

Role of Infrastructure in Economic Growth: A Case Study of Pakistan

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Abstract

The main objective of this study is to find out impact of infrastructure on economic growth of Pakistan. In this regard, time series data has been collected from 1972 to 2009 and Gross Domestic Product (GDP) is considered as dependent variable, while Gross Fixed Capital Formation (GFCF), Per Capita Health Expenditure (PCHE) and Total Generation of Electricity (TGE) used as proxy for infrastructure. After collection of data on above cited variables, stationarity of all variables checked by Augmented Dickey Fuller (ADF) test and found that all variables are non-stationary at their levels and become stationary at their first difference. When all the variables are integrated of same order then we applied Johansen Cointegration to detect long run association between the variables and found the there is no long run relationship exists. Then we apply Ordinary Least Square (OLS) to find short-run relation between variables and found that infrastructure is positively and significantly contributing in Pakistan. However, all the assumptions also checked to avoid the problem of spuriousness. On the basis of our empirical findings, its suggested that government and policy makers should focus for the development of infrastructure, and infrastructure is contributing in economic growth both directly and indirectly.

Keywords: Infrastructur, Economic Growth, Ordinary Least Square

Introduction

The development and maintenance of essential physical infrastructure is an important ingredient for sustained economic growth. Poor infrastructure is perhaps the most binding constraint to economic growth of developing countries like Pakistan. Physical infrastructure refers to facilities and structures that are essential to the functioning of the economy. For present purposes, it comprises roads, bridges, railways and transit systems, airports, air traffic control systems, waterways, and water supply, and wastewater treatment systems, hospitals, energy and power generation. Such infrastructure underpins economic activity by facilitating the movement of people and goods and by providing environment essential for growth. Because it has some characteristics of a "natural monopoly" in particular, high fixed costs that may inhibit private investors, it is generally provided by some level of government. So the investment into the infrastructure plays an important role to achieve the social objectives and that are contributing to the sustained economic growth. Likewise when investment is made into the transport infrastructure it improves the access to services and markets in rural areas.

In the background of a rapidly growing population, economic growth is vital because it is the single hope of generating massive employment opportunities for youth which is now 60% of our population. According to an estimate of Planning and Development Commission of Pakistan, labor force is annually growing at the pace of approximately 3.5% and to engage such aggressively increasing labor force, GDP must grow by 7% annually. Obtaining high

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growth trajectory and maintaining that momentum is the life line for Pakistan. Among the set of factors which spur economic growth, infrastructure is pivotal as it contributes to the reduced costs of production, minimized trade and transaction costs and improved market competitiveness. Better infrastructure is also a magnet for foreign investment as it reduces the sunk costs to fill in the loop holes in the prevailing business and social environment. Both the local and foreign investors bear in mind the available infrastructure facilities while making their investment decisions. In the present situation amid unpopular and unwelcomed load-shedding due to which hundreds of thousands of workers are directly unemployed and also it reduces the productivity of services sector, the appetite for new energy and power generation infrastructure is drastic.

For Pakistan, an agrarian country with more than half of the population directly or indirectly related to this sector, it seems quite reasonable to make huge investments in building new water reservoirs along with maintaining and overhauling the existing dams and canal systems. Similarly; education and health infrastructure is decisive for human capital formation. To make the demographic liability (177.1million) of the country an asset, it is necessary to acquaint them with life skills, formal and technical education. To achieve the Millennium Development goals (MDG's) which are set for 2015 in terms of poverty, water supplies, sanitation, health and education, the investment in the industry, trade and energy infrastructure plays a deterministic role.

The main objective of this paper is to analyze the impact of the physical infrastructure on the economic growth of Pakistan for the period 1972-2008. The rest of the paper is organized as follows: Section 2 encompasses the review of the existing literature, section 3 covers the data and methodology utilized, section 4 interprets the results and finally section 5 is pertinent to the concluding remarks.

Literature Review

Infrastructural development of any economy both in economic and social is one of the major determinants of the economic growth particularly in the case of the developing countries like Pakistan. Its role is crucial to create the production facilities, boost up the economic activities, reducing the transaction and trade costs, minimizing production costs and improve the market competitiveness. This section provides a glimpse of the literature on the infrastructural investments and economic growth.

