Do Public Expenditure and Macroeconomic Uncertainty Matter to Private Investment? Evidence from Pakistan

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This study examines the role of macroeconomic uncertainty and public expenditure in determining private fixed investment in Pakistan. It is found that individual series are non-stationary. There is a long-run relationship between private fixed investment, public consumption expenditure, public development expenditure, and market activities. It is revealed that public development expenditure stimulates private investment, whereas public consumption expenditure is detrimental to private investment. The preferred dynamic private fixed investment function confirms that in the short run, public development expenditure enhances private investment. Moreover, macroeconomic instability and uncertainty depresses private investment in Pakistan.

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1. INTRODUCTION

The study attempts to investigate the determinants of private fixed investment in Pakistan and determine the interrelationship between public and private investment. Policy-makers in developing countries generally believe that private investment would be slow-moving due to the lack of socio-economic infrastructure and insufficient government investment in infrastructure and other basic industries.

Keynesians (1936) believed that there is need for government intervention to activate and regulate saving and investment behaviour of the society. Generally, it is argued that public investment either crowd-in or crowd-out private investment. Therefore, the impact of public expenditures on private investment has received a considerable attention, both in developed and developing countries. The lack of strong empirical evidences may lead to irrational policy advice to Least Developed Countries that are presently struggling for the improvement of structural imbalances. They may require reducing large fiscal deficits, but they do not have a clear picture as to which components of expenditures may be minimised and which can be enhanced to encourage private investment activities [Hermes and Lensink (2001)]. Thus, an in-depth analysis of effects of public development and non-development expenditures on private fixed investment is required.

A number of studies [e.g., Akkina and Celibi (2002); Mamatzakis (2001); Ghura and Goodwin (2000); Ramirez (1994); Oshikaya (1994); Shafik (1992); Greene and

Villanuva (1991)] have examined the relationship between public and private investment for developing countries. However, evidence on these countries is not clear-cut. Most studies [e.g., Aschauer (1989); Greene and Villanuva (1991); Munnell (1992); Shafik (1992); Oshikaya (1994); Ramirez (1994); Ghura and Goodwin (2000) and Mamatzakis (2001)] find a positive relationship. However, some studies [e.g., Akkina and Celibi (2002); Pereira and Sagales (2001); Williams and Darius (1998); Wai and Wang (1982)] have reported a negative relationship.

Studies on private investment behaviour in Pakistan [e.g., Khan (1988) and Naqvi, *et al.* (1993)] estimated only disaggregated private investment functions using conventional econometric methodologies. Looney (1997) estimated the relationship between private investment in large-scale manufacturing and infrastructure, applying the Engle-Granger (1987) methodology. These studies paid no attention to dynamic specification of the private investment function and the stability of the estimated relationships. Naqvi (2002) estimated the relationship between aggregate public and private fixed capital formation for Pakistan, but did test stability of preferred function.

In Pakistan, over the past 60 years, GDP growth remained on average at 5 percent per annum, while investment was around 17 to 18 percent of GDP which was relatively low as compared to the neighbouring developing economies. In 1949-50 investment level was just 4.1 percent of GDP, but at the end of 1950s it had risen to around 10 percent of GDP. It further increased to 22.3 percent of GDP in 1964-65 because of increase in foreign aid, improvement in infrastructure level, and profitable investment opportunities in various sectors of the economy. However, after 1965 Pak-Indo war, the investment declined sharply and reached at 15.6 percent of GDP in 1969-70. This is mainly due to decline in capital inflows. Furthermore, manufacturing sector suffered from lack of demand, private sector was reluctant to invest in new industries and limited possibility of further extension in existing industries.

In early 1970s, private investment was curtailed due to the large-scale nationalisation. However, in the same period, public investment in non-traditional sectors increased rapidly. This led to a rise in aggregate investment in the 1970s that lies between 12 and 20 percent of the GDP. Despite the reversal of the policies from nationalisation to denationalisation in the late 1970s, private investment remained low during 1980s and started increasing after 1987-88. Investment reached at 20.6 percent of GDP in 1992-93. Subsequently, due to the inconsistency and discontinuity of policies structural adjustment programmes curtailed development expenditures [Kemal (2002)]. Total investment in 2001-02 was only 13.9 percent of the GDP. The deceleration in the public sector investment was more pronounced than the private sector.

Fixed investment is the main factor to sustain economic growth. In fiscal year 2004-05, gross fixed capital formation increased by 15.6 percent. However, there was a considerable change in the composition of private and public investment. Private sector investment increased by 19.3 percent in 2004-05. The private consumer demand backed investment and supported the major macroeconomic target of the economy.

