THE EFFECT OF PUBLIC INVESTMENT ON PRIVATE INVESTMENT IN KENYA

Abstract

Public investment largely influences the socio-economic development of a country despite inefficiency concerns. A strong private sector would cause growth of the economy due to the efficient management of the resources compared to an economy dominated by the public sector. Nevertheless, public spending patterns influence the economic activities such as social welfare dynamics of a country. However, high levels of government activities curtail or could replace private investment due to the competition for scarce financial resources in the economy. This paper sought to analyze the effect of public investment on private investment in Kenya using a vector error correction model. The findings showed a strong positive impact of public investment on private investment.

Key words: Public investment, Private investment, Vector error correction model

1. Background

The main driver of sustainable development in any economy is the private sector investment (Forni and Sessa, 2009). Studies have also revealed that growth driven by the private sector rather than the state sector has more positive impact to the economy (Levine and Renelt, 1992). This assertion is premised on the private sector efficiency in resource utilization compared to the public sector, something which has enactment of policies to increase private investment (Hermes and Lensink, 2001).

However, it's still unclear how public investment affects private investment (Karagol and Ozdemir, 2006). In addition, research on how government spending affects private investment, particularly in developing nations, has become a hot topic in policy discussions (Mallick, 2019; Ahmad et al, 2009). Infrastructure spending encourages private investment (Zou, 2006; Mohanty, 2020). Even so, economic literature suggests that excessive government borrowing substitute private investment eventually crowding it (Mallick, 2019).

The economic theory about public and private investment gives inconsistent and mixed results as to whether the former compliments or crowds-out the latter (Mallick, et al., 2018). Investment is important because it boosts technological development and the adoption of new practices that foster industrial expansion, which enhances the economy's capacity for production (Ahmad *et al*., 2008). Several factors determine investment and that during business cycle; the investment volatility is a significant factor that causes fluctuation of GDP (Thirlwall, 2015; Dornbush, 1999). The classical economists believed that market forces alone may bring about national wealth and prosperity, negating the need for government intervention in the economy. On the other hand, Keynes (1936) argued for governmental involvement to control society's saving and investing habits.

Several mechanisms have also been identified by which public investment may influence private investment. For example, development investment influences private investment positively through a reduction in production cost (Rahman et al., 2016). Infrastructure related investment complements private investment and improves productivity. This, in turn raises output demand and other related services that ultimately support the overall resource availability through expansion of aggregate output and savings (Rahman et al., 2016).

Additionally, government consumption spending boosts aggregate demand, which benefits private investment, but it has a negative impact on investment due to rising budget deficits (Alfred and Sagales, 2001). Moreover, the source of financing public investment whether by the taxes or debt also reduce the available resources to the private sector (Khan, 2022;Obeng et al.,2018; Aswata et al., 2018; Mallick, 2006; Nyamongo *et al*., 2012).

Public capital spending is important because it lowers transport costs and plays a critical role in increasing private returns. In this view, public capital increases the output generated by the private factors and in so doing affects growth significantly (Fujita and Thisse, 2002). However, the private sector will be crowded out if the government resorts to heavy domestic borrowing of the scarce resources in the economy. In the end the effect depends on strength of the opposite forces hence it is not impossible to guarantee their substitutability or complementarity (Mallick *et al,.*2018). Aschauer (1999a), emphasizing the significance of public infrastructure for economies, blamed insufficient infrastructure expenditure for the 1980s productivity decline in the United States.

Private investment enhances the overall macroeconomic development in an economy (Mbaye, 2014). Increasing the share of the private investment is poised to cause increase in economic growth and employment (Tyce, 2020). To restrain government expenditure and lower the budget deficit,

policymaker have pursued fiscal consolidation strategies which have sparked discussion over the role that public investment plays in encouraging or crowding out the private sector (Thanh,*et.al.,* 2020). This is due to the possibility that public expenditure depletes resources available for private sector investment, raising interest rates in the process and lowering overall levels of private investment. Private investment has been erratic in Kenya throughout the years. Public investment was 24 and 15 percent in 1970 and 2020 in that order while during the same period; private investment was 4 percent and 14 percent respectively.

