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Public-Private Investment and Economic Growth in Pakistan: An Empirical Analysis

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1. INTRODUCTION

Investment is an important component of aggregate demand and a leading source of economic growth. Change in investment not only affect aggregate demand but also enhance the productive capacity of an economy. A third important role highlighted in the literature refers to the innovation and modernisation of the capital equipment via technological progress. The investment plays an essential and vital role in expanding the productive. Maryam capacity of the economy and promoting long term economic growth [Jongwanich and Kohpaiboon (2008)]. Levine and Renelt (1992) argued that investment in capital goods is the most robust and vital determinant of economic growth. Gross domestic investment boosts economic growth by increasing physical capital directly and indirectly through technological spillovers [De Long and Summers (1995)].

1.1. The Role of Investment in Growth Process

There has been heated debate in policy-making and academic circles regarding the roles of public and private investment in the process of economic growth. In the 1950s and 1960s available economic models seemed to offer only limited insight into the practical problems facing by developing world. The dominant one-sector macro models of the day, from Keynesian to Harrod-Domar [see Harrod (1939) and Domar (1957)] to Solow 1956, seemed to have relatively little relevance for developing societies like Pakistan.

Available literature including recent extensions of the neo-classical growth model as well as the theories of endogenous growth has highlighted the role of investment in economic growth [see, for example, Kormendi and Meguire (1985); Romer (1986); Lucas (1988); Grier and Tullock (1989); Barro (1991); Levine and Renelt (1991); Rebelo (1991); Mankiw, Romer, and Weil (1992); Barro and Lee (1993); Fischer (1993) and Barro and Sala-i-Martin (1999)]. The effect of public investment on economic growth depends on how the increased spending is financed by the government [Bukhari (2006)]. If public and private investments are perfect substitutes, then an increase in public investment would have the same effect on growth as an increase in private investment. Both contribute to the accumulation of physical capital, which increases the productive capacity sustains a higher level of output [Lachler and Aschauer (1964)]. Public

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investment in the infrastructure has to boost up private investment indirectly that in turn increases the marginal productivity of private capital and enhances the growth of GDP [Looney, *et al.* (1997)]. It generates positive spillovers by provision of health, education, basic scientific research and physical infrastructure, and may also "crowd in" the private investments. In contrast, the literature also suggests that public investment negatively effects the private investment via the well-known "crowding out" phenomenon via attracting the domestic scare sources through bond floating [Erden and Holcomble (2005)]. These contrasting views about the impact of public investment on private investment are important, however yet unsettled.

So for as Pakistan is concerned, several studies have been carried out, which concentrate on public and private investment and economic growth. The most important are the studies inter-alia by Khan (1988), Looney and Frederiken (1995), Loony, *et al.* (1997), Khan and Sasaki (2001), Naqvi (2003), Ghani and Din (2006), Khan and Khan (2007), Ahmad and Qayyum (2007) and Majeed and Khan (2008). In some studies the relationship between growth and investment is investigated, while others have attempted to examine the determinants of public and private investment.

Given the vital importance of investment in the process of economic growth, this study endeavours to develop an econometric model to examine the relationship between public and private investment and growth. The present study attempts to follow a comprehensive approach by examining the overall effect of investment on growth, explaining the determinants of public and private investment and evaluating the mutual relationship of the both the components. Thus the rationale is obvious; instead of following a piece meal strategy, it looks more efficient to place all the components in one place and discuss the issue as a whole using different models.

2. REVIEW OF EMPIRICAL LITERATURE

A number of empirical studies are available, which illustrate the relationship between public investment, private investment and economic growth with reference to Pakistan economy. This part presents a brief review of the empirical literature relating to the issue concerned.

Looney and Frederiken (1995) estimated the relationship between public and private investment and concluded that certain types of government investment—especially in rural works 'crowded out' private investment in non-manufacturing activities. Likewise, the public infrastructure investment in energy projects provided the greatest inducement to private investment. Side by side Loony, *et al.* (1997) studied the impact of Government investment on private sector in Pakistan over the period 1972 to 1995 and concluded private sector investment depends on the lagged change in GDP, the change in private sector credit, the lagged value of private investment, government expenditure in the infrastructure and other projects.

Khan and Sasaki (2001) analysed the role of public capital in Pakistan s' economy. The results showed that public labour ratio and public capital had significantly positive effect on output. Public capital productivity contributes largely at the aggregate and sectoral level and so it played an effective role in the production process. According to Naqvi (2003) public investment had a positive impact on private investment, and that economic growth pushes forward both private and public investment. Naqvi (2003)

proved that long run estimates of the elasticities of public and private investment are different under different assumptions made about the evolution of technology. If technology was considered exogenous, the elasticities of private and public capital with respect to output and rate of return were similar to each other.

