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Physical Infrastructure and Economic Development in Pakistan

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Abstract: This paper aims to investigate the relationship between physical infrastructure and economic development of Pakistan. A composite index of physical infrastructure has been constructed through Principal Component Analysis. This has been done by taking into account three different dimensions of infrastructure i.e. transportation infrastructure, energy infrastructure and telecommunication infrastructure. Johansen Co-integration Technique has been applied to confirm the existence of co-integration among the variables of our interest. The empirical analysis shows that co-integration exists among the variables of economic development, employed labour force, gross private fixed capital formation and physical infrastructure. The variables of employed labour force, gross private fixed capital formation and physical infrastructure have statistically significant and positive effect on economic development of Pakistan.

Key words: Infrastructure · Economic Growth · Poverty · Economic Development · Investment · Labour

INTRODUCTION

There are numerous studies that have tried to unfold the mystery of poverty and prosperity in different countries of the world. The new and old growth theories in economics have emerged to unfold the same mystery. These theories have offered a standardized set of determinants of prosperity and poverty for different countries of the world. The most important of these determinants are physical capital, labour, human capital in the form of education and health, institutions, geography, trade openness, macroeconomic stability and technological progress [1]. However the World Economic Forum (1) mentions that different sets of determinants are important for the development of different countries depending upon their specific stages of development. As, according to World Economic Forum [2], Pakistan falls in the first stage of development, so institutions, macroeconomic environment, infrastructure, primary education and basic health facilities are more important for the development of Pakistan. Moreover Faiz [3], Looney [4] and the World Bank [5], have emphasized the undersupply of physical infrastructure like roads, telecommunications, energy and water as the main constraint on the better performance of almost all sectors in Pakistan. In this study we specifically focus on the long run effects of different physical indicators of infrastructure on the GDP in Pakistan.

Physical infrastructure is a comprehensive term and it encompasses the facilities like electricity, piped gas, telecommunications, piped water, sanitation and sewerage system, solid waste collection and disposal, roads, railways, airports, seaports, dams, irrigation and drainage system and now the mobile phones and broadband internet facilities. Most of the infrastructure facilities are consumed directly by the people. They consume piped water, piped gas and electricity etc. They use modern transportation and communication facilities to access; the information for better decisions, the job markets for employment, the goods markets for marketing their agricultural products, the hospitals for health care and the schools for educating their children. This widens the employment opportunities for the people and also increases the productivity of the people through increased human capital. This results in high economic growth and thus higher level of per capita income. Physical infrastructure increases productivity, reduces cost of production, facilitates the easy and wider diffusion of information and technology, enlarges markets and promotes more innovations. Physical infrastructure affects the location decisions of the investors and firms. This helps more industrialization and provision of more employment opportunities and thus high GDP.

The investigation of the link between development and physical infrastructure has been initiated by Aschauer [7] followed by a voluminous theoretical and

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empirical work. Aschauer (1989) has investigated the relationship between public infrastructure capital and total factor productivity in the US economy. He has concluded that the effect of public infrastructure capital was highly significant and positive. The World Bank [8, 9, 5, 10 and 11] has emphasized the importance of physical infrastructure for better investment and business climate and thus for economic growth and development. The Doing Business report of the World Bank [6] has mentioned that the availability and reliability of electricity is one of the most important factors that contribute to the business activity. This report has mentioned that poor supply of electricity adversely affects the productivity and investment of the firms. World Bank [10] points out that inadequate supply of electricity and poor-quality roads and infrastructure are the significant constraints for investment in the rural areas of the developing countries. Asian Development Bank (ADB), The International Bank for Reconstruction and Development (IBRD), World Bank (WB), Japan International Cooperation Agency (JICA) [12] found that a large number of Japanese firms operating in Vietnam viewed poor infrastructure as the major obstacle to their business. Escribano and Guasch [13] found infrastructure very important for productivity in Guatemala, Honduras and Nicaragua. Straub [14] has reviewed 30 macro-level studies written between 1989 and 2006. These studies have investigated the effect of infrastructure on output and productivity. Most of the studies have reported positive and significant effect of infrastructure on economic performance and development. It has been mentioned in this study that the respondents of the World Bank's investment climate assessment (ICA) surveys have viewed electricity, telecommunications and transport as major obstacles to their businesses. Different researchers like Canning and Pedroni [15], Looney [4], Calderon and Serven [16], Banergee *et al* [17], Shrestha [18], Easterly and Rebelo [19], Sanchez-Robles [20] have checked the effect of electricity, telephone and roads on the development of different countries and regions in different time periods. They have found positive and significant coefficients for the physical indicators of infrastructure.