Section 2 describes theoretical foundation and specification of econometric model. Section 3 deals with estimation methodology and data issues. Estimated results of Unit Roots, Cointegration and Error Correction Mechanism (ECM) are given in Section 4. Finally, conclusions and policy implications drawn from the analysis are presented in Section 5.

2. ECONOMETRIC MODEL

Theories of investment postulate that investment mainly depends on interest rate, income factor, and uncertainty variables. Public development expenditures and public consumption expenditures are incorporated to capture explicit role of public expenditures in the determination of investment [Aschauer (1989)]. The interest rate negatively affects private investment because when interest rate increases, the returns on investment decline. Private investment is affected positively by the income level, as higher income level would tend to dedicate more resources to finance investment.[1] Public development expenditure provides basic infrastructure to the private sector and prompts private investment. Whereas the public consumption expenditures are a substitute of private investment, it is expected that this type of expenditure may negatively affect private investment. Private investment is considered to be negatively related to uncertainty as the fixed investment decisions cannot be undone if future events turn out to be unfavourable [Dixit and Pindyck (1994)]. Capital once installed is immobile as compared to labour.[2] There are number of variable that could be used to capture uncertainty such as lack market premium, fiscal deficit/surplus and the change in inflation, among others. The inflation is often taken as a summary measure of the overall macroeconomic stance, and hence the volatility of its unpredictable component can be viewed as an indicator of overall macroeconomic uncertainty [e.g., Eberly (1993)]. Following Able (1980), Pindyck and Solimano (1993) and Eberly (1993) we use change in inflation as a proxy to measure uncertainty because inflation is used as a measure of the overall macroeconomic stance and the volatility of inflation as an indicates macroeconomic uncertainty.

The function of private investment can be written as:

$$PI_t = F(R_t, Y_t, CG_t, IG_t, UN_t, e_t) \qquad \ldots \qquad \ldots \qquad \ldots \qquad \ldots \qquad \ldots \qquad (1)$$

Where

PI_t = Real Private Fixed Investment
Y_t = Real Gross domestic product
IG_t = Real Public development expenditure
CG_t = Real Public consumption expenditure
R_t = Interest rate (weighted average rate of return on advances)
UN_t = Uncertainty measure (derived by percentage change in the annual inflation rate, where inflation rate is derived from consumer price index)
e_t = Random error term assumed to be independent and identically distributed (iid).

Assuming individual time series are non-stationary and the private investment and its determinants are cointegrated, the dynamic private investment model can be represented by error correction mechanism. The relationship between cointegration and

[1]Private investment is positively affected by income level as Chhibber and Wijnbergen (1988) for Turkey, Ramirez (1994) for Mexico, Monadjemi (1996) for Australia, and US, Mamatzakis (2001) for Greece, Pereira, and Sagales (2001) for Spain, Akkina, and Celibi (2002) for Turkey, Kim and Lim (2004) for Korea and Ouattara (2005) for Senegal.

[2]Capital equipment becomes industry-specific and can hardly be put to another use or productive process or activity without incurring a substantial cost.

error correction mechanism has already been proved in the Granger representation theorem [Engle and Granger (1987)].

Following Johansen (1988) and Johansen and Juselius (1990) the dynamic error correction private investment function is thus approached through the process of autoregressive-distributed lags (ADL). Therefore, from the above Equation (1) the following ADL formulation could be achieved.

$$X_t = \mu + \Pi_1 X_{t-1} + \Pi_2 X_{t-2} + \text{----------} + \Pi_k X_{t-k} + e_t \qquad \dots \qquad \dots \qquad \dots \qquad (2)$$

Where X_t is a vector of variables included in the model, μ is a vector of constant term and e_t is iid with $(0, \sigma^2)$ disturbance term. From this model, using $\Delta = 1 - L$, where L is the lag operator, we can deduce the following dynamic error correction model (ECM) of real private investment.

$$\Delta X_t = \mu + \sum_{i=1}^{k-1} \Gamma_i \Delta X_{t-i} + \Pi X_{t-k} + \varepsilon_t \quad \dots \qquad \dots \qquad \dots \qquad \dots \qquad \dots \qquad (3)$$

where

$$\Gamma_i = -(I - \Pi_1 - \dots\dots - \Pi_i) \qquad i = 1, 2, 3, \dots, k-1 \qquad \dots \qquad \dots \qquad \dots \qquad (4)$$

and

$$\Pi = -(I - \Pi_1 - \dots\dots - \Pi_I \quad \dots \qquad \dots \qquad \dots \qquad \dots \qquad \dots \qquad \dots \qquad (5)$$

