Emprical Results

Computation of the empirical results involved four steps as follows: First, the study examined for the order of integration of the variables using the Augmented Dickey Fuller (ADF) test. Second, cointegration test using the Bounds Test for the sample period was done. If the test shows that the dependent and independent variables are cointegrated, then the long run and short run elasticities are computed using MICROFIT 4.1. Third, diagnostic analysis was conducted to ensure that the residuals satisfied the standard regularity conditions and the estimated UECM is correctly specified. Finally, the ECM was estimated for the sample period. As indicated former, in this study four different indexes of infrastructure are used, lead to four different models that all involve four stages, explained former.

Model 1: pg= per worker electricity annual production (pelec)
Model 2: pg= per worker railway length (prail)
Model 3: pg= per worker roadway length (proa)
Model 4: pg= per worker fixed telephone line (ptel)
Model 5: pg= per worker air transport length (pair)

5-1- Testing for Unit Roots

Even the bounds test for cointegration does not depend or no prior knowledge about the integration is needed, but to ascertain the order of integration, the work begins through applying the Augmented Dickey Fuller

1- For some variable data are available form 1976.

(ADF) unit root test. The results of ADF tests in table 3 suggest that all the variables included in this study are integrated at order one, I (1).

Table 2: ADF Unit Root Test Results

Variable	ADF Test Statistics (Level)	ADF Test Statistics (1st Difference)	Order of Integration
95% critical value	-2.9591	-2.9627	1
Log (py)	-.56659	-3.9865	1
Log (pk)	-.34564	-4.4854	1
Log (prail)	-.36956	-4.9451	1
Log (ptel)	.02365	-5.1262	1
Log (pelec)	-.51256	-4.8654	1
Log (proa)	-.63549	-2.9968	1
Log (pair)	-.96558	-4.6358	1

Source: Estimation results

5-2- Testing for Cointegration

The next step is where equation (2) is estimated to examine the long-run relationships among the variables. As suggested by Pesaran and Shin (1999) and Narayan (2004), since the observations are annual, we choose two as the maximum order of lags in the ARDL and estimate for the period 1985-2008. In fact, we also used the SBC to determine the optimal number of lags to be included in the conditional ECM, whilst ensuring there was no evidence of serial correlation, as emphasized by Pesaran et al. (2001). The lag length that minimizes SBC is one. The calculated F-statistics for the cointegration tests are displayed in table 3. The critical values are reported also in table 4 based on the critical value suggested by Pesaran and Pesaran (1997). The calculated F-statistics for model 1, 2, 3, 4 and 5 in order are higher than the upper bound critical value at the 5%, 5%, 1% and 10% level of significance. Thus, the null hypothesis of no cointegration is rejected. There is indeed a cointegration relationship among the variables as presented in Equation (2).

Table 3: F- Statistics for Bounds Test

Model	Computed F-statistic
1	5.2639
2	6.4468
3	5.7144
4	5.3745
5	4.9926

Source: Estimation results

Table 4: Critical Bound's value [1]

Level	Critical Bound's value	
	Lower	Upper
1%	5.29	6.31
5%	3.79	4.86
10%	3.18	4.13

Source: Table F of Pesaran and Pesaran

The discussion of long-run coefficient of variables in this study is based on the data in Table 6 below:

-Logarithm of per worker Private investment (Log (pk)):

The coefficient of this variable in all models is significantly positive and according to importance of privet sector and its efficiency, this result conforms (confirms) our expectations.

-Logarithm of per worker electricity annual production (Log (pelec)):

The coefficient of this variable is positive but not significant in the probability level of 10%. This may refer to the high subsidies to the energy consumption that leads to discount in price of this variable and as a result decreases the efficiency of it.

-Logarithm of per worker railway length (Log (prail)):

The obtained results indicate that the coefficient of this variable is positive and significant so that 1% increases in length of railway per worker leads to 56% increase in economic growth while 1% increases in investment per worker causes only half of this amount, about 25% increase in economic

1- The Critical bounds value was taken from Table F of Pesaran and Pesaran (1997).

growth. This issue indicates the importance of transportation infrastructures specially railway in economy of Iran.