An amount of $70 billion is required each year to meet the irrigation and water needs in Pakistan. Every year an amount of $1 billion is required to build new dams and the economy loses $5 billion each year because of poor and deficient roads infrastructure. The power shortages will increase to 30,700 megawatts by the year 2020. These energy shortages constrain the industrial growth and all other sectors of Pakistan's economy [5]. According to the World Bank's Doing Business report [6], in Pakistan, one has to go through 6 procedures in 266 days with an average cost of 1829.2 % of the income per capita to get a new electricity connection as compared to Germany, one of the developed countries, where one has to go through 3 procedures in 17 days with an average cost of 51.9% of the income per capita. According to the Global Competitive Index of the WEF [2], Pakistan's overall rank is 123rd, while 110th in infrastructure among 139 countries.

If we look at the economic performance of Pakistan, we find that Pakistan has been successful in increasing its GDP; however its growth rate has not been consistent in the previous decades showing large ups and downs. GDP grew by 4.83% in the decade of 70s, by 6.2% in the decade of 80s showing an upward trend, however GDP growth rate declined to 4.41% in the decade of 90s. The economy once again regained the momentum by growing at an average rate of 5.2% from 2000 to 2008, but started growing slowly after 2008. The growth rate of GDP fell to 1.7% in 2009. In this study we take GDP as a proxy for development and analyze the importance of the physical indicators of different infrastructural facilities for the sustained growth of GDP. We specifically focus on the role of roads, electricity and telephony in the economic development of Pakistan. The rest of the paper is organized as follows: estimation results, discussion of the results and conclusion are presented in the next sections respectively.

Theoretical Framework: The familiar Cobb-Douglas production function augmented by the infrastructure capital is used in this study. It is given as follows:

$$Y_t = A_t L_t^{a_1} K_t^{a_2} K_t^{a_3} e^{U_t}$$

After taking the natural log of the above equation, we arrive at the following estimation equation

$$InY_t = \alpha_o + \alpha_1 InL_t + \alpha_2 InK_t + \alpha_3 InG_t + U_t$$

The term Y is the GDP in Pakistani Rupees at constant prices of 1999-2000, L is the employed labour force, K is the gross private fixed capital formation in Pakistani Rupees at constant prices of 1999-2000, the term G is the infrastructure index for the physical measures of transportation, energy and telecommunication. The term A is the technology parameter and the U is the usual error term. The subscript 't' represents the time period from 1973 to 2008, while α_1, α_2 and α_3 are the elasticities of GDP with respect to labour, private capital and physical infrastructure respectively. The total length in Kilometers of all types of roads are taken to proxy the transportation infrastructure, the electricity generation in million Kilo Watt Hours is taken to proxy the energy infrastructure and the number of telephones in thousands are taken to proxy the telecommunication infrastructure. The Principal Component Analysis has been used to derive individual weights for the physical indicators of infrastructure to construct infrastructure index. Then by using these weights for the physical indicators of infrastructure, i.e. roads, electricity and telephony, we have developed a composite infrastructure index through the weighted sum method[1].

Data Sources: The data for the physical indicators of infrastructure has been taken from the different issues of Pakistan Economic Survey. The data for the gross domestic product and for the gross fixed private capital formation has been taken from State Bank of Pakistan. The data covers a period from 1973 to 2008 and all the variables have been taken in aggregate form.

Empirical Findings: Investigation of unit root problem in the time series data is the first step before applying Johansen Co-integration Test for the confirmation of co-integration. We apply Augmented Dickey-Fuller (ADF)

Table A-1: Data of infrastructure index

Years	Infindex	Years	Infindex
1973	48692.62	1991	122799.9
1974	49465.72	1992	132352.7
1975	51124.38	1993	138132.8
1976	52502.81	1994	143688.7
1977	55106.88	1995	151793
1978	56674.76	1996	160069.7
1979	58863.72	1997	167911.2
1980	63055.11	1998	176251.2
1981	63579.77	1999	182027.2
1982	66210.99	2000	182873.7
1983	69101.07	2001	185315
1984	77347.34	2002	188966.8
1985	81838.35	2003	191905.7
1986	87846.33	2004	196914.6
1987	94121.49	2005	201386.8
1988	101882.8	2006	206498.6
1989	107685.6	2007	210610.3
1990	115802.7	2008	206994.5