This model includes variables both in levels and in differences. If individual series have unit root at frequency one, that is they are individually I (1), then first difference of the series are stationary. Moreover, if there is a cointegrating relationship between I (1) variables then linear combination of these variables is I (0). It means that $\Pi_i X_t$ term is stationary. Thus all variables included in the error corrects model are stationary. Therefore, this equation can be estimated with the ordinary least square method[3] [Granger and Lee (1989)]. The error correction model captures the short-run dynamic of the private investment. The analysis of matrix Π of Equation 3 is crucial to investigate the long run relationship among the private investment and its determinants. It contains all relevant information that is number of cointegrating relationships among the variables.[4] The long-run matrix (Π) can be factorised as ($p \times r$) matrices of a and ß such as $\Pi = \alpha\beta'$. In the presence of cointegrating relationship, vector ß has property that $\beta'X_t$ is stationary, though X_t itself is non-stationary. The vector a is a loading vector, the elements of which weight each cointegrating relationship in each of the p equation of the system. The expected sign of error correction parameter is negative. It gives the speed of adjustment towards state of equilibrium.

The vector β_i (where $i = 1, 2, \dots 5$) may be interpreted as the long run cointegrated relationship between aggregate private investment, real gross domestic product, real public development expenditures, real public consumption

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[3]Moreover, Banerjee, *et al*. (1990) show that Instrumental Variable method and OLS yield same estimates.

[4]The *r* can be said: (1) the number of cointegrating vectors, (2) the rank of Π, (3) the number of columns of α, (4) the number of columns in β, and (5) the number of nonzero canonical correlations between the elements of ΔY_t and the elements of Y_{t-1}.

expenditures, rate of interest on advances and the macroeconomic uncertainty. The theoretical expectations about the sign of estimated parameters are $ß_1 > 0$, $ß_2 > 0$, and $ß_3$, $ß_4$, $ß_5 < 0$. If $ß_2 > 0$, this implies complementarity hypothesis is true for the public development expenditures. Public consumption has negative impact on private investment if $ß_3 < 0$. The $ß_4 < 0$ shows interest rate is negatively related to private investment and $ß_5 < 0$ shows that macroeconomic instability and uncertainty negatively affect private investment.

3. ECONOMETRIC METHODOLOGY

We apply the following three-step methodology [Qayyum (2002)] to achieve the stable dynamic private investment function.

Step I. The univariate statistical analysis of a time series.

Step II. The multivariate cointegration analysis and the estimation of the long-rum private investment function by using the Johansen (1988) maximum likelihood method.

Step III. To obtain a parsimonious short-run dynamic private investment function through the error correction mechanism.

Step I. Univariate Analysis

In the process of model specification it is assumed that individual data series are non-stationary. If a variable is stationary, it is said to be integrated of order zero I(0). If a variable is not stationary at level but can be transformed into stationary by taking first difference, it is said to be integrated of order one, or I(1). To test the presence of unit root in univariate time series, we applied following Augmented Dickey-Fuller (1979, 1981) and Phillips-Perron (1988) tests.

Augmented Dickey-Fuller (ADF) test considers following regression equation;

$$\Delta X_t = \alpha + \beta_t + \delta X_{t-1} + \sum_{i=1}^{m} \gamma \Delta X_{t-i} + \varepsilon_t \qquad \ldots \qquad \ldots \qquad \ldots \qquad \ldots \qquad (6)$$

$$\text{for } i = 0,1,2,3,\ldots\ldots m$$

Where X_t is any time series to be tested for unit roots, t is time trend and e_t is white noise error term. In case $i = 0$, it is simple Dickey and Fuller (1979, 1981) test.[5] The lagged dependent variables in the ADF regression equation are included until the error term becomes white noise. We test the hypothesis that d=0 in Equation 6 by t-test.

Phillips and Perron (PP) have developed a non-parametric method of detecting whether a time series contain a unit root. Existence of unit root in a series, say X_t, is identified by estimating the following regressions;

$$\Delta X_t = a_0 + a X_{t-1} + u_{1t} \qquad \ldots \qquad \ldots \qquad \ldots \qquad \ldots \qquad \ldots \qquad \ldots \qquad (7)$$

$$\Delta X_t = ß_0 + ß_1 t + ß X_{t-1} + u_{2t} \qquad \ldots \qquad \ldots \qquad \ldots \qquad \ldots \qquad \ldots \qquad \ldots \qquad (8)$$

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[5]Banerjee, *et al*. (1993) says that the lag structure in the ADF tests is ad hoc; it seems safest to over-specify the ADF regression.

Where ΔX_t denotes first difference of X_t and t is a deterministic time trend. In Equation (7), for X_t to stationary, the adjusted *t*-statistic, i.e., $Z(t_a)$ should be negative and significantly different from zero. For X_t to be stationary around a linear trend in Equation (8), the adjusted *t*-statistic, i.e. $Z(t_\beta)$ should be negative and significantly different from zero. The critical values for Philips-Perron statistics are precisely those that are given for Dickey-Fuller test.

