

RURAL INFRASTRUCTURAL DEVELOPMENT AND ECONOMIC GROWTH: A TIME-SERIES EVIDENCE FROM PAKISTAN (1981-2010)

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ABSTRACT

Main purpose of this study is to find out the role of rural infrastructural development on economic growth of Pakistan. It has been hypothesized that rural infrastructural development has significant positive role for enhancement of economic growth. For the purpose of investigation we utilize such a model which may reflect the steady-state equilibrium differences in a Barro-type framework consisting of Solow type sets of variables and allow conditional convergence. On the basis of time series data set of Pakistan from 1981 to 2010, we employ OLS methodology so as to measure the impact of rural infrastructural development on economic growth of Pakistan. In view of limitations regarding categorization of data on regional basis, we use developmental public expenditures in rural areas as a proxy for rural infrastructural development. After analysis, we are of the view that rural infrastructural development has a positive role for economic growth of Pakistan, however, its role has found to be less significant in comparison to capital and labour as determinants of economic growth.

Keywords: *Rural Development, Infrastructure, Economic Growth*

1. INTRODUCTION

Positive role of infrastructural development for growth enhancement, development, industrialization, and capital formation etc has been identified and mentioned by the early economists who termed it as social overhead capital [Rosenstein-Rodan (1943), Nurkse (1953), Ekstein (1957), and Rostow (1959)]. It is also an admitted fact that public sector has a pivotal role for attainment of economic development by increasing the supply of social overhead capital. Larger piece of evidence shows that rural areas are normally underdeveloped in case of public infrastructure. On account of increased transaction costs, most of the people of rural areas are found to be poor because infrastructural facilities have been available to them at a longer distance from their residential areas [Binswanger and Deininger (1997)]. Infrastructure in shape of roads, communications, electrification, financial and product markets etc has found to be helpful in poverty reduction of rural areas [Fan, Hazell and Haque (2000), Ashley and Maxwell (2001)]. Recently, under Market-Friendly approach the role of private sector along with public sector has also been recognized for provision of infrastructure [Estache, Foster and Wodon (2002), Calderon and Chong (2004)]. Infrastructural variables have also been proved useful in reducing income inequalities [Lopez (2003)] and liberalization of trade. Therefore, we could easily point out that public investment for provision of infrastructure will be an important factor determining growth of any economy through different channels.

Taking into these considerations regarding the role of infrastructure for growth enhancement, this study also attempts to find out the impact of rural infrastructural development on economic growth of Pakistan. Earlier, Khan and Sasaki (2001) explored the role of public capital productivity in growth augmentation. On the other hand causation between infrastructure, private investment and GDP has been investigated by Looney and Winterfold (1992) and Looney (1997). However, on the basis of limitations attached to the studies relating to Pakistan economy it could be easily noticed that till yet the observed evidence did not take into consideration the impact of rural infrastructure on economic growth of Pakistan. This is why this study specifically includes the rural infrastructural development as a determinant of economic growth and tries to contribute this evidence from Pakistan.

On the basis of time series analysis over secondary dataset of Pakistan at macro level while employing OLS methodology, this study attempts to find out the response of GDP to the variations in public sector investment for rural infrastructural development. Findings of this study not only contribute to the current literature relating to the topic but may also be proved helpful in providing a guideline to policy makers and researchers for the purpose of framing and assembling strategies relating to growth enhancement and rural infrastructural development of Pakistan specifically and for the rest of the World in general.

