Impact of Public Infrastructure Investment on Private Infrastructure Investment

Faisal Nadeem Shah [a], Zainab Fatima [b], Bilal Bashir [c]

[a] Department of Economics, University of Sargodha, Pakistan
  Email: faysalshah87@gmail.com
[b] Department of Economics, National University of Modern Languages, Islamabad, Pakistan
[c] Department of Economics, Govt. Graduate College of Commerce, Sargodha, Pakistan

ARTICLE DETAILS	ABSTRACT
History: *Accepted 25 August 2021* *Available Online September 2021*	*The aim of this paper is to find the relationship among government and private capital formation in Pakistan during the period 1981 to 2018. This study employs Auto Regressive Distributive Lag (ARDL) bound test. The results show that government infrastructure investment negatively effects on private infrastructure capital formation in long run and short run, indicating that government infrastructure investment crowds out private infrastructure investment. In determining the role of the government in investment and liberalization policies, the results of this paper have important policy implications.*
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Corresponding author's email address: faysalshah87@gmail.com

1. Introduction

Investment is essential for a country's economic growth since it enhances productivity, increases employment, and encourages technological progress through the incorporation of new techniques. It is also vital for regulating an economy's long-run productivity since capital creation generates capital products; therefore a faster rate of capital formation implies that the capital stock expands instantly. Private infrastructure investment is also among most significant and necessary factor for economic growth. It is widely believed that government infrastructure investment has a positive effect on private infrastructure investment. If in this situation, by encouraging private investment cannot only directly, increase economic growth. Public infrastructure investment can be a necessary requirement for aggregation in private sector. Also, government infrastructure investment in many other government goods which is beneficial for society but for private motivation are absent may improve human investment in which private sector may lead to economic growth.

Many reports, however, indicate that public infrastructure investment is crowding out private infrastructure investment, which would edge a wide range of public policy investment outcomes. The effect on the economic article of government infrastructure investment on private infrastructure investment was a matter of great interest. While policy-makers allow that investment has a significant impact on financial development, the equilibrium in division among government and private infrastructure investment is undecided matter.

Public infrastructure investment can affect private investment in two ways. First, it is necessary to investment the raise in government investment, which applies additional taxes for capital in the capital market from government, resulting in higher interest rate. This would decrease the group of savings accessible for private investors and lower the projected rate of return on private capitals; As a result, private infrastructure investment has a crowding out effect. Secondly, government infrastructure investment can create further good conditions for private infrastructure investment, e.g. By supplying or supporting related transportation as bridges and airports. The presence of infrastructure facilities could make private investment more competitive, which can then benefit from better overall services and better market conditions. This would lead to a crowding in private infrastructure investment.

Investment impacts on financial development are of dual. Firstly, investment goods demand is part of total economic demand. Thus, an increase in investment demand, this demand is not contended by imports, encourage investment goods generation, which in turn contributes to high financial development. Secondly, private investment promotes the productivity of the economy in a way that the economy is able to produce more yields.

Increase in private infrastructure investment increase GDP and raises the tax revenues that is used for public investment. In developing countries, government infrastructure investment crowding - out- effect on private infrastructure investment. In United States, Aschauer (1989) reported that when Increase of marginal capital productivity compared to increase of private capitals public capital crowds. Economic theory indicates that public infrastructure investment financed by financing, decreases the loan-able funds accessible for investment, elaborate interest rates, and reducing the level of investment. If, as Keynesians declare, the positive effect of increased public infrastructure investment cancel out the negative impact of diminish investment then financial development will increase.

Public investment gives private investment more favourable conditions. Public investment provides better infrastructure. "The availability of common public goods and existence of services can raise the output of private investment, which force get improvement of better employment conditions. E.g. public investment in telecommunication, energy may have energized private investment" (Pereira & Andraz 2013). Aschauer (1989) accentuate the possibility that government investment may about private investment. Similarly, king and Baxter (1993) argue that private investment and output is stimulated by public investment. The effects are heterogeneous over countries (Afonso & Aubyn, 2009). Aschauer (1989) claims that ''the positive influence of public investment towards private investment can be explained by the public capital hypothesis"p.199). Increased public investment results in increased private investment, according to this hypothesis.