Step II. Multivariate Cointegration Analysis

Multivariate cointegration analysis starts with the testing of hypothesis of no cointegration between the private investment and its determinants. To analyse the prospects of existence of cointegrating relationship between private investment and its determinants Johansen (1988) maximum likelihood method is applied. Main hypothesis to be considered is that there exist r cointegration vector(s). Inference on the "r" of the system is conducted through the method of likelihood ratio (LR) test. The null of

$$H_{0(r)}: \text{rank} (\Pi) = r \qquad \dots \qquad \dots \qquad \dots \qquad \dots \qquad \dots \qquad \dots \qquad (9)$$

is tested against the unrestricted alternative of

$$H_{1(r)}: \text{rank} (\Pi) = P \qquad \dots \qquad \dots \qquad \dots \qquad \dots \qquad \dots \qquad \dots \qquad (10)$$

by the trace statistic. Similarly, the validity of $H_{0(r)}$ against the alternative of $H_{1(r+1)}$ is tested by looking at the maximal eigenvalue statistic.[6] The likelihood ratio (LR) test statistic for the hypothesis that there are at most "r" cointegrating vector is:

$$-2\ln Q = -T \sum_{i=r+1}^{p} \ln(1 - \hat{\lambda}_i) \qquad \dots \qquad \dots \qquad \dots \qquad \dots \qquad \dots \qquad (11)$$

Where $\hat{\lambda}_{r+1},\dots\dots\dots\dots\dots\hat{\lambda}_p$ are the (p-r) smallest canonical correlations. Johansen (1988) proved that these statistics are asymptotically distributed as χ^2 with r (p–r) degrees of freedom. The precise relevant critical values are provided by Osterwald-Lenum (1992). Likelihood Ratio (LR) test is applied to test the significance of estimated parameters in cointegrating relationship between the private investment and its determinants. The LR test has Chi-square distribution and the Chi-square values are calculated by imposing zero restriction on the estimated coefficients of individual variables.

Step III. Short-run Dynamic Private Investment Function

This step involves estimation of parsimonious private investment function specified using the error correction mechanism, that is Equation (3). Step I indicates the variables that required to be differenced to achieve stationarity and Step II provides estimates of the long-run private investment function. It also indicates variables that are placed in the error correction term that is ΠX_{t-k}. If these variables are found to be cointegrated, then the combination of the integrated variables is stationary i.e., I(0). Therefore, the residual term called error correction term is stationary.

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[6]Johansen and Juselius (1990) suggested that the maximal eigenvalue test has greater power than the Trace test.

The estimation of dynamic model starts with the unrestricted general model. In which every variable enters with a predetermined optimal lag length. As all variables of the model are stationary, the function is estimated by OLS. The preferred dynamic private investment function would pass a number of diagnostic tests. To test the hypothesis of no serial correlation in the residual term the Lagrange Multiplier (LM) test is applied. The Jarque-Bera (1987) test is applied to examine the normality of the residual term. The LM version of Hetroskedasticity test and ARCH test are also used. The Brown, *et al.* (1975), CUSUM and CUSUM of Squares test of stability are also applied to test the stability of estimated functions.

3.1. Definition of Variables and Data Sources

The data on variables such as Aggregate Private Investment (PI_t), Gross Domestic Product (GDP_t), Public development expenditure (IG_t), and Public Consumption Expenditure (CG_t) are collected at constant market prices of 1980-81. The data for Advancing Rate (A_t) and Consumer Price Index are taken from various issues of *Annual Report* of the State Bank of Pakistan and data for all other series are obtained from *Pakistan Economic Survey* (Various Issues), Government of Pakistan. Each of the variables is defined herein after.

Private investment (PI_t) is the gross fixed capital formation in private sector. Where, gross fixed capital formation is the expenditure on purchase and own-account construction of fixed assets which includes improvement of land, construction of buildings, other construction i.e., roads, dams, culverts, drainage, ports and wharfs, machinery and transport equipment etc. The capital repairs are also included while sale of fixed assets is deducted. Gross Domestic Product (GDP_t) is derived from gross output of the economy at market prices i.e., total flow of goods and services, which are produced during the period.

Public Development expenditure (IG_t) is the gross fixed capital formation in construction, electricity, gas, transport and communication (railway, post office and T&T plus others) by the public sector. Public consumption (CG_t) is the general Government current consumption expenditure. Interest Rate (A_t) is measured as weighted average rate of return on advances (total advances). Inflation Rate (Inf_t) is calculated from the consumer price index. Finally the Uncertainty variable (UN_t) is calculated by percentage change in the annual inflation rate.

4. EMPIRICAL RESULTS

We have followed three steps methodology, containing the time series properties of the data, estimation of long run private investment function and a parsimonious error correction private investment function. The results are reported here.