Same relationship is examined by Ghani and Din (2006) and indicated that public investment had a negative, though insignificant, impact on output. In contrast, there was a positive relationship between private investment and economic growth. Public investment had no favourable impact on private investment; in other words, it 'crowded out' private investment and this result raises some concern about the efficiency of public investment.

Khan (1988) examined the impact of fiscal and monetary policies on private investment in Pakistan. Private investment in aggregate as well as investment in manufacturing and agriculture sector was estimated. The study concluded that market conditions appear to have a strong influence on private investment in general, while changes in output had minor impact. Khan and Khan (2007) investigated the determinants of private investment in Pakistan. The results showed that real GDP had positive but insignificant impact on private investment while public investment had negative but insignificant impact on private investment. According Ahmed and Qayyum (2007) there was long run relationship between private fixed investment, public consumption and development expenditure and market activities. The relationship between public investment and private investment was positive.

3. INVESTMENT AND GROWTH IN PAKISTAN

Pakistan economy has faced many crises since independence in 1947. These crises have hampered the sustainable economic growth. During the 1950's decade, the Korean war boosted our exports and foreign exchange earnings that helped maintaining high economic growth. In 1960's, the continuous inflow of foreign aid and assistance also contributed to high and rapid growth. However, this momentum could not continue during 1970's due civil war, oil price shock and nationalisation policy. But above all, the political instability after 1970-71 has been the major cause of deterioration in Pakistan. High level of defense spending since then is one of the critical factors, which absorbs a significant fraction of scarce revenues and adversely affects public savings otherwise meant for development purpose. The tax revenues in Pakistan could not cope with faster growth in the non-development spending.

Table 1 illustrate the rate of GDP growth and public/ private investment and the total investment as percent of GDP.

Table 1

Average GDP Growth Rate and Ratio of Public/Private Investment to GDP Overtime

Time Period	GDP Growth (%)	Public .Inv. Ig/GDP	Priv.Inv Ip/GDP	Total.Inv Ig+Ip/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
2001-2012	4.70	20.28	10.009	30.28

Source: Pakistan Economic Survey (various issues).

Because of nationalisation policies during the period of 1970's, significant involvement of government in commercial activity and increase in the share of public sector squeezed private investment and adversely affected its growth. At that time, public investment was twice in volume relative to private investment. Domination of state owned/controlled institutions adversely affected the financial sector development in Pakistan. In the decade of 1980's, we notice some revival in private sector activity because of encouragement and incentives provided by the government. However, due to sever political instability during 1990's, the picture of the economy remained gloomy. The growth rate fell from 6.2 percent in 1980's to 3.99 percent in 1990's. There was a slowing down of public investment activity when compared to the trend level especially in the latter part of the decade, while there was some acceleration in the rate of private investment during 1990's relative to the position in the1980's decade. Political instability during the 1990's decade negatively affected the growth rate of the economy.

With the advent of 21st century, we observe some kind of revival in growth and investment activities. Economic reforms programme such as fiscal adjustment, privatisation of energy, telecommunication and production, reforms in the banking and trade sectors launched in 2000, played a vital role in the economic recovery of the Pakistan. Table 2 presents the year-wise percentage of public, private investment, total investment and percentage of GDP from 2000-2001 to 2011-2012 respectively.

Table 2

Percentage of GDP Growth and Public/Private Investment and Total Investment

Time Period	GDP Growth (%)	Public .Inv. Ig/GDP	Priv.Inv Ip/GDP	Total.Inv Ig+Ip/GDP
2000-01	2.0	5.7	10.2	15.9
2001-02	3.1	4.2	11.3	15.5
2002-03	4.7	4.0	11.3	15.3
2003-04	7.5	4.0	10.9	14.9
2004-05	9.0	4.3	13.1	17.1
2005-06	5.8	4.7	15.7	20.4
2006-07	6.8	5.7	16.2	21.9
2007-08	3.7	5.4	15.0	20.4
2008-09	1.7	–0.34	1.4	1.06
2009-10	3.1	–1.74	–1.1	–2.84
2010-11	3.0	–0.133	0.3	0.167
2011-12	3.7	5.03	5.8	10.83

Source: Pakistan Economic Survey (various issues).

