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Enigma of Public Assistance to Private Investment through Infrastructure: Evidence from Pakistan

[1]Ayza Shoukat, [2]Khalil Ahmad, [3]Muhammad Abdullah

[1]Lecturer in Economics at GCWU, Sialkot and PhD Scholar, University of the Punjab, Pakistan, ayzashouket@gmail.com
[2]Dean, Social Sciences and Professor of Economics at Government College Women University (GCWU), Sialkot, Pakistan
[3]Assistant Professor of Economics, Govt. Post Graduate College, Sahiwal, Pakistan

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ABSTRACT

Purpose: Public physical infrastructure development has fairly large impacts on private sector investment decisions and through this; it can affect economic performance (growth). The current study intends to explore the course in which public infrastructure affects private sector investment in Pakistan and whether there exist long run equilibrium between them or not. Time series annual data from 1972 to 2015 has been employed. Instead of using a single infrastructure indicator, the study has constructed a multidimensional composite index through principal component analysis (PCA). Real gross fixed capital formation is used as the proxy of private sector investment. The long run relationship is determined by Johansen's co-integration technique after checking for the order of integration. The empirical evidence shows that physical infrastructure availability is positively and significantly affecting private sector investment decisions. In addition, credit to private sector, per capita GDP, work force and inflation rate are positively and significantly affecting private investment. Further, private investment is sensitive to public physical infrastructure availability not only in long run but also in short run. A statistically significant and negative ECT (-1) term confirms the long run relationship and convergence towards equilibrium in case of Pakistan. Findings of the study show that public physical infrastructure services endorse the private investment both in the long run and the short run.

Corresponding author's email address: ayzashouket@gmail.com
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1. Introduction

Achieving sustainable growth and development through public capital stock is a popular approach in economic literature. Lately, economists and policy makers are more concerned about inputs of growth rather than outputs. Public infrastructure is one of these inputs and considered as fixed investment for the economy. Besides, the importance of private sector towards growth is undeniable. A reasonable rate of both public (physical infrastructure) and private investment keep an economy on the track of sustained growth. These indicators of growth are somewhat interrelated and their relationship is yet to unveil in case

of Pakistan.

Public physical infrastructure affects the private sector both directly and indirectly. The direct affect is significant as firms consume physical infrastructure as an intermediate unit of consumption. That is, marginal product of the physical infrastructure in private sector is positive (Prud'homme, 2005; Fay and Morrison, 2007 and Li and Li, 2009). The indirect effect suggests that public physical infrastructure and private investments are complimentary goods that are why, public physical infrastructure services must be provided to boost the private investment (Asante, 2000). Provision of public physical infrastructure raises rate of return of private capital, at one hand and on the other hand, it acts as a substitute that crowds out private investment. Empirical evidence support both ends but public infrastructure supports private investments on equilibrium (Delgado and Alvarez, 2001).

Pakistan's economy is characterized as a developing economy due to lower growth rates, high poverty levels, insufficient infrastructure, and low literacy rate, deficiency of capital inflow and capital formation and poor governance. Internal as well as external circumstances played crucial role over the short history of economy of Pakistan. Korean War in 1950s and bulk of foreign aid in 1960s helped Pakistan's economy to grow faster. However, the decade of 1970s came up with the shock of separation of East Pakistan, followed by nationalization policy and an adverse oil price shock. Not only the growth rate of the economy but the private sector was also affected due to nationalization scheme. During this period, private investment contracted and public investment expended. The era of 1980s was contrary in polices. In this decade, private investment boosted due to policy of decentralization. Further, foreign inflows due to Afghan war also helped economy to grow on an average growth rate of 6.8 percent. Total investment as well as private investment also increased. The decade of 1990s was distinguished in history of economy of Pakistan because of the choice of rightful growth promoting polices. Most important were export led growth and import liberalization policies. A significant amount of foreign inflows was also attracted. But the result of these polices was not very urging. Instead, growth rates (export, investment and GDP) were low even negative. Many internal as well as external factors were responsible for it like, heterogeneity of interests, political imbalance, absence of necessary infrastructure, unstable exchange rate and global inflation. In addition, emergence of Pakistan as nuclear power was also responsible for falling investment (Khan, 2007). As a result, growth rate fell to 4 percent. Private investment also dropped to 3.8 percent.