4.1. Testing of Unit Roots

First individual series are tested for the order of integration by Augmented Dicky-Fuller (ADF) and Phillips-Perron (PP) tests. These two tests confirmed the order of integration of theses series. The data for public consumption expenditure (CG_t), public development expenditure (IG_t), Private investment (PI_t), inflation rate (INF_t), interest rate

(A_t) and Gross Domestic Product (GDP_t) are used in log form. Therefore ADF test is applied on the log form with an intercept and a linear trend term (as is appropriate) included in the ADF regression equation of these variables. Appropriate lag length is used so that serial correlation is removed from error term. The results are presented in Table 1. The results show that all variables are integrated of order one i.e., I(1) except UN_t that is I(0). To confirm the finding of I(1) property of variables, the ADF test is also applied on first difference of the series.

Table 1

Results for Augmented Dickey-Fuller Test of Unit Roots

Variables Level	ADF-stats	Lag Length	Result	Variables First Difference	ADF-stats	Lag Length
LCG_t	-1.8929^C	1	I (1)	ΔLCG_t	-5.7572^{C*}	0
LIG_t	-2.0418^C	0	I (1)	ΔLIG_t	$-6.3662*$	0
LPI_t	$-2.9464^{C,T}$	0	I (1)	ΔLPI_t	$-4.1524*$	0
$LGDP_t$	-1.8033^C	0	I (1)	$\Delta LGDP_t$	-4.8653^{C*}	0
$LINF_t$	-0.8715	0	I (1)	$\Delta LINF_t$	$-6.9322*$	0
LA_t	-2.4434^C	0	I (1)	ΔLA_t	$-4.0108*$	0
UN_t	-6.6425^{C*}	0	I (0)			

Note: *Denote significance at 5 percent; "c" indicates the constant term is significant; c, t indicates that both the constant and the trend are significant.

The Phillips-Perron (PP) test is performed on the original series (in log) at level and also on the first differences. The truncation lag parameters are determined following Schwert (1987). The results are reported in Table 2. The results confirm the finding of ADF test that is there exist unit roots at level of the original series except UN_t which is stationary at level. The findings further highlight that taking first difference will take care off the problem of non-stationarity. These results provide ground to move to apply the cointegration method to estimate the long run private investment function.

Table 2

Results for Phillips-Perron Test of Unit Roots

Variables	Series in Level PP Test-statistic Truncation Lag Parameters L 4=2	L 12=8	First Differences PP Test-statistic Truncation Lag Parameters L 4=2	L 12=8	Result
LCG_t	-1.3749	-1.3978	-5.7480^*	-5.8181^*	I (1)
LIG_t	-2.0655	-2.0954	-6.3157^*	-6.2686^*	I (1)
LPI_t	-3.0923	-3.1636	-4.1008^*	-4.3389^*	I (1)
$LGDP_t$	-1.7435	-1.6257	-4.9082^*	-5.1849^*	I (1)
$LINF_t$	-0.8504	-0.8594	-7.0026^*	-7.0527^*	I (1)
LA_t	-2.0841	-2.0830	-3.8157	-3.7881	I (1)
UN_t	$-6.7503*$	$-7.1177*$	$-$	$-$	I (0)

Note: *Denote significance at 5 percent.

4.2. The Long-run Private Investment Function: A Cointegration Analysis

Major purpose of this paper is to examine the determinants of private investment. The analysis shows that weighted average rate of return on advances and rate of inflation are insignificant at 5 percent level by using LR test. Therefore these variables are dropped from the final estimation process. The proxy for uncertainty (UN) is to be used in the short-run ECMs under the assumption that investment decisions are likely to be affected by recent uncertainty. This variable captures the instability in the macroeconomic climate.

At this stage, the existence of cointegrating relationship between the private fixed investment and its determinants are estimated. The optimal lag structure of the model is necessary before obtaining the correct model estimation, i.e., the number of lags, which will capture dynamics of the series. The appropriate lag length of the VAR is three, which is determined by following Schawarz Bayesian information criteria (SBC) for model selection [Enders (1995)].

We have investigated the number of cointegrating vectors by applying the likelihood ratio test that is based on the maximal eigenvalue and trace statistics of the stochastic matrix of the Johansen (1988) procedure. The critical values depend upon position of deterministic terms included in the VAR/ECM. Preliminary analysis shows at least one variable have linear trend therefore we restricted constant in the cointegration space. The results from the Johansen cointegration test (both the eigenvalue and the trace test) are presented in Table 3.