On the average GDP growth rate increased twice as compared to 1990s decade and total investment also increased from 16.48 percent of GDP in 1990s to 18.08 percent of GDP in the early years of the current decade. Private investment has increased overtime and public investment relatively slowed down. Economy has grown by more than 6.5 percent per year on the average since 2003-04. As a percentage of shares of GDP, investment increased from 15.5 percent in 2001-02 to 20.4 percent in 2007-08, which is a healthy sign. After that it declined rapidly in 2008-09 and in 2009-10 its growth rate

became negative both in public and private investment. In 2011-12 its rose slightly due to some increase in both type of investment due to recent election era.

The financial sectors reforms after 1990 have shown a positive impact on the degree of interest rate liberalisation, moderate reduction in credit subsidies and progress towards the market-based transactions. However, because of high rate of inflation, the interest rate on deposits became negative in real term and discouraged the financial saving [Hassan (1997)]. To finance expenditures, the governments (both democratic and authoritative) have to rely heavily on external and internal borrowing and deficit financing. This practice has resulted into high stakes of debt and high inflation, which has increased debt servicing. The rising interest rate burden along with high defense spending together absorb about two-third of gross revenues. Consequently, nothing is left for the development budget and provision of social services like health and education. The political conditions deteriorated during 2007-08 and the new democratic government that took over in March 2008, has to face a lot of challenges both on the internal and external fronts. The rate of investment has surely slowed down during 2008 and 2009 due to the terrorist activities and shortage of electricity and gas for the industrial sector. The practice of out-wards looking policies on part of the government continues as usual and the prospects of growth and development depend heavily on the availability of foreign aid and assistance. 2012 has passed on the dream of self-sustaining growth and investment is yet far from turning into reality.

4. DATA, MODEL AND METHODOLOGY

Most of the data is retrieved from the *International Financial Statistic* (IFS) Yearbook published by International Monetary Fund (IMF). The data on some variables is collected from various issues of *Pakistan Economic Survey* compiled by the Federal Bureau of Statistics, Government of Pakistan and from the *Annual Reports* of the State Bank of Pakistan. All the data is expressed in million rupees except the Credit-to-GDP ratio, inflation rate, exchange rate and lending rate.

4.1. The Model

The link between private, public investment and economic growth is examined by the researchers like Ibrahim (2000). The relationship may be expressed as under in somewhat modified form:

$$Y_t = f(I_{pt}, I_{gt}, Cred_t, lr_t) \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad (1)$$

Where Y = real GDP, *Ig* = public investment, *Ip* = private investment, lr =lending rate, *Cred* = ratio of private sector credit to GDP. Theoretically both types of investments are positively related to the GDP but empirically it depends on the efficiency and productivity of investment. Private sector credit and lending rate is also included in the function as it affects the private investment directly and also the growth rate of GDP indirectly since the availability of easy credit provides incentives to private investors, which increases the growth rate of GDP. Similarly, an increase in the real interest rate increases the cost of borrowing and thus discourages new investment and growth of GDP.

Public investment is mainly determined by foreign aid and government revenue. It also depends on GDP. We expect positive coefficients of these three variables. Exchange rate and inflation rate also influence the public investment negatively. Following Rahman (2008), we specify following public investment function as under:

$$I_{gt} = f\,(Y_t\,,\, Aid_t\,,\, er_t\,,\, Gr_t\,,\, Inf_t) \qquad \ldots \quad \ldots \quad \ldots \quad \ldots \quad (2)$$

Where the symbols stand for: *Aid* = foreign aid, *er* = exchange rate, *Gr* = Government Revenue, *Inf* = inflation rate.

GDP plays an important role in determining private investment. The investment decisions are affected by domestic credit available to private sector, lending rate and inflation, while public investment may also include as explanatory variable to capture the "crowding out" or "crowding in" effect on private investment. Following Khan and Khan (2007), we specify the private investment function as follows:

$$I_{pt} = f\,(Y_t\,,\, Cred_t\,,\, I_{gt}\,,\, lr_t\,,\, er_t\,,\, Inf_t) \qquad \ldots \quad \ldots \quad \ldots \quad \ldots \quad (3)$$

The above three functions can be written in a testable form as:

$$\ln Y_t = \alpha_0 + \alpha_1 \ln I_{pt} + \alpha_2 \ln I_{gt} + \alpha_3 \ln Cred_t + \alpha_4\, lr_t + u_t \qquad \ldots \quad \ldots \quad (4)$$

$$\ln I_{gt} = \beta_0 + \beta_1 \ln y_t + \beta_2 \ln Aid_t + \beta_3 \ln Gr_t + \beta_4 \ln er_t + \beta_5\, Inf_t + v_t \qquad \ldots \quad (5)$$

$$\ln I_{pt} = \gamma_0 + \gamma_1 \ln y_t + \gamma_2 \ln I_{gt} + \gamma_3 \ln Cred_t + \gamma_4\, lr_t + \gamma_5 \ln er_t$$
$$+\gamma_6\, Inf_t + \omega_t \qquad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad (6)$$

The terms *u*, *v* and *w* are the stochastic/error terms as usual.