Table-1: Shows the situation of private and public investment over the years in Pakistan.

Average Growth RatesTime Period	**GDP Growth Rate** (percentage)	**Public Investment** (percentage of GDP)	**Private Investment** (percentage of GDP)	**Total Investment** (percentage of GDP)
1971-80	4.78	9.44	5.32	14.76
1981-90	6.25	9.17	7.79	16.96
1991-2000	3.99	7.34	9.14	16.48
2001-12	4.70	20.28	10.0	30.28

Source: various issues of Pakistan Economic Survey

Last decade, 2000 has introduced the economy of Pakistan as an open economy in global market. Since, trade promoting polices as well as foreign investment especially in physical infrastructure (telecommunication and energy) helped to build a new image of Pakistan in community of foreign investors. The outcome of such growth friendly policies could be fairly large but adverse circumstances (like military takeover, incident of 9/11, food inflation and oil price shock) had left economy underdeveloped. Currently, Pakistan is facing the problems like food price escalation, poor law and order, inappropriate health and education facilities, high inflation rate, deficiency of capital investment, inadequate policies and poor infrastructure services. One of the major reasons of the lower growth rates in Pakistan was the inadequate supply of public physical infrastructure services (Faiz, 1992 and Jan et al., 2012).

The contribution of investment and physical infrastructure towards growth is discussed by numerous researches. It is evident that both of above mentioned entities are growth promoting in both developing and developed countries. In empirical research, computing public physical infrastructure is very difficult because it is a multidimensional phenomenon. The conventional economic literature either consider a single infrastructure service as a measure of all or take the monetary measure like how much cost has been born to construct a road or a power house. In either case, situation is misleading (Easterly, 2001 and Loayza et al., 2005). In reality, physical infrastructure is a multidimensional approach which in aggregate is provision of different services (like transportation, power or energy and telecommunication). By considering these features of infrastructure, we have constructed a composite index of public physical infrastructure with multiple dimensions. These dimensions are measured with different variables and combined to a single indicator through principal component analysis (PCA).

The causal relationship of infrastructure provision and flow of private investment is not much explored. Particularly, the case of Pakistan is not yet unfolded. The current study seeks the dynamic and complex relation of how public infrastructure pertains to private investment and resolves the bottle necks. The data set used is 1972-2015 for Pakistan's economy. The study is consisting of four sections. Section two briefly represents the literature review. Model specifications and empirical results are discussed in section three. Section four summarizes the concluding remarks with policy implications.

2. Review of Literature

Many researchers including Aschauer (1987 and 1989), Looney (1997), Asante (2000) and Prud'homme (2005) have concluded that public infrastructure is an efficient input for output growth. Others (Mankiw et al., 1992; Benhabib and Spiegel, 1994 and Dutt and Ravaillon, 1998) have included human capital as a productive input too. Where the importance and contribution of private investment towards economic growth needs no introduction in economic literature (Long and Summers, 1991; Nelson and Phelps, 1996 and Alfaro et al., 2006). This study aims to explore the complex relationship that how public capital (infrastructure) assists the private sector to grow and flourish.

Reinikka and Sevensson (1999) has examined the relationship of public infrastructure services provision and private investment for the economy of Uganda. They have found that the poor infrastructure services leads to lower productivity in private sector. Further, inappropriate public services also tend to increase the cost of private investment. They have called the basic public infrastructure services (roads, railways, telephones, sanitation and power) 'complimentary capital' as a necessity for higher returns of private investment in developing countries.