- Logarithm of per worker fixed telephone line (Log(ptel)):

The coefficient of this variable according to the estimating results is positive and significant,that indicates Telecommunication infrastructures are important for cost reduction and economic growth in Iran.

-Logarithm of per worker roadway length (log (proa)):

Like the log (prail), this variable has positive and significant effect on per capita production growth, too. And the quantity of this effect in compare with private investing is noticeable and significant.

-Logarithm of per worker air transport length (log (pair)):

This variable has positive and significant effect on per capita production growth, too. And the quantity of this effect in compare with private investing is noticeable and significant.

Table 5: Long Run Coefficients

Variable	Coefficient(Prob.)				
	1	2	3	4	5
Log(pk)	.282 [.004]	.193 [.002]	.229 [.000]	.237 [.000]	0271 [.000]
Log(pelec)	.08 [.112]	-	-	-	-
Log(prail)	-	.54 [.009]	-	-	-
Log(ptel)	-	-	.11 [.012]	-	-
Log(proa)	-	-	-	.49 [.011]	-
Log(pair)	-	-	-	-	.52 {.000]
Intercept	-1.99 [.000]	1.58 [.092]	1.42 [.057]	1.86 [.001]	1.55 [.000]

Source: Estimation results

5-3- Diagnostic Analysis

A number of diagnostic tests to the ECM were applied and reported in tables 6-10. According estimation results no evidence of serial correlation, heteroskedasticity was found. The models also pass the function form and normality test which suggests that the errors are normally distributed. Based on the CUSUM and CUSUMSQ tests, Figure 1 shows that the long run relations are relatively stable as most of the cumulative sum of the recursive residuals or squared residuals fall within the 5% critical lines.

Table 6: Diagnostic Tests for Model 1

Test Name	Test Statistics (Prob.)
Serial Coloration	F= 1.2023 [.281]
Function form	F= 0.7910E-5 [.998]
Normality	CHSQ= 1.3703 [.504]
Heteroskedasticity	F= 2.3596 [.133]

Table 7: Diagnostic Tests for Model 2

Test Name	Test Statistics (Prob.)
Serial Coloration	F= 2.2210 [.145]
Function form	F= 1.4098 [.243]
Normality	CHSQ= 4.5863 [.101]
Heteroskedasticity	F= 1.1836 [.283]

Table 8: Diagnostic tests for Model 3

Test Name	Test Statistics (Prob.)
Serial Coloration	F= 0.078128 [.783]
Function form	F= 2.5425 [.126]
Normality	CHSQ= 3.9296 [.140]
Heteroskedasticity	F= 2.0972 [.160]

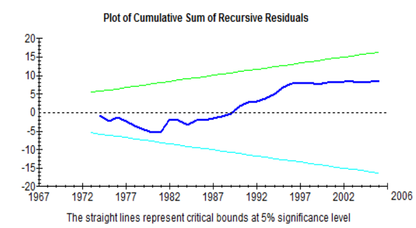
Table 9: Diagnostic tests for Model 4

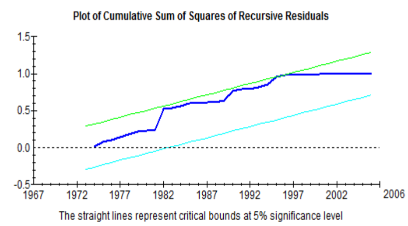
Test Name	Test Statistics (Prob.)
Serial Coloration	F= 0.11834 [.734]
Function form	F= 0.97558 [.334]
Normality	CHSQ= 4.4915 [.106]
Heteroskedasticity	F= 2.2619 [.144]