4.2. Econometric Methodology

The above model will be estimated in three steps. First, using the Augmented Dickey Fuller (ADF) unit root tests and assuming individual time series as non-stationary, we examine the time series properties of the data. Second, conditional to the results of the unit root test, we check co-integration between the variables specified in each equation using the method proposed by Johansen (1988) and Johansen and Juselius (1990). Third, based on the results of the long-run co-integration parameters, we will estimate the short-run error-correction models of each equation.

4.2.1. *Co integration Analysis*

Let's we have an endogenous variable of kth order, which can be written in a vector error correction model (VECM) as follows:

$$Y_t = \pi_0 + \pi_1 Y_{t-1} + \pi_2 Y_{t-2} + \ldots\ldots\ldots + \pi_k Y_{t-k} + v_t \qquad \ldots \quad \ldots \quad (7)$$

Where Y_t is a (px1) random time series vector (the variables with order of integration of at most one are denoted by 1 (1), Π represents the vector of constant term and v_t is the vector of error term which is I (0) and distributed with (0, σ^2). Defining Δ =1-L, where L

is the lag operator, the dynamics of the error correction model (ECM) is deduced as follows:

$$\Delta Y_t = \pi_0 + \sum_{i=1}^{k-1} \Gamma_i \Delta Y_{t-1} + \Pi Y_{t-k} + v_t \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad (8)$$

$$\Gamma_i = -(I - \Pi_1 - \ldots . - \Pi_i) v_t \quad \text{i=1, 2, 3} \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad (9)$$

where $\prod Y_{t-1}$ is a (px p) matrix of parameters, the rank of which contains information about long-run relationships among the variables in the model. If $\prod Y_{t-1}$ has full rank p, all elements in Y_t are stationary. If the rank of $\prod$ is zero, the model reduces to VAR in the first-differences. When $0 < rank < p$, there exist co-integrating relationships equal to the rank. In this case there exist (*pxr)* matrices α and β. If the individual series is I (1), then the first differences of the series are stationary. If there is co-integration relationship between I (1) series, then the linear combination of these variable is I (0), so that the $\prod_t Y_t$ term is stationary.

To test whether there exists co-integration between the variable or otherwise, two test statistics are used, which determine the rank of co-integration space. One is the likelihood ratio test based on the maximum Eigen value (λ_{max}) of the stochastic matrix and the second test is the value of the likelihood ratio test based on the trace of the stochastic matrix (λ_{trace}). The likelihood ratio test statistics developed by Johansen are given below:

$$LR\lambda_{trace} = -T \sum_{t=r+1}^{n} \ln(1 - \hat{\lambda}_1) \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad (10)$$

Where λ_{t+1}, λ_{t+2},……., λ_n are the n-r smallest eigen-values and T stands for number of observations.

$$LR\lambda_{\max} = -T \ln(1 - \hat{\lambda}_{t+1}) \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad (11)$$

The first statistics (λ_{max}) tests the null hypothesis that there are less than or equal to "*r*" co-integrating vectors against the general alternative where "*r*" is the number of co-integrating relations. The second statistics (λ_{trace}) tests the hypothesis that there are "*n*" numbers of co-integrating vectors against the alternative of *r*+1.

4.2.2. Short-run Analysis of the Variables

The short run dynamics are examined using the error correction mechanism (ECM), the ECM is important for many reasons. It is a convenient model, which is formulated in term of first differences. It measures the correction from disequilibrium of the previous period. ECM eliminates trend from the variables and resolves the problem of spurious regression. This model follows the general to specific approach in econometric modeling. By definition of co-integration disequilibrium, the error term is stationary. Two variables are co-integrated implies that there is some adjustment process which prevents the error into the long-run relationship. Thus the concepts of co-integration and the error correction mechanism (ECM) are closely related.