When government investment increases, private investment is expected to grow by raising the marginal product of capital (Cavallo & Daude, 2011). Government infrastructure investment, on the other hand, crowds out private infrastructure investment by lowering the availability of savings to the private sector or increasing the cost of money. The goal of this research is to determine the link

between government and private investment.

2. Literature Review

Economist and researchers have been paid more attention on the effect of government investment on private investment; Due to previous results that showed contentious perspective, some of them evaluates public investment has a positive effect on private investment.

By utilizing a VAR model to study Pakistan's agricultural sector and economy, Saeed, Hyder and Ali (2006) found that the unstructured VAR model employing the specification of the production function was estimated to be more accurate. Increased governmental investment in the agriculture sector supports private investment. Consequently, we might conclude that the agricultural sector has become overcrowded.

Dreger and Reimers (2015) investigated the relation among government and private investment for Euro areas during the time period 1991-2012. The authors apply ECM which concludes the long-term correlation among government and private investment in Euro area. Private and government investment is co-integrated. Karadag, Deliktas and Onder (2003) observed the effects on manufacturing industries in seven regions of the public investment in Turkey during the time period 1980-2000 by using the methodology of VAR model, which shows the result that the government infrastructure investment has a positive effect on private production in the manufacturing sector at national level.

Cruz and Texixeira (1999) carried out the ECM model to assess the behaviour of private investment as the function of the aggregate products of the interest rate and of government investment for the Brazilian economy, which indicates that the coefficient of government investment has a negative impact on private investment when the (error correction model) is used to at least for the time period 1947-1990. Javid (2019) found to measure the part of aggregate ,government and private infrastructure investment on aggregate and subsector of the economy of Pakistan during the time period 1972-2015 by using the methodology of VAR model, which give the feedback that both government and private infrastructure investment has a remarkable but separate impacts on economic development.

Xu and Yan (2019) study the relationship among government investment and private investment in china by using the methodology of VAR model and ADF test ,which suggests that public expenditure in public goods and infrastructure extensively crowds ''in'' private expenditure. Mitra (2014) study the relationship among government expenditure and private expenditure in India by using the methodology of VAR model, which suggests that result is persistent with the idea that public expenditure may supplement private investment in the average and long term. The result of the different model also supports crowding out.

Naqvi (2002) founds the relationship among economic development, government investment, and private investment in the existence of unit roots in Pakistan during the time period 1964-2002 by using the methodology of VAR model, this analysis indicates that public investment has a remarkable impact on private expenditure. Bahal (2018) suggested the relationship among government and private investment in India along the following features over the time period 1996-2015 by using the methodology of (SVECMs) model, this analysis indicates that government investment crowds out private investment in India cross the period 1950 to 2012.

Martuez, Ramajo and Hewings (2011) explored the effect of government investment on regional development using the variables of time-series frameworks based on (VAR) models in spin. This

analysis finds the domestic effects of alterations in public investment using a (S-VAR) methodology for the Spin. Khan and Reinhart (1990) found the developing help for market-adjust strategies, and for a significant role of investment, development models for developing countries commonly make no difference among the private and government integral of investment, using VAR model.

Epaphra and Massawe (2012) examined the effect among domestic private investment, public investment, and financial development in Tanzania over the time period of 1970-2014, by using the method of B-G serial correlation LM test. Makuyana (2016) found the effect of public expenditure and private infrastructure investment on financial development in developing economies, by using the methodology of VAR model. This study examines help for the private infrastructure investment growth to make for developing countries.

Aubyn and Iseg (2017) explored the effects of investment in government and private partnerships, government and private infrastructure investment in Portugal through a VAR model using variables: government and private investment and Gross domestic product, from the period 1998 to 2013. The result finds that government and private expenditure has a remarkable impact on GDP. Jongwanich and Kohpaiboon (2008) found sample and motivations of investment in an effort to realize why levels of investment in South Asia have not fully recapture, and use Thailand as a study. Investment is finds over the time period 1960 to 2005.The results show that it was capital scarcity rather than making extra volume hold up recovery of short run investment.