Flynn (1993) critically analyzed the joint effects of infrastructure and public sponsorship on the survival and expansion of newly born enterprises via factor analysis. The data consists of six indicators of infrastructure which include per pupil educational expenditures, hourly cost of manufacturing labor, persons over age of 25 with four or more years of college, tax paid per capita, income per capita and cost of single family home per capita for the sample of fourteen randomly selected regions and five different time periods. The study concluded that enriched infrastructure through public sponsorship supports existence of high technology firms.

Bougheas *et al* (2000) found a significant positive relationship between infrastructure and degree of specialization and also confirmed a robust non-monotonic (inverted-U) relationship between infrastructure and growth by using OLS regression models. The variables utilized are paved roads per thousand kilometers, telecommunication lines per thousand inhabitants and per capita GDP. Wanmali and Islam (1997) proposed in their policy paper that rural infrastructure is necessary to be developed in Southern Africa in order to achieve multiple objectives including economic growth. Countries selected for the case study are Zambia and Zimbabwe.

Demetriades *et al* (2003) used data of 16 European countries from 1987-1995 to investigate the international aspect of investment in public infrastructure. The variables used for infrastructure are per capita road stock, per capita stock of rail lines, maritime ports and airports. Infrastructure investments in one country have strategic implications for its partner country and equilibrium levels of infrastructure are not optimal from a global perspective. Zhang and Fan (2004) examined the impact of infrastructure enhancement on productivity by using GMM method. The variables included are road density and irrigation form 1971-1994. They found that infrastructure development in rural India contribute to total factor productivity growth in agriculture.

Paul *et al* (2004) used annual data of 12 manufacturing industries from 1961-1995 to capture the impact of public infrastructure on manufacturing industries productive performance by using seemingly unrelated regression. The study found strong empirical evidence that infrastructure plays a pivotal role in the productivity enhancement. Cheng Fu *et al* (2004) employed maximum likelihood method on the sample covering time period from 1994-2000 to capture the effect of public infrastructure on labor productivity of China. The data constituted of 22 provinces and the main variables are investment in transportation, storage, post and telecommunication. They end up with the finding that infrastructure is significant factor in explaining labor productivity in China.

Hulten (1996) used sample of 46 developing countries over the period 1970-1990 to sort out the effectiveness of infrastructure in stimulating economic growth. Variables central to analysis are public infrastructure (paved roads, electricity generation), private infrastructure and human capital (primary enrollment, secondary enrollment). OLS method is utilized to conclude that low and middle income countries are underutilizing existing infrastructure which is vital in explaining growth differentials of Africa and East Asia. Eakin and Schwartz (1994) stated a negligible impact of infrastructure investment on productivity growth using annual data of 48 U.S. states from 1971-1986. Variables employed are output per effective worker and public capital per worker.

Morrison and Schwartz (1992) explored the impact of state infrastructure on productive performance of manufacturing sector of 48 U.S. states by employing seemingly unrelated regression over the period 1970-1987 annually. They study resulted in the fact that infrastructure investment is beneficial for firm's production and cost. Donaldson (2010) used archival data of colonial India on 235 districts from 1870-1930 to evaluate the effect of rail road network. Utilizing OLS, a profound impact of rail network was found on reducing trade costs, interregional price gaps and increasing trade volumes. Real agricultural income increased by 16% due to railroad extension to average district.

Data and Methodology

This section describes the econometric technique and variables used for empirical analysis. The functional form of the model is as:

$$GDP = f(GFCF, PCHE, TGE)$$

Where

GDP = Gross Domestic Product

GFCF = Gross Fixed Capital Formation

PCHE = Per Capita Health Expenditures

TGE = Total Generation of Electricity

In this model, GDP is taken as dependent variable, while GFCF, PCHE and TGE are used as independent variables and also proxy for infrastructure. This study covers time period from 1972 to 2009 and data is collected from World Development Indicators (WDI) and State

Bank of Pakistan (SBP). Sample period includes 36 yearly observations from 1972 to 2008. All the variables are used in the model in logarithmic form as log form shows the relative growth and also to check the elasticity of GDP with respect to independent variables. An additional benefit of log form is that it makes interpretation more robust and meaningful.