We formulate the error correction models for the real GDP, public investment and private investment respectively as follows:

$$\Delta \ln y_t = \beta_0 + \beta_i \Delta \ln y_{t-1} + \sum_{i=0}^{k} \delta_i \Delta \ln I_{pt-i} + \sum_{i=0}^{k} \phi_i \Delta \ln I_{gt-i} + \sum_{i=o}^{k} \gamma_i \Delta lr_{t-i} + \sum_{i=o}^{k} \mu_i \Delta \ln cred_{t-1} + \gamma ECM_{t-1} + \varepsilon_t \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad (12)$$

$$\Delta \ln I_{gt} = \theta_0 + \rho_i \Delta \ln I_{gt-1} + \sum_{i=0}^{k} \sigma_i \ln \Delta y_{t-1} + \sum_{i=0}^{k} \sigma_i \Delta \ln G_{rt-i} + \sum_{i=o}^{k} \varphi i \Delta \ln AiD_{t-i} + \sum_{i=o}^{k} \Omega_i \Delta \ln er_{t-i} + \sum_{i=o}^{k} \theta_i \Delta \inf_{t-i} + \sigma ECM_{t-1} + \mu_t \quad \ldots \quad \ldots \quad (13)$$

$$\Delta \ln I_{pt} = \gamma_0 + \alpha_1 \Delta \ln I_{pt-1} + \sum_{i=0}^{k} \psi_i \ln \Delta y_{t-1} + \sum_{i=0}^{k} \eta_i \Delta \ln cred_{t-i} + \sum_{i=o}^{k} \omega i \Delta lr_{t-i} + \sum_{i=o}^{k} \rho_i \Delta \ln I_{gt-1} + \sum_{i=o}^{k} \kappa_i \Delta \ln er_{t-i} + \sum_{i-0}^{k} \chi_i \Delta \inf_{t-i} + \delta ECM_{t-1} + \eta_t \ldots \quad (14)$$

Where Δ is the difference operator and ECM_{t-1} is an error correction term. The expected signs of the parameters γ, σ and δ should be negative, which will measure the speed of adjustment towards long run equilibrium.

5. EMPIRICAL RESULTS

We examine the order of integration using Augmented Dickey Fuller (ADF) unit root test. All variables, except the lending rate and inflation are in log form. Table 3 reports the results.

Table 3

Results for Augmented Dickey-Fuller Test of Unit Roots

Variables	ADF at Level	ADF at First Difference	I( )(Decision)
ln y	0.4973	–5.3540	I(1)
ln I_g	–0.370	–6.2386	I(1)
ln I_p	–2.421	–4.8709	I(1)
ln Cred	–0.4618	–5.1788	I(1)
ln Aid	0.9546	–8.7650	I(1)
ln er	–1.6619	–7.1341	I(1)
Lr	–2.6125	–4.3394	I(1)
Inf	–2.3405	–5.5965	I(1)

Note: ADF test is based on the Mackinnon (1991) critical values.

It can be seen from above that all the variables are non-stationary at their levels but stationary at their first differences.

5.1. The Long Run Growth Function

To examine the co integration between real GDP and its determinants we use multivariate co-integration test. Two lags were selected on the basis of Akaike information criterion (AIC). By applying the two stage likelihood ratio tests the number of co-integrating vectors is investigated. We follow the degree of freedom adjustment method[1] due to Cheung and Lai (1993) for trace and max statistics. The results are reported in Table 4 below.

The maximum Eigen-values test (λ–max) indicates the existence of two co-integrating vectors, while the trace statistics (λ–*trace*) indicates the existence of three co-integrating vectors at the 5 percent level of significance. However, when we use the adjusted max and the adjusted trace statistics, it is indicated that there are one and three co-integrating vectors respectively included in the model.

Table 4

GDP & Co-integrating Factors: Johansen Test

Null Hypothesis	Alternative Hypothesis	Test Statistics	(T-K/T) Adjusted Max Statistics	5% Critical Value
Maximum Eigen-values Test (λ–max)				
r=0	R=1	40.649*	32.77*	33.87
r=1	R=2	26.988	22.66	27.584
r=2	R=3	18.011*	15.93	21.136
r=3	R=4	8.881	7.46	14.264
r=4	R=5	2.419	2.0	3.8416
Trace Test (λ–*trace*)				
r=0	R≥1	109.95*	85.67*	69.818
r=1	R≥2	67.301*	54.9*	47.856
r=2	R≥3	34.312*	29.85*	29.797
r=3	R≥4	17.300	12.492	15.494
r=4	R≥5	5.419	2.03	3.8414

Note: * Indicates significance at 5 percent level.

The long run output function (real GDP) is obtained by normalising the first co-integrated vector on the growth rate. The results of long run relationship are reported in Table 5 below.