Chotia and Rao (2017) explored the factors effecting economic development and construct of government infrastructure investment and private investment and use the panel data of Brazil, Russia, India and china over the time period of 1990 to 2014.These results indicates that the private investment plays a significant role in financial development. Omitogun (2018) examined the crowding out effect of public expenditures on investment in Nigeria and use the annual data cross from 1981 to 2015 by using methodology of ARDL. The results find that the effect of public expenditures on investment depends upon the section of expenditures.

Olaifa and Benjamin (2014) examined the relationship among public investment and private investment in Nigeria and use the time series data cross from 1981 to 2016. Public investment was separated into different section and ADF unit root test was implementing to establish the stationary effects of the variables.

Saidjada and Jahan (2016) found the relationship among government and private infrastructure investment in Bangladesh for the period 1981-2015 and investigates how the liberalization of the financial sector affected the relationship between two given variable by using the methodology of ARDL bound test. The results show that government infrastructure investment negatively affects on capital formation both in short run and long run, suggesting that public infrastructure investment crowds out private infrastructure investment. Ouedraogo, Sawadogo and Sawadogo (2019) explored the crowding-out or crowding-in effect of government investment on private infrastructure investment in Africa. Use the large sample 44 African countries cross the period 1960 to 2015.the result finds that on average government infrastructure investment crowds in private infrastructure investment in Africa.

3. Data and Methodology
The present study collected the data of private infrastructure investment, public infrastructure investment and investment in energy sector from the handbook of statistic, state bank of Pakistan while data on gdp growth is collected from world development indicator (WDI).

3.1 Details of variables

This study uses annual data of Pakistan on variables like private infrastructure investment (piib), public infrastructure investment (piia), gross domestic product (gdpga) and investment in energy sector (ies) for the period 1981-2015. This study uses the ARDL methodology to finds the effect of public infrastructure expenditure on private infrastructure investment.

3.2 Econometric Model

To evaluate the correlation among government infrastructure investment and private infrastructure investment, I will use mathematical and econometric form of model is as follows;

$Lnpiib = \beta_\circ + \beta_1 lnpiia + \beta_2 gdpga + \beta_3 lnies + e$
Lnpiib=log private infrastructure investment

Independent variables,
Lnpiia=log public infrastructure investment
Gdpga= gdp growth (annual %)
Lnies=investment in energy sector

Where lnpiib, lnpiia, gdpga and lnies represents private infrastructure investment, public infrastructure investment, gross domestic product and investment in energy sector. Parameters β_1, β_2 and β_3 are the long run elasticises of lnpiib with respect to public infrastructure investment, gross domestic product and investment in energy sector respectively.

Consider above advantages of ARDL approach to co-integration, we specify the following model:

$$\Delta \ln(piib_t) =$$
$$\beta_\circ \sum_{i=1}^{q} \beta_1 i \Delta \ln(piib_t^-i) + \sum_{i=0}^{q} \beta_2 i \Delta \ln(piia_{t-i}) + \sum_{i=0}^{q} \beta_3 i \Delta \ln(gdpga_{t-i}) + \sum_{i=0}^{q} \beta_4 i \Delta \ln(ies_{t-i}) + \beta_5 \ln(piib_{t-1}) + \beta_6 \ln(piia_{t-1}) + \beta_7 \ln(gdpga_{t-1}) + \beta_8 \ln(ies_{t-1}) + u_t$$

Where Δ is the first difference operator, q is optimal lag length, β_1, β_2, β_3 and β_4 represents short-run dynamics of the model and β_5, β_6, β_7 and β_8 are long-run elasticities. Before running the ARDL model we tested the level of integration of all variables. An error correction version of above equation is given as below:

$$\Delta \ln(piib_t) = \beta_\circ \sum_{i=1}^{q1} \beta_1 i \Delta \ln(piib_t^{-i}) + \sum_{i=0}^{q2} \beta_2 i \Delta \ln(piia_t^-i) + \sum_{i=0}^{q3} \beta_3 i \Delta \ln(gdpga_t^-i) + \sum_{i=0}^{q4} \beta_4 i \Delta \ln(ies_t^-i) + \lambda EC_t^{-1} + \varepsilon_t$$

Where q_1, q_2, q_3 and q_4 represent optimal lag length, λ is the speed of adjustment parameter and EC represents the error correction time derived from long- run relationship.