2. LITERATURE SURVEY

Firstly, the study of Aschauer (1989) empirically explored the role of infrastructural development for enhancement of private sector productivity while exploiting the neoclassical modeling and a robust impact was observed. Findings of this study originated a debate in literature on the topic of infrastructure for economic growth. Contradictory evidence was the outcome of the debate. Academics not only questioned the robustness of explained variations in growth out of infrastructure but also take into consideration the direction of causation path between these two variables. However, there is agreement between the academics that infrastructure is a vital factor for growth enhancement. Earlier than Aschauer (1989), Ratner (1983) attempted to investigate the role of infrastructural variables on private investment, which could be termed as a pioneer empirical study in this regard. Within a framework of Cobb-Douglas production function, Ratner (1983) concluded that estimates of public as well private capital confirmed their productivity for output, nonetheless, estimates of private capital were more elastic. On the basis of advanced econometric techniques, Hotz-Eakin (1992), Garcia-Mila, McGuire and Porter (1996) put question marks on the estimates drawn by Aschauer (1989) and concluded that causation run from economic growth to public capital while observing negligible impact of infrastructural variables on economic growth. Munnell (1992) confirmed the positive role of infrastructure in this regard. The endogenous growth theory introduced by Aschauer (1989) was reframed by Barro (1990) who then put the evidence in favour of infrastructure and observed infrastructural variable to be vital factor for growth enhancement in the long-run. Production function approach was adopted by Wylie (1996) for exploring the explanatory power of infrastructure in case of economic growth of Canada and comparatively strong positive effects were observed. The panel dataset, covering the period from 1950 to 1992 while considering countries as cross-sections, was employed by Canning and Pedroni (1999) so as to observe the impact of infrastructural development on growth of the countries and found heterogeneous evidence in this regard. The conception of endogenous growth modeling developed by Aschauer (1989) and enlarged by Barro (1990), was exploited by Demurger (2001) for finding out the results obtained by infrastructural development for economic growth of China and found confirmatory results in line with Aschauer (1989). Chakraborty and Guha (2009) also put their evidence in favour of infrastructure as a robust determinant of economic growth. In case of Pakistan, impact of public capital on economic growth and its substitutability with private capital was observed by Khan and Sasaki (2001) while utilizing production function and investment function methodologies. They found that when we invested public capital so as to achieve enhanced growth then it was a significantly suitable investment and for this purpose there exists a complimentary relationship between public and private capital. Looney and Winterfold (1992) and Looney (1997) wanted to explore causation path between economic growth, private investment and infrastructural development. The secondary dataset related to Pakistan from 1972 to 1975 was utilized in these studies. It was found out that direction of relationship run from private investment to infrastructure because infrastructure was needed to be expanded in case of increased private investment. High productivity of infrastructure investment was also noticed.

3. THEORETICAL BACKGROUND, MODEL AND METHODOLOGY

Production function has been considered as the basic tool for analysis in most of the studies which explored the response of economic growth in lieu of variations observed in infrastructure level of any region. Cobb-Douglas approach for production function was normally the starting point in this regard as mentioned below:

$$Y = bL^{\alpha}K^{\beta}$$

Output has been signified by Y while factor productivity has been denoted by b. The notations L and K represent the inputs of labour and capital respectively and α , β are known to be output elasticities of inputs. So far as the role of infrastructural variable is concerned in a production function, literature provides neoclassical growth model as under:

$$Y = bL^{\alpha}K^{\beta}F^{\gamma}$$

Here, the notation of F is included so as to indicate infrastructural variables and γ is output elasticity of infrastructural variables as incremental input. Such models are open to the possibility of constant returns to scale [Solow (1956)]. The methodology employed by Demurger (2001) has been utilized in this study so as to

capture the impact of infrastructure on economic growth of Pakistan. Demurger (2001) used extended growth equation introduced by Barro (1990). In line with Demurger this study models following growth equation:

$$G_t = \alpha + \sum \beta_i X_{it} + \sum \gamma_j Y_{jt} + \sum \lambda_k Z_{kt} + \mu_t$$

This Barro-type framework allows the test of conditional convergence by the addition of Solow type set of variables, and such variables will reflect the differences in steady-state equilibrium. Growth has been represented by G_t , whereas X_{it} , Y_{jt} , and Z_{kt} are three major vectors of the equation. The vector of X_{it} is consisting of labour and capital as factors of production. Rural infrastructural variables have been represented by different elements of vector Y_{jt} . Different variables relating to the economic environment of Pakistan economy have been included in vector Z_{kt} . This vector consists of renowned determinants of economic growth. Parameters of the model are shown by α , β , γ and λ which are to be estimated with the help of OLS methodology. The error term has been indicated by μ .

3.1 METHODOLOGY AND BRIEF DESCRIPTION OF THE DATASET

We utilize secondary data of Pakistan from 1981 to 2010. Within a framework of time-series dataset the technique of OLS has been employed in a regression analysis so as find out the impact of rural infrastructural development on economic growth of Pakistan. There are severe limitations for data availability in a time series framework when we talk about the rural infrastructure because disaggregation of data, on the basis of rural and urban regions, has not been offered in secondary sources of datasets available in Pakistan. This is why straightforward quantification of rural infrastructure development outlined in time-series may not be likely to accomplish in case of Pakistan, therefore, we endeavor to quantify these variables with the help of public expenditures aimed at rural infrastructure development.