Table 5

Normalised Coefficients of Co-integrating Vector on Real GDP

Variables	Coefficients	Standard Error	t-Value
ln I_g	–0.785*	0.153	5.78
ln I_p	0.558*	0.169	–4.181
ln Cred	0.107	0.345	–0.227
Lr	–0.0732	0.0437	0.980
Constant	–9-44	–	–

Note: * Indicates significance at 5 percent level.

[1]Cheung and Lai (1993) method is used to scale up the Johansen Critical Value by the factor (T-K/T), where T indicates the number of observations and K stands for the number of variables used in the study.

It is evident from the table that in long run public investment exerts negative impact on the growth rate of GDP. This is because government is mainly investing in the sectors, which are unproductive and inefficient. This result is line with Ghani and Din (2006). On the other hand, private investment positively affects the GDP in long run and enhances the growth rate. This result confirms the findings of Khan and Sasaki (2002) and Ghani and Din (2006). The coefficient of private sector credit relative to GDP is positive but insignificant. The lending rate has negative and insignificant impact, which reflects that economic growth is not much responsive to lending rate.

5.2. The Long Run Public Investment Function

The estimated results are quoted in Table 6. Two lags were selected on the basis of Akaike information criterion (AIC). The likelihood ratio statistics for (λ–max) indicates the existence of five co-integrating vectors where the (λ–*trace*) indicates the existence of six co-integrating vectors at 5 percent level of significance. By using the test with degree of freedom adjusted, the max statistics indicates existence of four co-integration while the trace statistics shows six co-integrating relationships in the model.

Table 6

Public Investment and Co-integrating Factors: Johansen Test

Maximum Eigen-values Test (λ–max)				
Null Hypothesis	Alternative Hypothesis	Test Statistics	(T-K/T) Adjusted Trace Statistic	5% critical Value
r=0	r=1	66.893*	55.454*	40.077
r=1	r=2	52.223*	43.292*	33.876
r=2	r=3	33.995*	28.181*	27.584
r=3	r=4	18.673	15.479	21.131
r=4	r=5	15.674*	12.971	14.264
r=5	r=6	7.525*	6.238*	3.841
Trace Test (λ–*trace*)				
r=0	r≥1	194.96*	161.62*	95.75
r=1	r≥2	128.06*	106.17*	69.818
r=2	r≥3	75.842*	62.87*	47.856
r=3	r≥4	41.846*	34.69*	29.797
r=4	r≥5	23.173*	19.21*	15.494
r=5	r≥6	7.525*	6.24*	3.841

Note: * Indicates significance at 5 percent level.

The long run public investment function is obtained by normalising the first co-integration vector on public investment. The results are reported in Table 7 below.

Table 7

Normalised Coefficients of Co-integrating Vector on Public Investment Function

Variables	Coefficients	Standard Error	t-Value
ln y	6.403 *	0.785	–5.585
ln Aid	0.178	0.023	–0.981
ln Gr	–2.371	0.403	7.003
ln er	–0.276	0.172	1.256
Inf	–0.109*	0.013	9.654
Constant	25.134	–	–

Note: * Indicates significance at 5 percent level.

The above results indicate that the real GDP has positive and significant impact on public investment. It confirms the theoretical relationship of these two variables as implied by accelerator model. The foreign aid is important but to a limited extent so far as public investment in Pakistan is concerned. This result hardly supports the findings of Rahman (2008) in the case of SAARC countries and the Blejer and Khan (1984) that inflow of foreign capital positively affects the investment rate. This is because the flow of foreign aid has been irregular and too much fluctuating during the period of study. The exchange rate shows negative but insignificant impact on public investment. An increase in exchange rate makes imported goods relatively expensive which is likely to compress investment. On the other hand, the government revenue has (surprisingly) a negative and significant impact. This could be explained by the fact that government revenue is merely used to finance current expenditure of the government and seldom available for development purposes [Rahman (2008)]. The inflation rate exerts a negative and significant impact on public investment because an increase in inflation leads to increase the nominal interest rate as well as the cost of raw material and machinery/equipment.

5.3. The Long Run Private Investment Function

The co-integrating relationship between private investment and its determinants based on Johansen co-integration test, is presented below in Table 8. The model includes unrestricted intercept and no trend. Two lags were selected on the basis of Akaike information criterion (AIC).

The likelihood ratio statistics (λ–max) indicates the existence of six co-integrating vectors while (λ–*trace*) indicates the existence of seven co-integrating vectors at 5 percent level of significance. By using the degree of freedom adjusted test statistics, the max-test indicates the existence of two co-integrating vectors and the trace-statistics indicates that of five co-integrating vectors. Thus the estimated results confirm the existence of long-run relationship among the variables concerned. The long-run private investment function is obtained by normalising the estimated co-integrated vector on the private investment function. The results are reported in Table 9.