The discussion of public investment vs private investment often comes up with crowding in or crowding out effect. In former case, private investment is boosted as a result of raised government expenditure by encouraging demand for goods. As the demand for a good is high, private spending rises. Later is opposite. Crowding out causes the private spending to fall as a result of increased government spending. Aschauer (1988) has analyzed the enigma of crowding in and crowding out in case of public capital stock. The results suggested that increased public capital drives down the private investment. Besides, public capital raises the rate of return of private investment leads to private capital formation. The net effect of these forces is positive on private investment.

Erenburg (1993) conducted an analysis to check the effects of public capital on private investment. The main concern of the study is that whether public capital drives down or drives up the private investment by improved supply of public infrastructure services. Also, this study investigates the consequences of previous government investment along with the government deficit expenditures on private sector investment behavior. This has been done by taking into account the method of maximum likelihood. The results reveals a positive and statistically significant relationship between public capital and private investment behavior. The results further showed that government deficit expenditures are statically

insignificant and have no impact on private investment spending.

Sakr (1993) seeks for the determinants of investment in private sector for the economy of Pakistan with particular stress on public investment. Public investment is divided into expenditures on infrastructural investment and expenditures on non-infrastructural investment. The results of the study indicates that private investment is significantly and positively affected by GDP growth and infrastructural investment. However, the effect of non-infrastructural investment is found negative on private investment.

Looney (1997) has conducted an analysis of public physical infrastructure provision on private investment for economy of Pakistan. The study focuses to explore the existence of long run equilibrium between infrastructure facilities, private investment and GDP growth. The findings of this study suggest that at first it appears improved infrastructure has not contributed much towards the growth of Pakistan's economy. But at the same time, infrastructure services has supported the private investment to grow faster by accomplishing the needs of private sector at one hand, on the other hand, infrastructure has taken out the economy from sever bottlenecks. The study concludes that overall impact of public physical infrastructure on private investment is positive in case of Pakistan's economy.

Delgado and Alvarez (2001) have analyzed the effects of public infrastructure services on private investment in 17 different regions of Spain. They have used multiple indicators for infrastructure by using each indicator as a regressor. Also, they have investigated the process that how infrastructure services act as an input in production process. They have used a modified production function with the data set from 1980 to 1995. The empirical results supported the view that provision of public infrastructure is positively affecting private investment.

Everhart and Sumlinski (2001) has analyzed the public private investment nexus. Their study has focused the key issues like the quality of public investment, corruption in public investment and the impact of both on investment by private sector. The study has confirmed the long run relationship between public capital and private investment. Further, it concludes that corruption in public sector investments reduces the quality of public capital and this poor quality causes the returns of private sector to fall. That is, provision of lower quality public capital leads to reduction in private investment.

Erden and Holcombe (2005) have used a panel of developing countries from 1980-97 to check whether public infrastructure spending crowds in or crowds out private investment. The study also investigates the credit facilities to private sector by banks the empirical results of the study states that on average, ten percent increase in public infrastructure spending leads to two percent increase in private investment in developing economies. The study also checked the same for developed economies and finds that public spendings on infrastructure crowds out the private investment in developed economies and supports private sector in developing economies.

Dash (2016) has investigated for the relationship of public infrastructure and private investment for Indian economy. The data has been used from 1970 to 2013 and ARDL procedures have been adopted. The empirical result finds that public infrastructure investment which is measured by length of roads is negatively related to private investment in the long run. Whereas, in the short run, the effects of public infrastructure on private investment are positive.

The critical analysis of existing literature shows that impact of infrastructure provision on private investment is not much explored in case of Pakistan. The present study focuses to resolve the enigma of whether public investment through infrastructure supports private investment in Pakistan or not. Some studies are there which are using either a single indicator as a summary measure of all infrastructure services. Others are measuring the infrastructure by the extent of public expenditures in an economy. In both cases, the conclusions can be deceptive. For instance, in an economy, there can be an excellent

transportation infrastructure but inefficient energy sector or considering how many dollars has been spent on infrastructure development instead of considering how many bridges, kilometers of roads or power houses has been constructed. The present study focuses to resolve these issues by developing a composite infrastructure indicator, index of public physical infrastructure. This has been done by incorporating different indicators of public infrastructure which are measured by different variables. These variables are then combined through PCA.