Table 10: Diagnostic Tests for Model 5

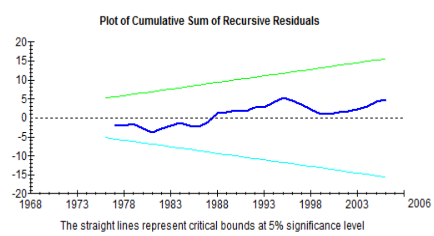
Test Name	Test Statistics (Prob.)
Serial Coloration	F= 0.12631[.725]
Function form	F== 2.48632 [.135]
Normality	CHSQ= 4.48226 [.119]
Heteroskedasticity	F=2.3719[.112]

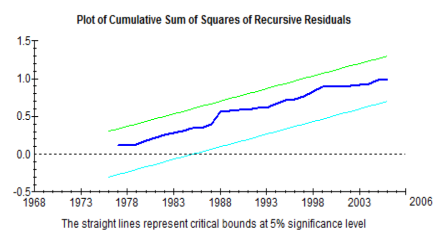
a-Model 1



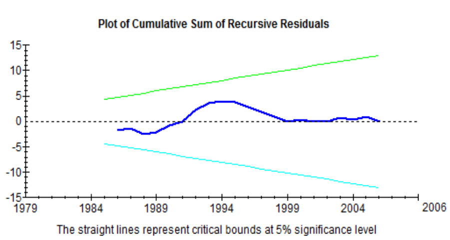


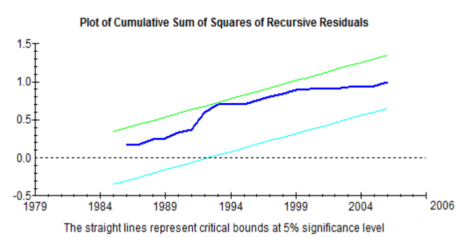
b-Model 2



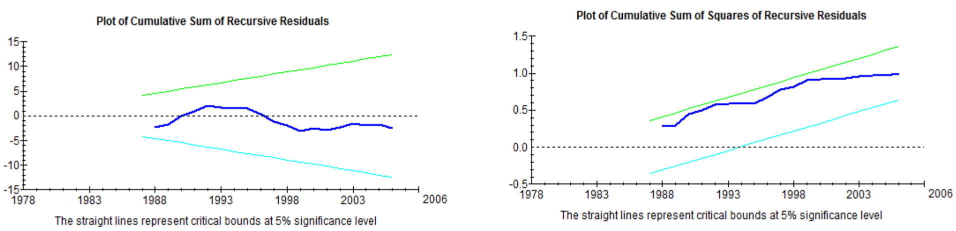


c- Model 3





d- Model 4



e- model 5

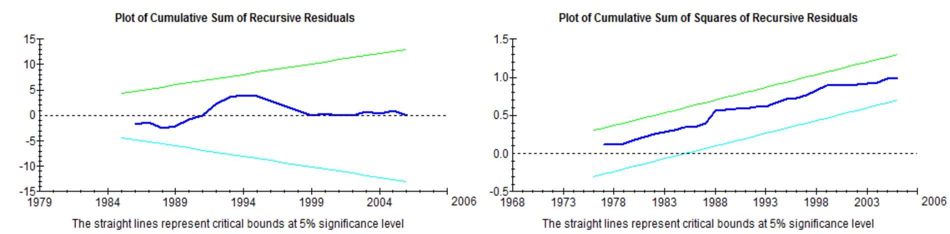


Figure 1: CUSUM and CUSUMSQ Plot for the ARDL

5-4- ECM Estimation

The results of our error-correction models are reported in Tables 11-15. Short run coefficients of variable are significant and they have the same sign of long run coefficients. The coefficient on ECM (-1) for model 1 shows a speed of adjustment of about 23.3 percent per year of the difference between actual and long-term equilibrium balances (Table 11). For model 2, an adjustment of 29.8% is recorded (Table 12) and for model 3, 4 and 5 an adjustment of 34.5% , 23.4 and 35.5 percents implied (Table 13, 14 and 15). This means that variable change forces are in operation to restore long-run equilibrium following a short run disturbance. On the average this will tend to suggest that after an initial disturbance it takes roughly 4 year for equilibrium to be restored. The t-statistics in each case show that the error-correction terms are significant at the 1% level.