Table 8

Private Investment and Co-integrating Factors: Johansen Test

Null Hypothesis	Alternative Hypothesis	Test Statistics	(T-K/T) Adjusted Trace Statistics	5% Critical Value
Maximum Eigen-values Test (λ–max)				
r=0	r=1	97.994*	57.995*	46.231
r=1	r=2	87.880*	75.995*	40.077
r=2	r=3	43.805*	30.391	33.876
r=3	r=4	35.395*	20.708	27.584
r=4	r=5	21.151*	15.630	21.131
r=5	r=6	13.992	11.225	14.264
r=6	r=7	11.078*	7.022	3.841
Trace Test (λ–*trace*)				
r=0	r≥1	266.297*	211.705*	125.615
r=1	r≥2	186.302*	148.74*	95.753
r=2	r≥3	116.422*	89.754*	69.818
r=3	r≥4	77.617*	66.362*	47.856
r=4	r≥5	42.222*	31.654*	29.797
r=5	r≥6	18.070*	15.193	15.494
r=6	r≥7	9.078*	4.022	3.841

Note: * Indicates significance at 5 percent level.

Table 9

Normalised Coefficients of Co integrating Vector on Private Investment Function

Variables	Coefficients	Standard Error	t-Value
ln y	0.375	0.437	–0.623
ln Cred	–0.567*	0.038	5.946
ln I_g	–1.973*	0.387	5.271
ln er	–0.578*	0.076	9.207
lr	–3.262*	0.766	5.255
Inf	–0.243*	0.026	5.946
Constant	–4.761	–	–

Note: * Indicates significance at 5 percent level.

As revealed from the above, the effect of real GDP is positive but statistically insignificant, showing weak accelerator. This finding is consistent with Blejer and Khan (1984), Naqvi (2003), Ahmed and Qayyum (2007) and Khan and Khan (2007). Surprisingly, the coefficient of private sector Credit-to-GDP ratio has negative and significant impact on private investment. This may be explained by the factual position that credit was extended mainly to sick units who used the funds to repay their outstanding loans to the banks [Khan and Khan (2007)]. The negative and significant values of lending rate and inflation confirm the theoretical relationship between these variables and private investment. Likewise, an increase in the rate of inflation leads to enhance the prices of raw material, machinery and equipment as well as the wage bill,

which discourage private investment. Same is the case with exchange rate since depreciation of domestic currency definitely increases the cost of imported goods. The public investment has negative and significant impact on private investment, which implies the "crowding out" effect. The results is consistent with findings of Ghani and Din (2006), Khan and Sasaki (2001), Khan and Khan (2007) and Majeed and Khan (2008).

5.3.1. *The Short-run Growth Function*

The results show that three regressors are important in establishing the short run relationship with the growth rate of GDP and the remaining two variables, being insignificant, are dropped from the model following the general to specific methodology. The change in private investment lagged by one year (ΔLI_{pt-1}), current public investment (ΔLI_{gt}) and a dummy included for uncertainty (UN_t)[2] are significant variables while other variables like the credit-to-GDP ratio and lending rate are proved to be insignificant. The results are given below in Table 10.

Table 10

Error Correction Model of Real (GDP)

Variables	Coefficient	Std. Error	t-Statistic
$\Delta \ln_{pt-1}$	0.0808**	0.0463	1.744
$\Delta \ln_{gt-1}$	0.1195*	0.0467	2.553
UN_t	–0.0035**	0.018	1.84
ECM_{t-1}	–0.0058*	0.00085	6.861
R-squared = –0.20	Adjusted R-squared= –0.13		
D.W Test=2.32	F(4,33)=.466		

Note: *Shows significance at 5 percent level and ** shows significance at 10 percent level.
$ECM_{t-1} = (\ln y_t + 0.785^* \ln I_{gt} - 0.585^* \ln I_{pt} - 0.1017^* \ln cred_t + 0.0738^* \text{lr})$

The estimated error correction coefficient (ECM_{t-1})[3] is – 0.0058 has theoretically correct negative sign and significant at 5 percent level. In short run private investment positively and significantly affects the growth rate of GDP, likewise public investment is positive and significant, thereby indicating a strong impact on the growth of GDP. The reason is that in short run it stimulates the demand in some extant but in long run its effect dampen. The estimated coefficient of uncertainty is negative which indicates that macroeconomic instability and uncertainty has always depressed economic growth in Pakistan. The estimated model passes different diagnostic tests, such as ARCH test for serial correlation (F-statistics: 0.244, probability: 0.784) and White test for Hetroscedasticity (F-Statistics: 2.21, probability: 0.669).