3. Model Specification and Empirical Analysis

There are numerous factors that are affecting private investment in Pakistan's economy. Based on previous studies (Greene and Villanueva, 1991 and Sakr, 1993), we have constructed our model as follows:

$$GFCFpvt = f(Z, DCpvt, ELF, GDP, INF)$$

Where GFCFpvt is real gross fixed capital formation in private sector as proxy of private investment. Z is indicator of index of public physical infrastructure. DCpvt is domestic credit extended to private sector by banks as percentage of GDP measures the financing constraints in private sector. GDP is per capita GDP represents the accelerator component determining private investment. INF is inflation rate as a measure of investment environment in the economy (Beaudry et al., 2001). Time series annual data from 1972 to 2015 has been used for the empirical analysis. Data has been collected from various issues of Pakistan Economic Survey and World Development Indicators (WDI) (2016).

3.1 Principal Component Analysis (PCA)

Principal Component Analysis (PCA) is a suitable method while dealing with multivariate procedures. The common name for PCA is data reduction method. In a certain study, if for instance, ten or more variables indicate an economic measure, then there are more chances of correlation among these variables. In such a case, PCA helps us by providing us uncorrelated principal components from these multiple variables which are supposed to be correlated before.

A composite indicator of public physical infrastructure Z has been constructed. It is based on multiple indicators of infrastructure like transportation measured by length of roads (RDS), communication measured by number of post offices (POST) and number of telephone lines (TELE) and energy by oil (OIL) and electricity consumption (ELC). The correlation matrix shows that above mentioned indictors of infrastructure are highly correlated as reported in Table-2.

Table-2: Correlations Matrix of Infrastructure Indicators

Indicators	RDS	POST	TELE	OIL	EC
RDS	1.000000				
POST	0.714858	1.000000			
TELE	0.933784	0.532187	1.000000		
OIL	0.977749	0.734198	0.875796	1.000000	
ELC	0.956529	0.612493	0.924769	0.922103	1.000000

Since, the infrastructure indicators are highly correlated, to overcome the problem of multi-collinearity and to reduce the number of explanatory variables we have employed Principal Component Analysis (PCA). Because correlation matrix instead of the covariance matrix is utilized in the PCA (Chatfield and Collins, 1980), therefore, Eigenvalues and Eigenvectors are reported in Table-3. Eigenvalues and Eigenvectors are computed by using ordinary correlations.

Table-3: Eigenvalues and Eigenvectors of Infrastructure Indicators

Principle Component	Eigenvalue Values	Proportion	Cumulative Proportion
1	4.306485	0.8613	0.8613
2	0.539357	0.1079	0.9692
3	0.084947	0.0170	0.9862
4	0.060253	0.0121	0.9982
5	0.008956	0.0018	1.0000

Eigenvectors (loadings)					
Variable	**PC 1**	**PC 2**	**PC 3**	**PC 4**	**PC 5**
RDS	0.478823	-0.074036	-0.127200	-0.176840	-0.847227
POST	0.365943	0.878041	0.282386	0.105199	0.065735
TELE	0.448274	-0.400624	0.711440	-0.274514	0.238843
OIL	0.470688	0.020392	-0.610136	-0.450902	0.449954
ELC	0.462944	-0.250293	-0.160207	0.824009	0.135571

The first principal component (PC1) explains the maximum variance (86%) in all the individual indicators (eigenvalue of 4.3). The scree plot of order eigenvalues and eigenvalue difference against principle component are shown in Figure-1 and Figure-2, respectively.