So far as variables of the model are concerned, real gross domestic product (RGDP) of Pakistan has been used as dependent variable for the purpose of quantification of economic growth. Macro determinants of economic growth have been disaggregated into three main groups i.e. vector of production function, vector of rural infrastructural development and vector of economic environment of Pakistan. Focused group of this study is the vector of rural infrastructural development. Brief description about independent variables is mentioned in the followings:

VECTOR OF PRODUCTION FUNCTION (X_{it})

LFPR:	Labour Force Participation Rate, which is defined as percentage of persons in labour force to the total population aged 10 years and above.
CAPS:	Capital Stock of the Pakistan calculated on yearly basis.

VECTOR OF RURAL INFRASTRUCTURE DEVELOPMENT (Y_{jt})

ERD:	Expenditures on Rural Development, which is defined as the expenditures met from revenue of provincial governments for rural infrastructural development of Pakistan
EIRR:	Expenditures on Irrigation, which is also defined as the expenditures met from revenue of provincial governments for irrigation development projects of Pakistan

VECTOR OF ECONOMIC ENVIRONMENT (Z_{kt})

INF:	Inflation Rate described by FBS on yearly basis
OPEN:	Openness, which is defined as ratio of 'sum of exports and imports' to real gross domestic product.
LITR:	Literacy Rate described by FBS on yearly basis

Foundation of the model used for the purpose estimation in this study, is a production function, therefore, on account of literature (mentioned in Section: 2 above), the functional form of the model has been chosen as log-log or double log model.

4. ESTIMATION AND RESULTS

Table: 1 represents descriptive analysis of the variables of the model and in Table: 2 regression results have been reproduced. So far as Table: 3 is concerned the statistic discussed may attempt to specify that whether there exist the problem of auto-correlation or not?

This study considers the time series data for analysis; therefore, it will be better to take into consideration the problems relating to stationarity¹ and spurious regression before discussion over the results of the analysis.

Normally, the problem of non-stationarity will be a key obstacle in the way of time series analysis. Stationarity within response and stimulus variables is a basic requirement of such analysis. In case that variables of the model are non-stationary, there will be a bold question mark on reliability and precision of the regression results. Because in this case significance level of estimates of the model may be increased spuriously. In time series analysis sophisticated techniques are available so as to get rid of problem of non-stationarity e.g. lagged variable technique, ARIMA modeling, Box-Jenkins methodology, Johnson's procedure and ARDL approach to time series analysis. This study will focus on a simple technique to check that whether variables of the model are stationary or not? As per the technique, the order of the variables of the model has been queried. If it has been found that all the variables of the model poses integration order of same level², then conclusion could easily be drawn that in the specified model there will be no problem relating to stationarity. The reasoning behind such a conclusion came out of the fact that when order of integration of variables of the model is same then the residuals obtained after estimation of the model will automatically show stationarity, hence, posing same order of integration. In literature this simple technique will be called as co-integration. Simple OLS technique will be taken as sufficient for estimation purposes in case of co-integration and the estimates of the model will not show high level of significance spuriously. Consequently, results will be taken as reliable and trustworthy.

Mathematically speaking the series of estimated residuals has been required for above mentioned model i.e.

$$\hat{\mu}_t = G_t - \hat{\alpha} - \sum \hat{\beta}_i X_{it} - \sum \hat{\gamma}_j Y_{jt} - \sum \hat{\lambda}_k Z_{kt}$$

With the help of Augmented Dickey Fuller procedure available in E-views, stationarity level of this series of estimated residuals could easily be found out. As per procedure if it has been come to the surface that series of estimated residuals is stationary at level i.e. I(0), then all the variables of given model could be termed as co-integrated and no problem of spurious regression results exists in the analysis. Following this procedure it has been found out in this study that series of estimated residuals is stationary at level, therefore, variables of the model are co-integrated and reliable and trustworthy regression results could be obtained by OLS methodology.

Table: 1

DESCRIPTIVE ANALYSIS				
VARIABLES	MEAN	ST. DEVIATION	SKEWNESS	KURTOSIS
RGDP	3269278	1247394	0.318915	2.070189
CAPS	752.3202	301.9859	0.067922	1.719734
LFPR	29.51267	1.404208	0.692205	2.898684
ERD	997.3433	1404.094	2.441686	8.613277
EIRR	5484.087	3561.364	0.696742	2.738857
INF	8.436667	3.971839	0.833856	4.083958
OPEN	36.88291	2.977527	0.290570	2.101082
LITR	40.36667	10.17954	0.194294	1.641342
NOTE: Results computed by authors with the help of E-Views				

4.1 Results Discussion

Descriptive analysis of the variables of the model is presented in Table: 1. Mean values are mentioned in Column No. 2 whereas variability of dataset around their mean has been given in Column No. 3. Skewness has been reported in Column No. 4 while kurtosis is mentioned in Column No. 5. Some of the variables have shown

¹ Stationarity means constant properties over time (mean, variance, dependence of ACF on lag etc)

² Order of integration may either be I(0), I(1) or I(2) etc which means that there exist stationarity at level or at first difference or at second difference respectively

high level of variability while some others show moderate and low level of variability. Shape of distribution of some of the variables is evident to be Plato-Kurtic while that of some of the variables have been observed to be Lepto-Kurtic.