[2]A dummy for uncertainty is used in the short-run under the assumption that investment decisions are likely to be affected by recent uncertainty which is created by macro economic uncertainty.

[3]The term error correction (ECM) consists of residual obtained from the long run output (real GDP), public investment and private investment functions. The estimated error correction coefficient is obtained by resetting the normalising coefficients obtained from long run growth function.

5.3.2. *Short-run Public Investment Function*

Estimated results for the short run relationship between the public investment and its determinants like real GDP, foreign aid, exchange rate, government revenue and inflation rate shows that all variables are insignificant in the short run except changes in public investment lagged by one year (ΔLI_{gt-1}), current inflation rate (ΔLinf) and lending rate (Δlr). These three variables show significant short-run relationship with public investment. The results are presented on Table 11.

Table 11

Error Correction Model of Public Investment Function

Variables	Coefficients	Standard Error	t-Values
$\Delta \ln_{gt-1}$	0.4102*	0.148	2.769
Δln inf	–0.0906*	0.035	–2.530
ln er_t	–0.842*	0.254	–3.302
Constant	–6.385*	1.234	–5.17
ECM_{t-1}	–0.591*	0.115	–5.14
R-squared =0.54	Adjusted R-squared=0.48		
D.W stat =2.59			

Note: *Shows significant at 5 percent level and ** shows significant at 10 percent level.

ECM_{t-1} = (ln I_{gt} + 2.371* ln G_{rt} –0.195* lnaid_t –6.841* lny_t +0.10inf*+0.276lner_t)

The estimated coefficient of ECM shows that approximately 59 percent of disequilibrium in the public investment is instantly corrected. The coefficient of lagged government investment is significant and has positive sign, which indicates that changes in previous period's public investment positively affect the short-run changes in current public investment. The changes in inflation rate and exchange rate exert significant and negative impacts on current public investment. The estimated model passes different diagnostic tests, such as ARCH test for serial correlation (F-statistics: 0.163, probability: 0.84) and White test for Hetroscedasticity (F-Statistics: 1.03, probability: 0.44).

5.3.3. *The Short-run Estimation of Private Investment Function*

The results show that the variables significant in determining changes in private investment include changes in public investment lagged by one year (ΔI_{gt-1}), changes in lending rate lagged by one year (Δlr_{t-1}) and current inflation rate (ΔLinf). The remaining variables are insignificant in the short-run. The results are presented below in Table 12.

Table 12

Error Correction Model of Private Investment Function

Variables	Coefficients	Standard Error	t-Values
$\Delta \ln_{gt-1}$	0.00015**	7.78 E-05	1.936
Δlr_{t-1}	–0.0438*	0.0179	–2.438
Δln inf	–0.0892*	0.0339	–2.630
ECM_{t-1}	–0.0117*	0.0029	–3.952
R-squared = 0.37	Adjusted R-squared =0.31		
D-W Test = 2.421			

Note: *Shows significant at 5 percent level and ** shows significant at 10 percent level.

ECM_{t-1}=lnI_{pt}–0.375*lnY_{t-1}+5.567*ln$cred_t$+3.262*lr+1.973*lnI_{gt}+0.243*lninf

The estimated error coefficient is –0.0117, with theoretically correct sign and significant at 5 percent level. The coefficient of lagged public investment is positive and significant, indicating a positive effect on current private investment. The coefficients of inflation rate and lending rate are significant. The negative signs confirm the theoretical relationship that these variables negatively affect private investment in the short-run. The estimated model passes different diagnostic tests, such as ARCH test for serial correlation (F-statistics: 0.355, probability: 0.703) and White test for Hetroscedasticity (F-statistics: 2.13, probability: 0.069).

6. CONCLUSION

The study has attempted to evaluate the inter-relationship among the three macro-variables, namely public and private investment and GDP growth both in the long and short run with reference to Pakistan economy. We have tried to pinpoint the important determinants of each variable, using the standard econometric techniques. As expected, the GDP growth has a strong positive relationship with public and private investment and there is a two-way causality between GDP and investment. The public investment is affected by the level of GDP, inflation and exchange rates. Likewise, private investment is affected by inflation and exchange rates, the lending rate, besides the level of GDP. The general negative theoretical relationship between public and private investment is confirmed in the context of Pakistan economy, i.e. public investment exerts a "crowding-out" effect on private investment at large. This is because public investment has primarily been financed in the past through internal and external borrowing. The government revenues collected through taxation has little contribution in promoting public investment.

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