Figure-1: Scree Plot of Order Eigenvalues

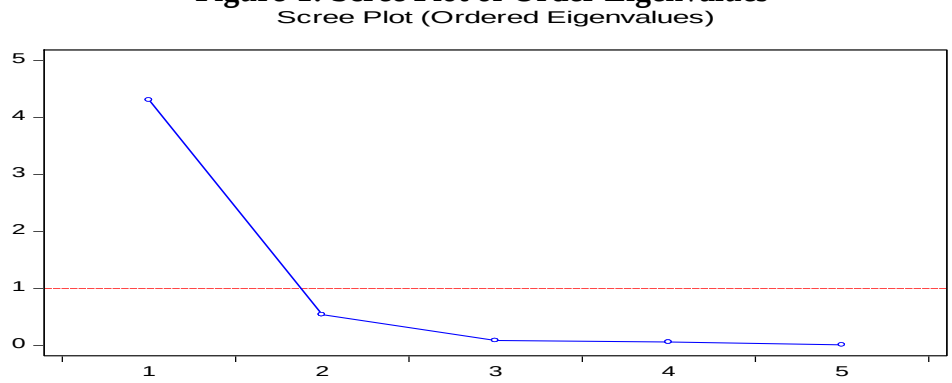
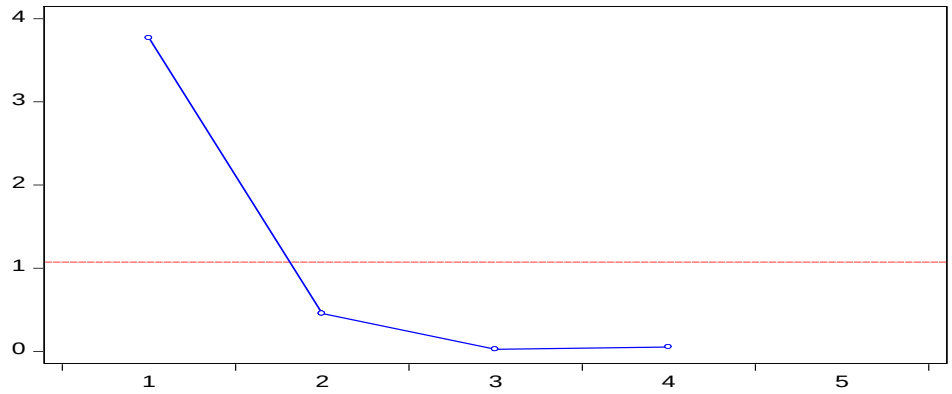


Figure-2: Scree Plot of Eigenvalue Difference



In Figure-1 and Figure-2, scree plots of ordered eigenvalues and eigenvalue difference, against principle component, showed a sharp decline from first principle component (PC1) to second principle component (PC2) which indicates the suitable use of PCA for constructing a composite indicator. Then data of infrastructure indicators is normalized by subtracting the minimum value and dividing by the range of the indicator values. These normalized values are weighted by multiplying with their respective PC1 and finally aggregated into single composite index of public physical infrastructure (Z_t).

3.2 Long Run and Short Run Analysis

The problem of non-stationarity or unit root exists in time series data. If series are non-stationary then regression would be spurious. To avoid this, we have conducted the test for unit root by employing ADF test. The results are reported in Table-4.

The results reported in Table-4 shows that all variables are non-stationary at level. However, these variables are stationary at first difference. As the level of integration is same we can apply Johansen co-integration to determine the existence of long run relationship. But before moving towards long run relationship, it is important to determine the optimal lag length first. The results of multiple lag selection criteria have been presented in Table-5.