Table 3

Johansen Tests for Cointegration*

Maximum Eigenvalue Test			Trace Test		
Null Hypothesis	Alternative Hypothesis	Test Statistic	Null Hypothesis	Alternative Hypothesis	Test Statistic
R = 0	R = 1	55.76606**	r = 0	R = 1	75.64948**
R = 1	R =2	21.19806	r = 1	R =2	25.11156
R = 2	R = 3	5.891993	r = 2	R = 3	5.900783
R = 3	R = 4	0.6192	r = 3	R = 4	0.561155

Note: * We used Johansen maximum likelihood method. For this purpose we used Eviews 5.

     ** Indicates significant at the 5 percent level. Variables included in the cointegrating vector: LPI, LCG, LIG and $LGDP_t$.

The likelihood ratio (LR) statistics from both tests indicate existence of one cointegrating vector at the 5 level of significance. In case of finite sample test statistics is biased by a function of T/(T-pk) and it too often indicate cointegration, therefore, the test statistics needs to be adjusted accordingly [Reimers (1992) and Cheung and Lai (1993)]. By using adjusted test statistics[7] we can conclude that there is one cointegrating relationship among the variables included in the model. The residual from cointegrating vector is presented in Figure 1. The error term is well behaved and stationary.

[7]We used Cheung and Lai (1993) method who suggested scaling up the Johansen critical values by factor T/(T-pk). Where 'T' is for number of observations, 'p' is for number of variables included in the analysis and 'k' is for number lags used.

Fig. 1. Error Series of the Long Run Private Investment Function
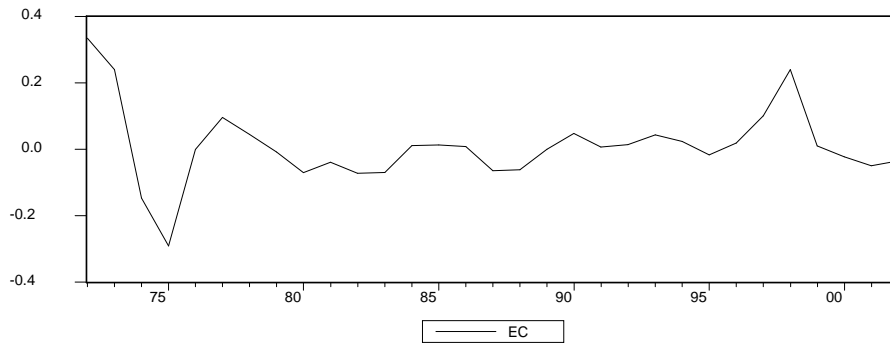
The empirical results suggest that there exist a unique long run relationship among private investment and its determinants. The long-run private investment function presented here is obtained by normalising the estimated cointegrated vector on the private investment (PI). So the results of estimated long-run private investment function are reported in Table 4.

Table 4

Normalised Coefficients of Cointegrating Vector on LPI$_t$

Variables	Coefficients	Standard Error	*t*-value	Chi-square
LCG$_t$	–0.174164*	0.07297	–2.38	6.06
LIG$_t$	0.207556*	0.06500	3.19	13.89
LGDP$_t$	1.097379*	0.06977	15.73	28.11
Constant	–3.94	–	–	–

Note: (*) represent significance at 5 percent critical values.

As can be seen from the Table 4, estimated coefficients of LCG$_t$, LIG$_t$ and LGDP$_t$ have expected signs and are significant at 5 percent level. The estimated equation indicates that the private investment is mainly determined by the public consumption expenditure, public development expenditure and national income.

The cointegration analysis indicates that the estimated coefficient of public consumption is –0.17, implying that in the long run there is negative effect of public consumption on private investment. This is mainly the outcome of an increase in government expenditures for wages and salaries of public sector employees, which captures the biggest share of public consumption expenditures and has no complementary effect on private investment.

The analysis reveals that there is positive long run relationship between private investment and public development expenditure. The estimated coefficient of public development expenditure is 0.21. It indicates the importance of providing basic infrastructure projects to the private sector of the economy as a way to create the appropriate economic environment that prompts private sector incentives to invest. Public development expenditures such as the gross fixed capital formation in construction, electricity, gas, transport and communication reduces the private sector's cost of

production or increases the returns to scale and hence raises the profitability of the private fixed investment. Thus public sector investment crowds in private investment activity. Although the negative effect due to increase in interest is there but complementary effect is more powerful. This result is consistent with Blejer and Khan (1984), Chhibber and Wijnbergen (1988), Khan (1988), Shafik (1992), Oshikaya (1994), Looney (1997), Mamatzakis (2001), Pereira and Sagales (2001). Akkina and Celebi (2002), and Naqvi (2002) but contradicts the results of Ghani and Din (2006).