Through our empirical analysis, we are going to check the impact of infrastructure on the economic growth of Pakistan. But almost all the economic variables are non-stationary at their levels. So, stationarity of the variables is checked through correlograms and more rigorous Augmented Dickey Fuller test and Philips Perron test at level form. Philips-Perron test is useful in the presence of structural breaks otherwise both tests give the same results. Results suggest that all the variables follow unit root process. So we go for appropriate transformation. Iterative mining suggests that all the variables in the study are I(1). Ordinary least Squares method has been employed in the framework of multiple regression analysis to approach a deterministic relationship. This exercise proved to be useful as data fits the model reasonably well.

Unit Root Test:

Considering a Simple AR(1) process

$$Y_t = \rho Y_{t-1} + \eta X_t + \mu_t \quad (1)$$

Where Y_t depicting a time series variable and X_t is a vector of independent variables, ρ and η are the parameters of Y_t and X_t respectively which are to be estimated and μ_t is the white noise error term with zero mean and constant variance. If $\rho=1$ then eq. (1) becomes random walk confirming unit root.

Subtracting Y_{t-1} from both sides:

$$\Delta Y_t = \beta Y_{t-1} + \eta X_t + \mu_t \quad (2)$$

where Δ is difference and $\beta = \rho - 1$. In practice eq. (2) is estimated to see whether $\beta=0$ or not. If $\beta=0$, it means in turn that $\rho=1$ and our variable follows unit root process. Thus Dickey Fuller statistic tests Null Hypothesis $H_0: \beta = 0$ ($\rho=1$) through ordinary least square (OLS) estimation under the critical values of tau statistic. If this null hypothesis is accepted it means that our variable is non-stationary.

But a sufficient condition for Dickey Fuller is that the error terms must not be serially correlated. In case of such violation, Augmented Dickey fuller (ADF) can be a remedy. It augments the contemporary Dickey Fuller equation with lagged values of dependent variable. Assuming that Y_t follows AR(p) process, it incorporates p lagged terms of the regressand in the eq. (2).

$$\Delta Y_t = \beta Y_{t-1} + \eta X_t + \sum_{k=1}^p \delta \Delta Y_{t-k} + \varepsilon_t$$

Augmented Dickey Fuller test for Unit Root		
Variables	Level	First Difference
LGDP	-0.797155(1)	-4.377777(0)***
LGFCF	-0.627969(0)	-4.551024(0)***
LPCHE	-2.467143(0)	-4.124468(0)***
LTGOE	-1.291646(1)	-14.28315(0)***

Note: () shows the lag length and *** shows significance at 1% level of significance

The result of ADF test shows that all the variables are non-stationary at their levels and become stationary at their first difference. When all the variables are integrated of same order then we may check long run association between the variables by applying Johansen Cointegration technique. Here we applied Johansen Cointegration technique but found that there is no long run association between the variables of the model.

When it was found that there is no long run association with infrastructure and economic growth, then we move toward OLS to detect short run association between the variables.

OLS framework:

$$LRGDP_t = \alpha + \beta k_t + \mu_t$$

Where; *LRGDP* is the log of real GDP (growth) and *k* is the vector of all explanatory variables included in the model for infrastructure. The positive sign of the coefficient represents that there is a positive relationship between infrastructure variables and economic growth. If there is an increase in infrastructure variables; they will promote economic growth in Pakistan. Conversely; if the relationship between infrastructure variables and economic growth is negative, they will not be helpful in economic growth of the country.

The hypothesis is stated as

Hypothesis 1:

$$H_0: \beta = 0 ;$$

$$H_1: \beta \neq 0$$

The null hypothesis $\beta = 0$ (there is no relationship between infrastructure variables and real gross domestic product) against its alternative $\beta \neq 0$, if less than lower bound critical value (0.05) then we do not reject the null hypothesis. Conversely, if the t-statistic value greater than 5 percent critical value, then we reject the null hypothesis and conclude that there exist a significant relationship between dependent and independent variable.

Table 1: Ordinary Least Square

Dependent Variable: LRGDP

Variables	Coefficient Value	Test Statistics	Probability
LGFCF	0.4375	4.3616	0.0001
LPCHE	0.2688	6.1799	0.0000
LTGE	0.0434	2.8057	0.0087

Model fit Criteria/Goodness of Fit

R-Squared	0.996611
Adjusted R-Squared	0.996046
F-Statistic	1764.394 [0.000]

Results suggest that 1% increase in Gross Fixed Capital Formation causes GDP to rise by 0.4375%. While unit proportionate increase in Per Capita Health Expenditure and Total Generation of electricity causes GDP to surge upward by 0.2688% and 0.0434% respectively.