Table: 2

Rural Infrastructural Development and Economic Growth: Time Series Macro Analysis of Pakistan (1981-2010)			
Dependent Variable	Logarithm of Real Gross Domestic Product		
Observations	30		
Method	Least Square		
Independent Variables	Coefficient	t-Statistic	Probability
C	2.653993	8.113157	0.000000
LCAPS	0.417313	5.752237	0.000000
LLFPR	0.296583	2.745701	0.011800
LERD	-0.005345	-0.928735	0.363100
LEIRR	0.04173	2.307807	0.030800
LINF	-0.005154	-0.976995	0.339200
LOPEN	0.13193	3.666296	0.001400
LLITR	-0.186523	-1.51298	0.144500
R2	0.897399	F Statistic*	1205.018000
Adjusted R2	0.886571	Probability (F Statistic)	0.000000
Durbin Watson Statistic			1.415229
NOTE : Decimals up to maximum six decimal places have been used. Results are prepared on the basis of estimation conducted by authors on the basis of collected dataset with the help of E-Views			

Regression analysis mentioned in Table: 2 above show that model is overall very good-fit while having R^2 equal to 0.89. Simultaneous impact of stimulus variables on response has been captured by F-statistic which is also sufficient to show that all the explanatory variables of the model simultaneously a significant impact on explained variable. Value of d-statistic³ has been observed to be 1.42 which is inconclusive in terms of interpretation for incarcerating autocorrelation; therefore, d-statistic will not be helpful in this regard. Instead of using d-statistic the methodology of LM Statistic⁴ will be employed in this study so as to find out the problem of autocorrelation. In Table: 3, results of LM Statistic have been reported and it has been observed that there exist no autocorrelation because LM statistic (i.e. 3.478) is lesser than critical value (i.e. 3.841).

Table: 3

BREUSCH-GODFREY SERIAL CORRELATION LM-TEST	
Statistic	Description
LM Statistics	3.478
Chi-Square Critical Value	3.841
NOTE: Results are based upon calculations conducted by authors with the help of E-Views	

Variables related to productions function i.e. CAPS and LFPR are evident to show an expected relationship with RGDP at a significance level of one percent. The vector of rural infrastructural

³ The procedure for finding out autocorrelation known as Durbin-Watson Statistic

⁴ Alternative test to check the problem of autocorrelation known as Breusch-Godfrey Correlation LM Test

development comprises of two variables i.e. ERD and EIRR. The variable of ERD has not shown a sign in line with hypothesis, however, this variable has proved to be insignificant. While the variable of EIRR not only has an expected sign but also observed to be significant at a level of five percent. So far as vector of economic environment is concerned the variables of INF, LITR, OPEN are included in the model. The sign of INF follows the hypothesis that high inflation will be negatively related to economic growth of any country as in the case of Pakistan. This variable has found to be statistically insignificant. The relationship of LITR is not in line with the hypothesis and has shown an inverse affect of literacy rate upon economic growth. However, LITR has also not been proved statistically significant. The only variable related to the vector of economic environment which has been proved statistically significant is OPEN and this variable also follows the hypothesis in this regard.

5. CONCLUDING REMARKS

The evidence in this regard endorses the positive impact of rural infrastructural development on economic growth of Pakistan. It has been found out that the variables of labour, capital, trade openness and rural infrastructural development have the force to enhance economic growth of Pakistan. However, the vector of production function (i.e. labour and capital) has shown comparatively a strong significant impact on economic growth. The effects of the vector relating to rural infrastructural development have been found to be modest whereas the vector of economic environment has shown the least impact for the data set we utilize for analysis purposes. Our main focus is on rural infrastructural development which even has shown the force for enhancement in economic growth but it has been observed that rural infrastructural development has shown comparatively a weak relationship with economic growth because in this regard a robust impact has been observed for the vector of production function i.e. capital and labour.