The estimated coefficient of gross domestic product (GDP) is 1.10. This result strongly supports the view that increase in GDP will enhance private investment in the economy. Also this result shows that there is demand-pull investment in Pakistan. It indicates that size of the market plays an important role in increasing the private investment. It shows GDP has higher impact on private investment as compared to the other variables in Pakistan. Policy-makers should always keep in mind this behaviour of investor. This finding is consistent with Blejer and Khan (1984), Chhibber and Wijnbergen (1988), Shafik (1992), Naqvi (2002) and Akkina and Celebi (2002).

In order to estimate single equation error correction model it is required to test weak exogeneity of variables against the parameters of interest. The weak exogeneity implies that the long run equation does not inter into all equations of the system. Therefore in the presence of weak exogeneity we can estimate short run error correction model of private investment by single equation approach rather than vector error correction approach.

We have tested the presence of weak exogeneity of variables (i.e., LCG_t, LIG_t and $LGDP_t$) by imposing restrictions on adjustment coefficients. It is to test hypothesis H_0: $a_2=a_3=a_4=0$ for unrestricted cointegrating vector (ß) by likelihood ratio test. The calculated chi-squared statistics is 4.41 which is less than critical value of $7.81 = \chi^2(3)$ at 5 percent level. The results indicate that variable LCG_t, LIG_t and $LGDP_t$ are weakly exogenous for the parameters of interest. This implies that these variables have no information about the cointegrating vector. The results therefore lead us to estimate dynamic error correction model of private investment for Pakistan by using single equation approach.[8]

4.3. Short-run Dynamic Model of Private Investment: The Error Correction Approach

After establishing the cointegration relationship an Error Correction Model is estimated to determine the short-run dynamics of investment behaviour. Following Hendry's general to specific approach we include different lags from top to low of explanatory variables and error correction term i.e., EC_{t-1}. The error correction term (EC) consists of the residual from the long-run private investment function.

We started with the following general ECM to obtain the short-run dynamic private investment model.

$$\Delta LPI_t = \ \text{ß}_0 + \text{ß}_1\Delta LPI_{t-1} + \text{ß}_2\Delta LCG_t + \text{ß}_3\Delta LCG_{t-1} + \text{ß}_4\Delta LIG_t + \text{ß}_5\Delta LIG_{t-1}$$
$$+ \text{ß}_6\Delta LGDP_t + \text{ß}_7\Delta LGDP_{t-1} + \text{ß}_8 UN_t + \text{ß}_9 EC_{t-1} \qquad \ldots \qquad \ldots \quad (12)$$

[8]This point is suggested by the anonymous referee.

After estimating this model, we gradually eliminate the insignificant variables. The results suggest that out of these regressors only three are establishing short-term relationship with the private investment significantly. All others insignificant variables are dropped from the model. Thus in the short-run ΔLPI_{t-1}, ΔLIG_{t-1} and UN_t have emerged significant variables, while others variables do not prove their existence in the short-run. The following specific ECM is found to be the most appropriate and fits the data best.

$$\Delta LPI_t = \beta_0 + \beta_1 \Delta LPI_{t-1} + \beta_2 \Delta LIG_{t-1} + \beta_3 UN_t + \beta_4 EC_{t-1} \quad \dots \qquad \dots \qquad \dots \quad (13)$$

All the variables are in first differences except the uncertainty variable (UN), which is used for capturing the effect of macroeconomic uncertainty on the private investment. The preferred model passed a set of diagnostic tests such as LM test of serial correlation, ARCH LM test, Brown, *et al.* (1975) CUSUM and CUSUM of Squares test of stability (graph is presented in Appendix). The results of preferred parsimonious dynamic error correction model are given in Table 5. Overall results are in line with theory and consistent with the studies conducted previously.

Table 5

Error Correction Model of Private Investment (ΔLPI)

Variables	Coefficients	Standard Error	*t*-value
ΔLPI_{t-1}	0.365729	0.109396	3.34
ΔLIG_{t-1}	–0.172844	0.070931	–2.44
UN_t	–0.047826	0.022856	–2.09
EC_{t-1}	–0.884592	0.141633	–6.24
Constant	0.027069	0.011745	2.30
R-square = 0.73		F (5, 32) = 16.18	

The estimated error correction coefficient is –0.88 and it is significant at 5 percent level with theoretically correct sign. The estimated coefficient of EC indicates that approximately 88 percent of disequilibrium in the private investment is corrected immediately, i.e. in the next year. It suggests a high speed of convergence to equilibrium if a disequilibrating shock appears.

The estimated coefficient of uncertainty proxy is –0.05 and significant at 5 percent level. This indicates that macroeconomic instability and uncertainty depresses private investment in Pakistan by creating uncertainty about current and future macroeconomic environment.

In the estimated dynamic error correction model the coefficient of lagged changes in private investment is positive and significant, which shows that the changes in previous period's private investment positively effect the short-term changes in the current private investment. This implies that present outcomes are not instantaneous; rather they are affected by the previous period's decisions.