4. Empirical Findings

Unit root tests are performed on all the series before utilizing an auto regressive distributed lagged model. At the first difference and at the level, ADF's results are shown in Table 3.1 While GDPGA are stationary at 1 percent significant level according to the Augmented Dickey Fuller test, the results of testing show that ln (IES), ln (PIIB), and ln (PIIA) are stationary at the first difference. It's possible to apply the ARDL model for cointegration in this instance.

Table 1 Unit Root test

VARIABLES	AUGMENTED DICKEY FULLER TEST (ADF) 1(0)	ADF 1(1)	PHILIPS PERRON (PP) 1(0)	PP 1(1)
LNPIIB$_t$	-0.684	-7.029	-0.631	-7.029
LNPIIA$_t$	-1.239*	-5.634	-1.045*	-9.655
GDPG$_t$	-3.542	-7.525	-3.510	-12.848
LNIES$_t$	-1.603*	-5.287	-1.492*	-8.899

Note. * shows the significance level at 1%

Table 1 represents the unit root test of all variables. This table consists of ADF and pp. Autoregressive distributed lag (ARDL) approach to co integration avoids some limitations. It is not necessary to apply ARDL model that all the variables are stationary are at same level or at difference. It can be applying when some variables are at 1st difference while some are at level. This method has receiving more advantages to other methods due to various econometric advantages. Before applying this method, we must test the integration of all variables. To check the stationary of all variables we conduct ADF and PP. In order to check long run relation among all variables we conducted bound test using F-statistics with two bounds which are lower and upper bounds. I f value of F- statistics is less than lower bound than null hypothesis is accepted and if value of F-statistics is larger than upper bound than null hypothesis is discarded and if it is lies between two bounds then there is no decision area. After all these techniques we used optimal lag length criteria to select the optimal lag length of variables for selecting the optimal lag we used Schwarz Info Criterion (SC).

The descriptive statistics are used to calculate the variability of the data and to calculate the distribution of the data collection. This made the normality of the variables used in the analysis simpler and also helped recognise the variables that had to be translated in to the natural log.

Table 2 Descriptive Statistics

	LNPIIB	LNPIIB	GDPGA	LNIES
Mean	9.897	10.267	4.707	9.856
Medium	9.540	10.080	4.832	9.761
Maximum	12.455	11.832	7.920	11.188
Minimum	7.446	8.494	1.014	8.124
Std. Dev.	1.781	1.143	1.973	1.061
Sum	346.428	359.375	164.745	344.969
Observations	35	35	35	35

Table 3 lag selection

Lag	Log L	LR	FPE	AIC	AC	HQ
0	-149.759	NA	0.130*	9.318	9.500	9.379
1	-71.204	133.304	0.002	5.527*	6.434*	5.832*
2	-62.120	13.213	0.004	5.946	7.579	6.496

Table 3 shows the lag length criterion in which we use different criteria. According sequential modified criteria lag length at order 1. According to final prediction error criteria lag length at 1. According to Akaike information criterion lag length at order 1. According to Schwarz information criterion lag length at order 1. At the end Hannan-Quinn information criterion lag length at 1. Now

author apply the bound test to check that ARDL applied or not.

Table 4 bound test

Order of lag	F-statistics
2	6.486

The upper bound value is the 3.77 while lower bound value is the 2.72. It is clear from Table 4 that there is no evidence to support the null hypothesis of no long-term association between the variables studied. As a result, we discover that the variables exhibit long-term correlation. The calculated F-statistics are included in Table 4 to help with the model's lag length selection. The ideal lag length of the variables included in the ARDL was determined using the Schwarz Information Criterion (SC).

Table 5 shows that LNPIIA is the most important element of private infrastructure investment. The impact of LNPIIA on LNPIIB is significant at 1% level of significance. At one % level of significance the impact of LNPIIA on LNPIIB as expected is negative. The coefficient (-1.012637) of LNPIIA indicates that 1% rise in public infrastructure expenditure deteriorates the private infrastructure investment by 1.012637 % in the long run.