Infindex = infrastructure index

Table 1: Augmented Dickey-Fuller (ADF) Test for Unit Root

Augmented Dickey-Fuller (ADF) Test at Level				
Variables	Without Trend	Prob. Values	Trend & Intercept	Prob.Values
$LGDP_t$	-0.886032	0.7808	-1.460504	0.8235
$LLAB_t$	0.206359	0.9692	-1.868083	0.6495
$LGFPCF_t$	-0.288946	0.9166	-3.038256	0.1367
$LINFINDEX_t$	-1.918294	0.3204	1.209017	0.9999
Augmented Dickey-Fuller (ADF) Test at 1st Difference				
Variables	Without Trend	Prob.Values	Trend & Intercept	Prob.Values
$\Delta LGDP_t$	-4.329751	0.0017	-4.282769	0.0093
$\Delta LLAB_t$	-6.294186	0.0000	-6.232103	0.0001
$\Delta LGFPCF_t$	-6.851109	0.0000	-6.738185	0.0000
$\Delta LINFINDEX_t$	-2.838299	0.0636	-3.426618	0.0645

Tale 2: VAR Lag Order Selection Criteria

Lag	Akaike information criterion (AIC)	Schwarz information criterion (SC)	Hannan-Quinn information criterion (HQ)
0	-6.190312	-6.008917	-6.129278
1	-16.02509*	-15.11812*	-15.71992*
2	-15.58505	-13.95250	-15.03575
3	-15.55244	-13.19431	-14.75900

*Indicates the optimum lag length selected by the criterion.

[1] See appendix for the values of infrastructure index

Table 3: Unrestricted Co-integration Rank Test (Trace)

H_0	H_1	Trace Statistic	0.05 Critical Value	Prob.
R = 0*	R = 1	49.23978	47.85613	0.0368
R = 1	R = 2	22.59515	29.79707	0.2665
R = 2	R = 3	5.531868	15.49471	0.7500
R = 3	R = 4	0.058054	3.841466	0.8096

*denotes rejection of null hypothesis at 5% level of significance.

Table 4: Long Run Relationship

Dependent Variable = $\ln y_t$			
Variable	Coefficient	T-Statistic	Prob-Value
Constant	6.457610	9.245654	0.0000
LLAB*	0.473910	2.627094	0.0134
LGFPCF**	0.098038	3.216157	0.0031
LINFINDEX**	0.468777	5.858659	0.0000

R-Squared= 0.99
Adj-R-Squared= 0.99
F-Statistic= 3745.18
Prob(F-statistic)= 0.000000
Durbin-Watson = 1.8138
* indicates 5% significance level. ** indicates 1% significance level.

test developed by Dickey and Fuller [21, 22] for this purpose. The results of ADF test are given in Table1.

The results indicate that there exists the problem of unit root in the data when all the variables are taken at level. However, when the variables are taken at their first difference, the problem of unit root disappears from the data. The next step is to find out the optimal lag length for our empirical analysis. All the criteria for determining the lag length used in this study suggest an optimal lag length of 1. The results are given in Table 2.

Johansen Co-Integration Method, as proposed by Johansen [23] and Johansen and Juselius [24], is used to determine the co-integration between variables of our study. The results are presented in Table 3.

The results for the trace statistics show the existence of one co-integrating vector. This confirms the existence of long-run relationship between GDP per capita and infrastructure. As the existence of a long-run relationship between different variables used in this study has been confirmed, so now we proceed to estimate the coefficients of our variables through OLS. The OLS results are given in Table 4. To remove the problem of Autocorrelation, AR (1) scheme has been applied.

The results presented in Table 4 shows that all the explanatory variables are statistically significant and carry positive sign. Thus physical infrastructure can be viewed as an important determinant of economic development in Pakistan.

DISCUSSION AND CONCLUSION

The present paper investigates about the existence of long-run relationship between physical infrastructure and economic development in Pakistan. The physical infrastructure in this paper is represented by the length of all types of roads in Kilometers, the electricity generation in million Kilo Watt Hours and the number of telephones in thousands. These three physical indicators of infrastructure are then combined and transformed into an index of physical infrastructure through Principal Component Method. This index is then used to analyze the relationship between physical infrastructure and economic development in Pakistan. Economic development is a vast concept and it encompasses material as well as non-material aspects of human well being. However, in this paper, we have used aggregate level of GDP as proxy for development. A time series annual data from 1973 to 2008 has been used for empirical analysis in this study.

The results of time series analysis confirm the existence of long-run relationship between GDP and infrastructure in Pakistan. The coefficient of infrastructure is positive and highly significant. A 1% increase in infrastructure facilities (like roads, electricity and telephony) increases the aggregate level of GDP by.47%. This confirms the importance of physical infrastructure for the economic development of Pakistan.

Pakistan is one of the less developed countries of the world as far as the different socio-economic indicators are concerned. The inconsistent economic growth, high poverty rates, high infant and maternal mortality rates, illiteracy, ill health and low life expectancy are some of the important features of Pakistan's economy. The empirical results of this paper indicate that infrastructure, human resources and private investment are the most important determinants of economic development in Pakistan.

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