Table 11: ECM Estimation Result for Model 1

Variables	Coefficients	Prob.
DLog(py)1	.29194	[.033]
DLog(pk)	.069048	[.040]
DLog(pelec)	.54223	[.017]
DIntercept	-.46416	[.011]
ECM(-1)	-.23288	[.001]
R-Squared	Durbin-Watson	F-statistic
.61154	2.2422	13.3810[.000]

Table 12: ECM Estimation Result for Model 2

Variables	Coefficients	Prob.
DLog(py)1	.28428	[.030]
DLog(pk)	.074986	[.022]
DLog(prail)	.16574	[.012]
DIntercept	.48029	[.277]
ECM(-1)	-.29812	[.000]
R-Squared	Durbin-Watson	F-statistic
.61768	2.3032	14.1364[.000]

Table 13: ECM Estimation result for Model 3

Variables	Coefficients	Prob.
DLog(py)1	.41719	[.003]
DLog(pk)	.12414	[.015]
DLog(ptel)	.18337	[.001]
DIntercept	1.2344	[.041]
ECM(-1)	-.34492	[.000]
R-Squared	Durbin-Watson	F-statistic
.73196	2.0420	15.0193[.000]

Table 14: ECM Estimation result for Model 4

Variables	Coefficients	t-stats
DLog(py)1	.38233	[.021]
DLog(pk)	.09463	[.000]
DLog(proa)	.10997	[041]
DIntercept	1.5328	[.119]
ECM(-1)	-.23357	[.000]
R-Squared	Durbin-Watson	F-statistic
.68632	2.1501	17.9359[.000]

Table 15: ECM Estimation Result for Model 5

Variables	Coefficients	t-stats
DLog(py)1	.46738	[.050]
DLog(pk)	.12952	[.000]
DLog(pair)	.22086	[051]
DIntercept	2.5026	[.009]
ECM(-1)	-.35449	[.000]
R-Squared	Durbin-Watson	F-statistic
.67132	2.0511	17.4551[.000]

6- Conclusion

The role of public infrastructure on output has received wide attention since the contributions of Aschauer (1989), who shows a significant effect on public investment on growth for the United States. We use Iranian annual data from 1985 to 2008 on real GDP growth, real private gross investment and public infrastructure variables, as in Canning and Pedroni (1999), comprise kilowatts of electricity annual production, kilometers of roads and railway, and number of fixed telephone lines and the distance of air transportation. Using a single cointegration technique, ARDL in version ECM, we find that public infrastructure capital have positive and significant effects on real output for three measures of infrastructure(roadway and railway length and fixed telephone line density and air transportation) but electricity annual production do not have any significant effect on economic growth in Iran.

According to the results of this study, the long run coefficients of transportation indexes are significant, and indicate the high efficiency of investments in transportation sector in Iran. Regarding the geographical extensiveness of Iran and its transit position, existence of suitable transportation system can play an important role in economy growth and development. So, paying attention to the development of transporting infrastructure and constructing different communication ways is inevitable.

Communication and information technology facilitates trading and economic growth through reducing trade costs. So, investment increase in this field can be a suitable way to achieve economic growth.

And, the results in this study indicate that the capacity of electricity production has no significant effect on economic growth. This may be because of high subsidies in both consumption and production of energy that reduces its price and leads to inefficiency in using this source in Iran.

References

1- Akbarian, R. and A. Ghaedi, (2011). "Investment in Economic Infrastructure and its Impact on Economic Growth", *Journal of Research in economic development and growth*, First Year, No. III. Pp. 48 -11.

2- Aschauer D. (1989), "Is Public Expenditure Productive?" *Journal of Monetary Economics* 23, 177-200.

3- Barro R. J. (1990), "Government Spending in a Simple Model of Endogenous Growth," *Journal of Political Economy*, Vol. 98, pp 103-125.