Table 5 ARDL Long Run Results

variable	Coefficient	Std. error	t-statistics	Prob.
LNPIIA	-1.012	0.529	-1.913	0.076
GDPGA	0.578	0.134	4.289	0.000
LNIEC	3.465	0.703	4.928	0.000
C	16.562	2.306	-7.181	0.000

Table 6 ARDL Error Correction Model

Variables	Coefficient	Standard error	t.ratio	Prob*
CONSTANT	-9.080	1.997	-4.545	0.000*
LNPIIB	0.286	0.153	3.453	0.003
LNPIIA	0.369	0.113	3.265	0.017*
GDPGA	0.136	0.029	4.652	0.012*
LNIES	0.173	0.218	5.754	0.000*
Coint(-1)	-0.548	0.112	-4.888	0.000

R-Squared=0.99, Adjusted R-squared=0.98, F-statistic=181.48, Prob(F-statistics) =0.000000
Durbin-Watson stat=2.090620
Note* shows the significance level at 5%.

Table 6 shows the results of the selected ARDL approach. Coefficients of the variables show the short run elasticity. Results represent that in the short run LNPIIA once again is the most significant factor (with largest t-ratio) of private infrastructure investment. However, the variable LNPIIA affect the private infrastructure investment added at 1% significant level. The 0.36 value of coefficient of LNPIIA reveals that ten % rise in PIIA take about 3.6 % additions in private infrastructure capital formation added in the short run.

4.1 Stability Testing

The CUSUM test Brown, Durbin and Evan (1975) is based on the cumulative sum of the recursive residuals. This opinion plots the cumulative sum together with 5% critical lines. If the total sum goes beyond the region between the two critical lines, the test considers parameter instability. It was calculated by using this stability variable.
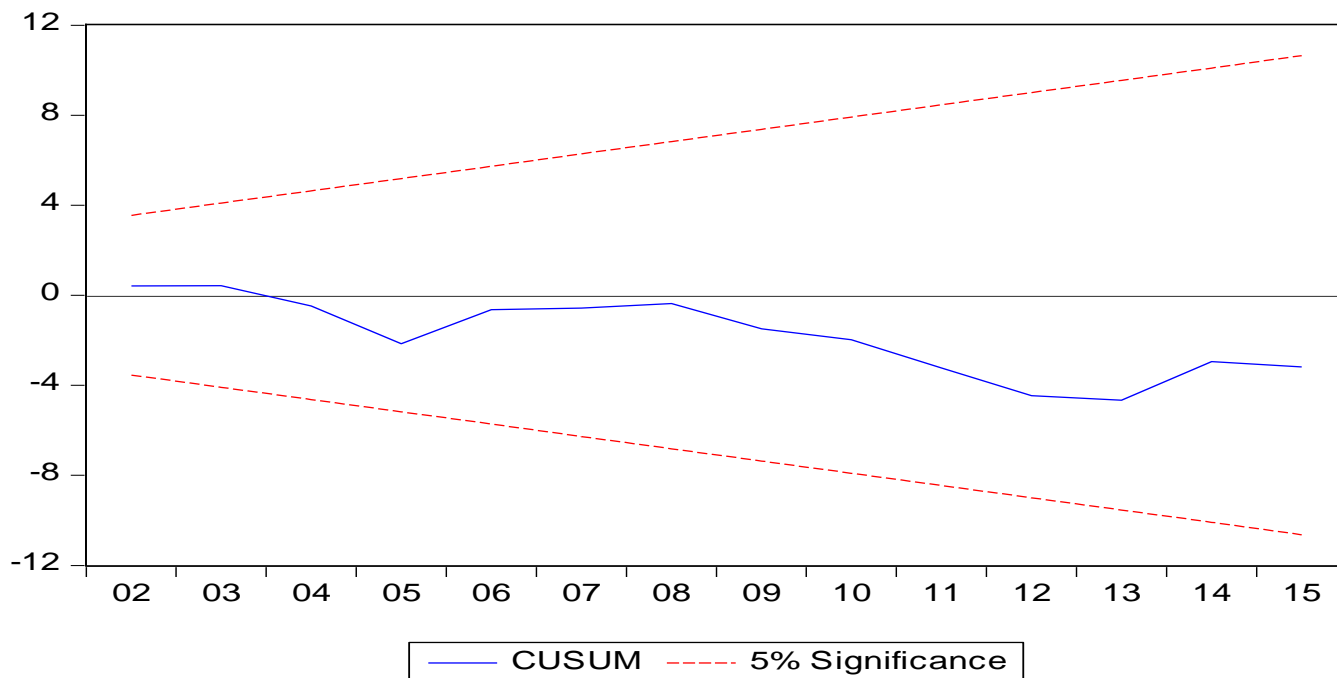