Table-4: Test for Unit Root (ADF Test Statistics)

At Level				
Variables	**Without Trend**	**Prob. Values**	**Trend and Intercept**	**Prob. Values**
$lnGFCFpvt_t$	**-1.002488**	**0.7438**	**-2.252656**	**0.4494**
lnZ_t	**-2.157297**	**0.2248**	**-2.034355**	**0.5623**
$lnELF_t$	**-0.641123**	**0.8502**	**-1.899698**	**0.6370**
$DCpvt_t$	**-2.410525**	**0.1452**	**-2.367530**	**0.3902**
$PCGDPG_t$	**-2.544670**	**0.1134**	**-2.855709**	**0.1876**
INF_t	**-2.180714**	**0.2163**	**-2.145264**	**0.5047**
First Difference				
Variables	**Without Trend**	**Prob. Values**	**Trend and Intercept**	**Prob. Values**
$\Delta lnGFCFpvt_t$	**-6.789297* ****	**0.0000**	**-6.777345* ****	**0.0000**
ΔlnZ_t	**-4.690897* ****	**0.0006**	**-4.203823***	**0.0108**
$\Delta lnELF_t$	**-5.973156* ****	**0.0000**	**-5.911166* ****	**0.0001**
$\Delta DCpvt_t$	**-4.903509* ****	**0.0003**	**-4.891361* ****	**0.0016**
$\Delta PCGDPG_t$	**-4.191647* ****	**0.0022**	**-4.776524* ****	**0.0023**
ΔINF_t	**-5.216983* ****	**0.0001**	**-5.338049* ****	**0.0005**
Note: * denotes 1% significance level and ** stands for 5% significance level				

Table-5: Criteria for VAR Lag Order

Lag	Log L	SC	AIC	HQ
0	**-309.0096**	**16.00381**	**15.75048**	**15.84208**
1	**-109.0830**	**9.327475***	**7.554152***	**8.195329***
2	**-75.21728**	**10.95418**	**7.660864**	**8.851623**

* indicates lag order selected by the criterion, SC: Schwarz information criterion, AIC: Akaike information criterion, HQ: Hannan-Quinn information criterion

According to the results reported in Table-5, optimal lag length by different criterion is 1. After determining the lag length, we can go for the co-integration to determine the long run relationship among the variables. The results of Trace Statistics and Maximum Eigen Statistics have been reported in Table-6 and Table-7 respectively.

Table-6: Unrestricted Co-integration Rank Test (Trace)

H_0	H_1	Trace Statistics	Critical Value At 5% level	Probability **
r = 0*	r ≥ 1	140.8386	95.75366	0.0000
r ≤ 1*	r ≥ 2	80.40633	69.81889	0.0056
r ≤ 2	r ≥ 3	45.07757	47.85613	0.0891
r ≤ 3	r ≥ 4	21.48529	29.79707	0.3281
r ≤ 4	r ≥ 5	11.06753	15.49471	0.2074

* denotes rejection of the hypothesis at the 0.05 level. ****** p-values.

Table-7: Unrestricted Co-integration Rank Test (Maximum Eigen Value)

H_0	H_1	Max-Eigen Statistics	Critical Value At 5% level	Probability **
r = 0*	r ≥ 1	60.43224	40.07757	0.0001
r ≤ 1*	r ≥ 2	35.32877	33.87687	0.0333
r ≤ 2	r ≥ 3	23.59227	27.58434	0.1496
r ≤ 3	r ≥ 4	10.41776	21.13162	0.7048
r ≤ 4	r ≥ 5	9.533331	14.26460	0.2444

* rejection of the hypothesis at the 5% level. ****** p-values.

A close insight of the Table-6 and Table-7 has disclosed that there are two co-integrating vectors in each of them or there is co-integration among the variables. In other words, existence of long run relationship between public physical infrastructure and private investment is confirmed. This long run relationship is further supported by the normalized values presented in Table-8.

Table-8: Normalized Co-integrating Coefficients

Variables	Coefficients	t-statistics
Dependent Variable: LRGFCF		
LZ	0.766695 (0.05548)	-12.8
LELF	1.211244 (0.16748)	-7.06
DCpvt	0.037356 (0.01078)	-3.36
PCGDPG	0.048796 (0.01870)	-2.47
INF	0.046723 (0.00668)	-6.7

*(standard error in parentheses)

The results reported in Table-8 shows that all variables bare positive sign including index of public

physical infrastructure (Z). Also, all variables are significantly affecting the private investment. One percent increase in public physical infrastructure services (represented by physical infrastructure index Z) leads to 0.76 percent increase in private investment.