The changes in public development expenditure having the negative and significant sign, shows that the changes in private investment are negatively related to the gross fixed capital formation in construction, electricity, gas, transport and communication in short run. This may be due to the reason that the speed of development

work in public sector is very slow but the nominal adjustment, i.e. in interest rate is quick. So in short run substitution effect is stronger than complementary effect. This finding reflects another fact that in short-period, public development expenditure initially crowds out private investment. This may be due to competition for human and financial resources. Over the long run, however, public development expenditure complements private fixed investment.

5. CONCLUSION AND POLICY IMPLICATIONS

The empirical findings support the proposition that public development expenditures lead to enhance the private investment in the economy. The well targeted public investments complements private investment and stimulate private sector's initiatives.

Public non-development expenditures have considerable negative effect on the private fixed investment. This result might be interpreted as a view that a larger government size is an obstacle to the private sector. It can be argued that higher public non-development expenditures leave less resource for development. It can also be argued that higher expenditures create expectations of higher future tax that might discourage the private investment activities in the economy.

We have found that Pakistan has been facing the macroeconomic instability and uncertainty that leads to depress the private sector. We can conclude that macroeconomic stability and policy credibility are key factors for the achievement of strong investment response. If the policy measures are perceived as inconsistent or suspected to be only temporary, then investors will prefer to wait and see before committing resources to irreversible fixed investment. Therefore, the present stabilisation programme should continue for the macroeconomic stability.

The results of the study also strongly support the view that private investment is positively related with the income level. It may also be argued that higher the size of market, higher will be the private investment in the economy. So it can be said that results are satisfied and provide the better basis for policy formulation and the future research.

APPENDIX

Plot of Cusum Test of Stability
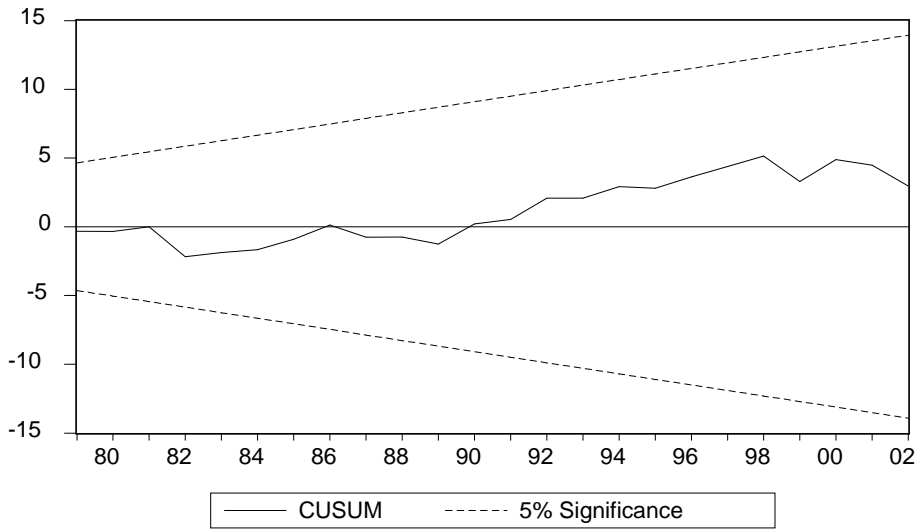
Plot of Cusum of Squares Test of Stability
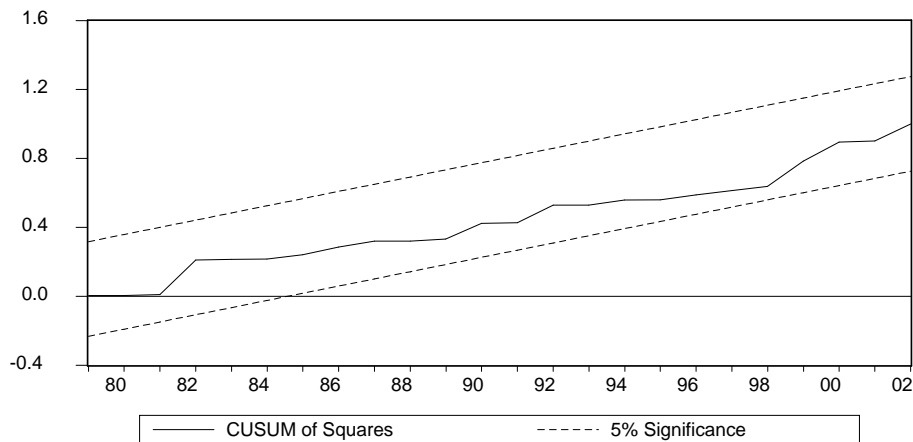
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