Diagnostic testing:

Diagnostic tests are also applied to check whether the series are free from autocorrelation, heteroscedasticity and normality problems.

Hypothesis 2:

H₀: There is no autocorrelation between members of series of observations ordered in time

H₁: There is autocorrelation between members of series of observations ordered in time

Autocorrelation (Breusch-Godfrey Serial Correlation LM Test)	
F-Statistic	0.668333 [0.5205]
Obs* R-Squared	1.638846 [0.4407]

For Breusch-Godfrey Serial Correlation LM Test, we are testing for autocorrelation at 0.05 significant level.

Hypothesis 3:

H₀: There are constant variances for the residual terms

H₁: There are no constant variances for the residual terms

Heteroskedasticity Test: White	
F-Statistic	386810 [0.3285]
Obs* R-Squared	29.66251 [0.3295]

For White test, we are testing heteroscedasticity at 0.05 significant level.

Hypothesis 4:

H₀: Residuals are normally distributed

H₁: Residuals are not normally distributed

If the computed p-value is greater than 0.05, we do not reject the null hypothesis and autocorrelation, heteroscedasticity and normality problems are not existing. On the other hand; if the p-value is less than 0.05 we reject the null hypothesis and there is existing autocorrelation and heteroscedasticity and residuals are not normally distributed.

Normality Test	
Jarque-Bera	0.892788 [0.639931]

Hypothesis 5:

H₀: Coefficients are not stable

H₁: Coefficients are stable

Ramsey RESET test is applied to check the stability of the coefficients. If the p-value is greater than 0.05, we accept the null hypothesis otherwise we reject it. While Confidence Ellipse test is given in the appendix.

Stability Test:

Ramsey RESET Test	
F-Statistic	5.586705 [0.0091]

For Ramsey RESET test, we are testing stability of the model at 0.05 significant level.

Another formal test for coefficients is Wald test which checks the collective significance of the coefficients by imposing a restriction. If p -value is greater than 0.05, we accept the null hypothesis otherwise we reject it. The hypothesis is stated below

Hypothesis 6:

H_0 : All the coefficients are equal to zero

H_1 : All the coefficients are not equal to zero

Wald Test	
F-Statistic	732.7938 [0.0000]

Note: probability value is stated in []

For Wald test, we are checking the coefficients of all independent variables at 0.05 significant level.

The results show that model does not suffer from autocorrelation and heteroscedasticity and the series is normally distributed.

All the coefficients are statistically significant even at 1% level of significance and their signs are according to priori expectations. Adjusted R^2 is 0.99 showing the high explanatory power of the model. Additional tests are also applied to check for various dimensions of model reliability and adequacy. Jarque-Berra test for the normality confirms error terms to be normally distributed. Breusch-Godfrey serial correlation LM test confirms no serial correlation and White test indicates homoskedasticity. Stability of coefficients is checked through Ramsey RESET and confidence ellipse test which authenticate the stability of coefficients. More formal Wald test for the collective significance of coefficients indicates coefficients to be significant.

Conclusion

The study concludes that infrastructure plays a crucial role in enhancing the economic growth of Pakistan. This is clear from the empirical results which show a clear-cut positive relationship between infrastructure and economic growth. The robustness of the results has been checked through various diagnostic tests. Economic growth can be stimulated by investment in infrastructural development. Government should also initiate private partnership to encompass infrastructure requirements of the country in order to overcome the shortcomings of the little fiscal gap.

On the basis of our empirical analysis, it is strongly recommended that Government must take aggressive moves to expand the infrastructure facilities and improve the quality of available infrastructure to fulfill the requirement of economic growth at a faster pace. As mentioned in New Growth Framework (NGF) by Planning and Development Commission of Pakistan that there is a need for an effort to fully utilize the available infrastructure for economic growth and our results are in conformity with it as Total Generation of Electricity is positively associated with GDP growth. Generating capacity of Pakistan is less than the installed generating capacity of electricity and there is a need to bridge this gap.

For policy perspective; this study suggests that infrastructure development plays an important role for the economic growth of Pakistan. In this scenario, the reasonably huge investment into the infrastructure is justified to achieve and sustain considerable economic growth.

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