Since the co-integration among our concerned variables has been confirmed we would now check for the short run relationship. For short run analysis, we have employed VECM. According to (Egert et al., 2009), the short-run ECT must be significant and negative to assure the long run relationship as well as equilibrium reversion. Results for short run have been accounted in Table-9.

Table-9: Short-Run Relationships

Variable	Coefficient	t-statistic
DLZT	**0.043371**	**0.486664**
DLELF	**1.701340**	**2.074893**
DDCpvt	**0.028742**	**2.629858**
DPCGDPG	**0.005405**	**0.535713**
DINFLATION	**0.007136**	**1.209261**
ECT(-1)	**-0.516409**	**-3.623510**
R^2	**0.495138**	
F-Statistic	**5.557531**	
Durbin-Watson	**1.822886**	

The short run analysis shows that except work force and credit to private sector, all variables are statistically insignificant. As reported in Table-7, a negative as well as statistically significant ECT term supports the view that there is a long run relationship between Z and private investment. Where its coefficient shows the speed of convergence towards equilibrium. The speed of convergence is significantly high. Our results have confirmed that public physical infrastructure certainly improves the conditions for private investment in Pakistan economy. Some important diagnostic tests have been applied and results are reported in the Table-10.

Table-10: Diagnostic Tests (Short-Run Model)

Diagnostic Tests	F-statistics	Probability
Breush-Godfrey LM Test For Serial Correlation	**0.727974**	**0.3997**
ARCH Test ForAutoregressive Heteroskedasticity	**0.191982**	**0.6638**
Ramsey RESET Test For Model Specification	**0.407733**	**0.5275**

The results reported in Table-10 shows that our model is free from the problem of serial correlation. Also, there is no issue of heteroscedasticity. The Ramsey RESET test statistics shows that our model is correctly specified.

4. Conclusion and Policy Implications

The empirical results of the present study suggest that public physical infrastructure and private investment are highly correlated. Increased level of public infrastructure would enhance the level of private investment in Pakistan. Differing from other studies, the present study has constructed an index of public physical infrastructure by using multiple indicators (transportation, telecommunication and energy) combined through PCA. Private investment is measured by real gross fixed capital formation in private sector. After checking for stationarity, we have incorporated co-integration and ECM for long run and short run dynamics respectively. The existence of long run relationship has been confirmed through co-integration as well as through negative and significant ECM term.

The provision of basic physical infrastructure in Pakistan remained low in past 20 years. According to World Bank (2013), there is undersupply of infrastructure availability in Pakistan. In order to bridge the gap, Pakistan needs to spend 5.5 percent of GDP on electricity generation, 0.71 percent of GDP on telecommunication and 1.23 percent of GDP on transportation every year. On the other hand, private investment is not that much high in Pakistan. According to the White (2005), for sustainable development, the level of private investment should be 25 percent of GDP in developed economies and in transitional economies, it should not be less than 20 percent of GDP. Where according to Pakistan Economic Survey (2014-15), private investment in Pakistan is only 9.66 percent of GDP. That is, less than half of required level. By investing in productive physical capital, the level of private investment can be raised along with higher growth rates. In this regard, regional discrimination and political interest must be avoided for collective benefit of economy.

Both infrastructure and private investment are important drivers of growth and their sound interaction would lead to a prosperous economy. Further, the extension of credit to private sector is also positively and significantly affecting private investment. That is, besides improving investment environment by provision of necessary infrastructure, the access and availability of credit to private sector must also be improved. Other determinants of private investment like business confidence, sustained interest rate, law and order, short and long term credit availability, governance and political stability are also important to attract the private investment.

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