FIGURE: 4. 1 CUSUM

The graph for CUSUM is shown in figure (4.1). We use this technique to verify the stability of our ARDL model, which is based on an error correction model. Brown et.al (1975) presented this strategy. If the blue lines remain inside the critical bound, then our ARDL is stable.
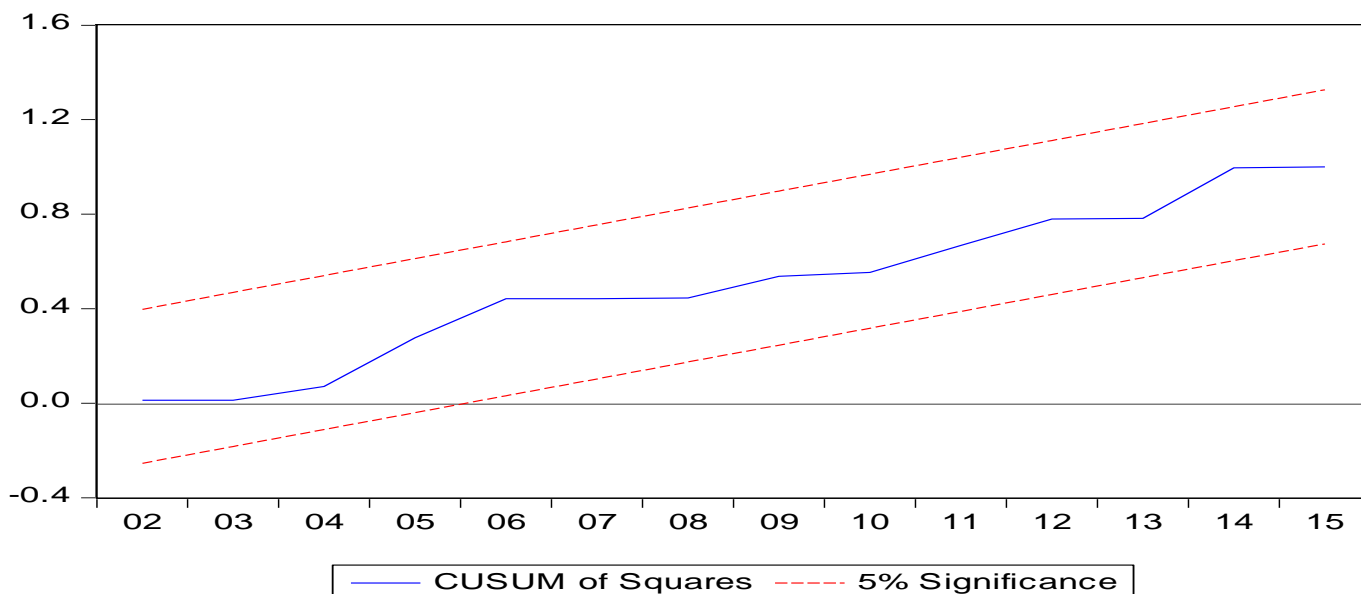

FIGURE: 4.2 CUSUM SQUARE

The above graph clearly shows that the variable has a maximum degree of stability level. At the blue line including the degrees of stability between red lines that exist. The 5% significance level is shown by the red lines.

5. Conclusions

This paper aimed to explore the causal factor of private infrastructure investment in Pakistan cross the period 1981-2015. We considered three variables (public infrastructure investment, gross domestic product, investment in energy sector) as the determinants of private infrastructure investment. Our results show that public infrastructure investment negatively effects on private infrastructure capital formation both in long run and short run, indicating that government infrastructure investment crowds out private infrastructure expenditure. However, the crowding-out effect is partly eliminated by liberalization that raises private infrastructure investment.

6. Policy Implication

In view of results of the current report, it is strongly recommended that the Government of Pakistan put in place policies that could increase the level of public investment and regulate the level of investment prices. The results of this paper have significant policy implications for determining the government position in investment and liberalization policies.

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