4- Baltagi, B., and N.Pinnoi, (1995), "Government Spending in a Simple Model Of Endogenous Growth: Further Evidence from an Error Components Model, " Emprical Economics, 20:2, 1995, 351-359.

5- Banerjee A., Duflo E. & Qian N. (2009), "On the Road: Access to Transportation Infrastructure and Economic Growth in China", http://igov.berkeley.edu/China09papers/On_the_Road_Access_to_Transportation_Infrastructure_and_Economic_growth.pdf.

6- Boopen, Seetanah (2006), "Transport Infrastructure and Economic Growth: Evidence from Africa Using Dynamic Panel Estimates, *the Empirical Economics Letters*, 5(1*)*, pp37-52.

7- Calderon C.A. and L. Serven (2003), "The output cost of Latin America's infrastructure gap", in Easterly W. and L. Serven, eds., The Limits of Stabilization: Infrastructure, Public Deficits, and Growth in Latin America. Stanford: Stanford University Press and the World Bank.

8- Canning, D. and Pedroni, P. (2004). .The E¤ect of Infrastructure on Long-Run Economic Growth.Mimeo. Harvard University.

9- Canning, David (1999). The contribution of infrastructure to aggregate output. Policy Research Working Paper, *World Bank*, Washington, DC.

10- Cashin, P., (1993), "Government spending Taxes and Economic Growth", Mimeo, Columbia University.

11- Demetriades, P. and Mamuneas, T., (2000). "Intertemporal Output and Employment Effects of Public Infrastructure Capital: Evidence from 12 OECD Economies." The Economic Journal 110, 687–712.

12- Devarajan S., Swaroop V. And Zou H. F. (1996), "The Composition of Public Expenditure and Economic Growth," *Journal of Monetary Economics*, Vol. 37, pp 313-344.

13- Dodonov B., Hirschhausen C., Opitz P. & Sugolov P. (2002), "Efficient Infrastructure Supply for Economic Development in Transition Countries - The Case of Ukraine", *Post-Communist Economies*, Vol. 14, No. 2.

14- Duasa J. (2007), "Malaysian Foreign Direct Investment and Growth: Does Stability Matter?" *Journal of Economic Cooperation,* 28, 2, pp. 83-98.

15- Easterly W. and Rebelo S. (1993), "Fiscal Policy and Economic Growth: An Empirical Investigation," *Journal of Monetary Economics*, Vol. 32, pp 417-458.

16- Easterly, William (2001). The lost decades: Explaining developing countries' stagnation in spite of policy reform, 1980-1998. Journal of Economic Growth 6 (2), June: 135-157.

17- Esfahani, H.S., and M.T. Ramírez (2003). Institutions, infrastructure and economic growth. *Journal of Development Economics* 70: 443-477.

18- Fay M., Perotti R., Canning D. (1994). "Infrastructure and Growth", In *International Differences in Growth Rates: Market Globalization and Economic Areas*, edited by M. Baldassarri and L. Paganetto. New York: St. Martin's Press, Inc.

19- Fernald J.G. (1999), "Roads to Prosperity?, Assessing the Link Between Public Capital andProductivity," *American Economic Review*, Vol. 89, pp 619-638.

20- Ford, R. and P. Poret (1991), "Infrastructure and Private-Sector Productivity, " *OECD Economics Studies,* No. 17, pp 63-89.

21- Garcia-Mila T., McGuire T. J. and Porter R. H. (1996), "The Effect of Public Capital in State Level Production Functions Reconsidered," *Review of Economics and Statistics*, pp177-180.

22- Gramlich E. M. (1994), "Infrastructure Investment: A Review Essay," *Journal of Economic Literature*, Vol. XXXII, pp 1176-1196.

23- Holtz-Eakin D. (1994), "Public Sector Capital and the Productivity Puzzle," *Review of Economics and Statistics*, Vol 76, pp 12-21.

24- Holtz-Eakin D. and Schwartz A.E. (1995), "Infrastructure in a Structural Model of Economic Growth," *Regional Science and Urban Economics*, Vol. 25, pp 131-151.