There may be many reasons for this finding but this study takes into consideration two reasons: Firstly, due to lack of capital, financial constraints and urban biased policies, governments have not given its due focus towards rural infrastructural development of Pakistan. Secondly, however, if a little attention has been paid, such an attempt was devastated due to unequal distribution of rural infrastructure across different provinces of the country.

REFERENCES

1. Aschauer, D. A. (1989). Is public expenditure productive? *Journal of Monetary Economics* No. 23: 177-200.
2. Ashley, C. and Maxwell, S. (2001). Rethinking Rural Development. *Development Policy Review* No. 19 (4). 395-425.
3. Barro, R. J. (1990). Government Spending in a Simple Model of Endogenous Growth". *Journal of Political Economy*: 98(5), 103-125.
4. Binswanger, H. and Deininger, K. (1997). Explaining Agricultural and Agrarian Policies in Developing Countries. *Journal of Economic Literature* 35: 1958-2005.
5. Calderon, C. and Chong, A. (2004). Volume and Quality of Infrastructure and the Distribution of Income: An Empirical Investigation. *Review of Income and Wealth*. Vol. 50, No. 1, pp. 87-106.
6. Canning, D. and Pedroni, P. (1999). Infrastructure and Long Run Economic Growth. Discussion Paper No. 57, Consulting Assistance on Economic Reforms II Discussion Papers funded by World Bank and USAID.
7. Chakraborty, D. and Guha, A. (2009). Infrastructure and Economic Growth in India: Analyzing the Village Level Connectivity Scenario of the States". *Journal of Infrastructure Development*, 1 (1), 67-86.
8. Demurger, S. (2001). Infrastructure Development and Economic Growth: An Explanation for Regional Disparities in China? *Journal of Comparative Economics*, 29, 95-117.
9. Eckstein, O. (1957). Investment Criteria for Economic Development and the Theory of Intertemporal Welfare Economics. *The Quarterly Journal of Economics*, 71(1), 56-85.
10. Estache, A. Foster, V. and Wodon, Q. (2002). Accounting for Poverty in Infrastructure Reform: Learning from Latin America's Experience. The World Bank, Washington. DC.
11. Fan, S., P. Hazell. and Haque, T. (2000). Targeting public investments by agro-ecological zone to achieve growth and poverty alleviation goals in rural India". *Food Policy* No. 25, 411-428.
12. Garcia-Mila, T., McGuire, T. J. and Porter, R. H. (1996). The effect of public capital in state-level production functions reconsidered. *The Review of Economics and Statistics* 78, 177-180.
13. Holtz-Eakin, D. (1992). Public-Sector Capital and the Productivity Puzzle. NBER Working Paper Series. Working Paper No. 4122. National Bureau of Economic Research, 1050 Massachusetts Avenue, Cambridge.

14. Khan, M. T. Y. and Sasaki, K. (2001). Role of Public Capital in Pakistan's Economy: Productivity, Investment and Growth Analysis". *RURDS*, 13(2), 143–162.
15. Looney, R. E. (1997). Infrastructure and Private Sector Investment in Pakistan". *Journal of Asian Economics*, 8(3), 393-420.
16. Looney, R. E. and Winterfold, D. (1992). The Role of Infrastructure in Pakistan's Economic Development: 1972-1991. *Pakistan Economic and Social Review*, 30(1), 69-93.
17. Lopez, H. (2003). Macroeconomics and Inequality. Research Workshop titled 'Macroeconomic Challenges in Low Income Countries', World Bank's PREM Poverty Group.
18. Munnel, A. H. (1992). Policy Watch: Infrastructure Investment and Economic Growth". *The Journal of Economic Perspective*, 6(4), 189-198.
19. Nurkse, R. (1953). *Problems of Capital Formation in Under-developed Countries*. Oxford University Press, New York, pp. 163.
20. Ratner, J. B. (1983). Government Capital and the Production Function for U.S. Private Output". *Economic Letters*: 13, 213-217.
21. Rosenstein-Rodan, P. N. (1943). Problems of Industrialization of Eastern and South-Eastern Europe". *The Economic Journal*, 53(2210/211), 202-211.
22. Rostow, W. W. (1959). The Stages of Economic Growth. *The Economic History Review*, 12-1-16.
23. Solow, R. M. (1956). A Contribution to the Theory of Economic Growth". *The Quarterly Journal of Economics*, 70(1), 65-94.
24. Wylie, P. J. (1996). Infrastructure and Canadian Economic Growth 1946-1991. *The Canadian Journal of Economics/Revue Canadienne d'Economique*, 29(Special Issue: Part 1), S350–S355.