25- Hulten C. R. and Schwab R.M. (1991), “It is There Too Little Public Capital? Infrastructure and Economic Growth,” Discussion Paper, American Enterprise Institute.

26- Ismihan M.& Metin-Özcan K. (2009), "Infrastructure and Economic Growth: The Turkish Experience, 1960-2006," *EconAnadolu 2009: Anadolu International Conference in Economics.*

27- Jayme F., da Silva G. & Martins R. (2009), “Public Expenditure on Infrastructure and Economic Growth Across Brazilian States”, http://www.cedeplar.ufmg.br/pesquisas/td/TD%20346.pdf

28- Johansen S. (1988), "Statistical Analysis of Cointegration Vectors", *Journal of Economic Dynamics and Control*, Vol. 12, pp 231-254.

29- Johansen S. *and K. Juselius,* (1990) “Maximum Likelihood Estimation and Inference on Coin tegration With Application to the Demand for Money, ”*Oxford Bulletin of Economics and Statistics, Vol. 52, 169-210.*

30- Kneller R., Bleaney M., Gemmell G.(2001), “Testing the Endogenous Growth Model: Public Expenditure, Taxation, and Growth over the Long Run”, *Canadian Journal of Economics*,vol.34, Issue.1, pp.36-57

31- Kocherlakota N.R. and Yi K.M. (1996), “A Simple Time Series Test of Endogenous Versus Exogenous Growth Models: An Application to the United States,” *Review of Economics and Statistics*, Vol. 78, pp 126-134.

32- Kocherlakota N. R. and Yi K. M. (1997), “It is there Endogenous Long-run Growth? Evidence from the United States and the United Kingdom,” *Journal of Money Credit and Banking*, Vol.29, pp 235-262.

33- Kularatne, C. (2006). .Social and Economic Infrastructure Impacts on Economic Growth in South Africa..Presented at the UCT School of Economics Sta¤ Seminar Series, October 2006.

34- Johansen S. (1988), "Statistical Analysis of Cointegration Vectors", *Journal of Economic Dynamics and Control*, Vol. 12, pp 231-254..

35- Kocherlakota N.R. and Yi K.M. (1996), “A Simple Time Series Test of Endogenous Versus Exogenous Growth Models: An Application to the United States,” *Review of Economics and Statistics*, Vol. 78, pp 126-134.

36- Kocherlakota N. R. and Yi K. M. (1997), “It is there Endogenous Long-run Growth? Evidence from the United States and the United Kingdom,” *Journal of Money Credit and Banking*, Vol.29, pp 235-262.

37- López, H., (2004). "Macroeconomics and Inequality." The World Bank Research Workshop, Macroeconomic Challenges in Low Income Countries, October.
38- Marrocu E., Paci R. (2007), "The effects of public capital on the productivity of the Italian regions," Centre for North South Economic Research, University of Cagliari and Sassari, Sardinia, http://sadapt.inapg.inra.fr/ersa2007/papers/174.pdf
39- Morrison, C.J. and A.E. Schwartz (1996), "State Infrastructure and Productive Performance," *American Economic*, Vol. 86, No. 5.
40- Narayan, P.K. (2004) "Fiji Tourism Demand: The ARDL Approach to Cointegration". *Tourism Economics*, 10(2), 193-206.
41- Nourzad, F. (2000): "The Productivity Effect of Government Capital in Developing and Industrialized Countries," *Applied Economics*, 32, 1181-1187.
42- Pedroni P. (1999), "Critical Values for Cointegration Tests in Heterogeneous Panels with Multiple Regressors," *Oxford Bulletin of Economics and Statistics*, Vol. 61, pp 653-670.
43- Pesaran, M.H., and Y. Shin, (1995), "Autoregressive distributed lag modelling approach to cointegration analysis". DAE Working Paper Series No.9514, Department of Applied Economics, University Of Cambridge.
44- Pesaran, M.H., (1997), "The role of economic theory in modelling the long run", *Economic Journal*, "Controversy", 107, 178-191.
45- Pesaran, M.H., and Pesaran, B. (1997), Microfit 4.0 (England: Oxford University Press)
46- Pesaran, M.H., and Y. Shin, (1996), "Testing the Existence of A long-run Relationship". DAE Working Paper Series No.9622, Department Of Applied Economics, University Of Cambridge.
47- Pesaran, M.H., and Y. Shin, (1999), "An autoregressive distributed lag modelling approach to cointegration analysis". In S. Strom (ed), Econometrics and Economic Theory in the 20th Century: The Ragnar Frisch Centennial Symposium, chapter 11, Cambridge, Cambridge University Press. ISBN 0 521 63323 0 (hardback); 0 521 63365 6 (paperback).
48- Pesaran, M.H., Y. Shin, and R. J. Smith, (2001) "Bounds testing approaches to the analysis of level relationships", *Journal of Applied Econometrics*, special issue in honour of J D Sargan on the theme "Studies in

Empirical Macroeconometrics", (eds) D.F. Hendry and M.H. Pesaran, 16, pp.289-326.

49- Ram, R. (1996), "Productivity of Public and Private Investment in Developing Countries: A broad International Perspective," *World Development*, 24, 8, pp. 1373-1378.

50- Ramirez, M. D. (1998), "Does Public Investment Enhance Productivity Growth in Mexico? A Cointegration Analysis," *Eastern Economic Journal*, 24, pp 63-82.

51- Rioja Felix K. (2001), "Growth, Welfare, and Public Infrastructure: A General Equilibrium Analysis of Latin American Economies", *Journal of Economic Development,* Vol. 26, No: 2, pp: 119-130.

52- Röller L-H. and L. Waverman (2001) "Telecommunications Infrastructure and Economic Development: A Simultaneous Approach", *American Economic Review* 91, 909--23.

53- Rodriguez Francisco (2007), "Have Collapses in Infrastructure Spending led to Cross-Country Divergence in Per Capita GDP?" *Department of Economics, Wesleyan University,* DESA Working Paper No. 52, http://repec.wesleyan.edu/pdf/frrodriguez/2006013_rodriguez.pdf

54- Sanchez-Robles B. (1998), "Infrastructure Investment and Growth: Some Empirical Evidence,"*Contemporary Economic Policy*, Vol. XVI, pp 98-108.

55- Shah, A., (1992), "Dynamics of Public Infrastructure, Industrial Productivity and Profitability", Review of Economics and Statistics, Vol, 74, pp 28-36.

56- Shioji, Etsuro (2001). "Public capital and economic growth: A convergence approach". *Journal of Economic Growth,* Vol. 6, pp 205-227.

57- Straub S., Vellutini C. & Warlters M. (2008), "Infrastructure and Economic Growth in East Asia", *Policy Research Working Paper* 4589. http://ssrn.com/abstract=1149092

58- Sugolov P., Dodonov B. & Hirschhausen C. (2003)," Infrastructure Policies and Economic Development in Transition Countries: First Evidence", *Institute for Economic Research (IER),* http://www.infraday.tu-berlin.de/fileadmin/documents/infraday/2002/papers/hirschhausen_etc-2002-Infrastructure_Policies_and_Economic_Development.pdf

59- Tatom J.A. (1991), "Public Capital and Private Sector Performance," *Federal Reserve Bank of Saint Louis Review*, Vol. 73, pp 3-15.

60- Tatom J.A. (1993a), "Paved with Good Intentions; the Mythical National Infrastructure Crisis," Policy Analysis, Cato Institute.

61- Tatom J. A. (1993b), "The Spurious Effect of Public Capital Formation on Private Sector Productivity," *Policy Studies Journal*, Vol. 21, pp 391-395.

62- Toen-Gout, M. W. and Jongeling, M.M. (1994), Investment in Infrastructure and Economic Growth, *OCFEB Research Memorandum,* No. 9404, Research Centre for Economic Policy, Erasmus University Rotterdam.

63- World Bank (1994), World Development Report, Infrastructure for Development, Washington D.C.