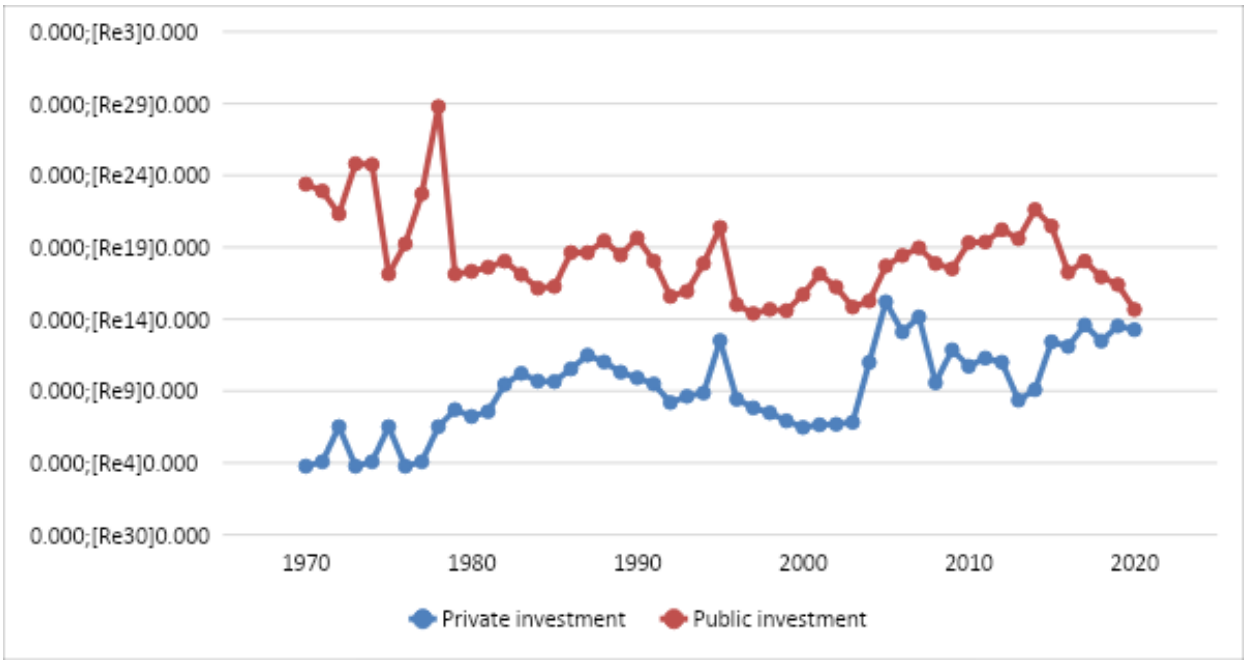


Figure 1: Public and Private Investment (1970-2020); Source: Author's computation

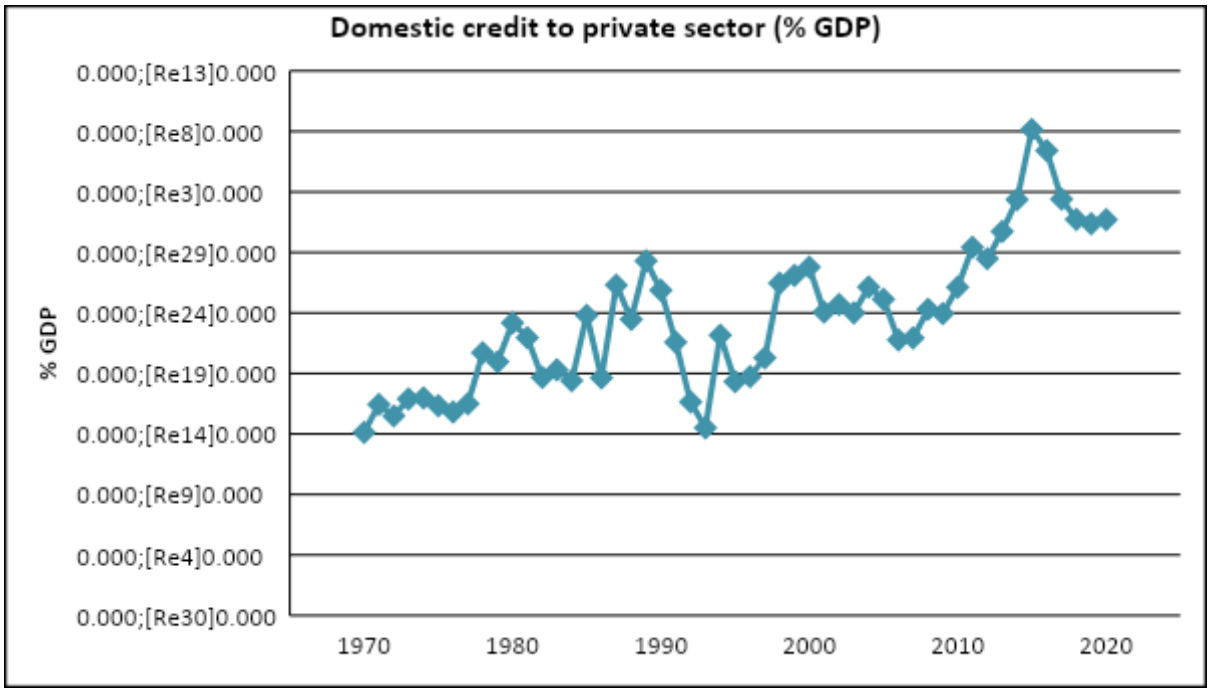
Towards the end of 1990 and early 2000, there was a sharp decline in private investment attributed to unfavorable event that affected private investment negatively. The political polarization of 1997 made the investment environment unfavorable and most of the investors relocated to other countries. In addition, the El- Nino rains of 1997 caused destruction of major infrastructure affecting the provision of essential services like power, transport and communication network (Republic of Kenya, 2003).

Upward trends were again experienced in 2003 with public investment increasing while private investment fluctuated downward from one period to another an indication of a possible crowding-out effect. Public investment showed a downward trend from 2014 to 2020 while private investment indicated upward trend over the same period. Private investment is also influenced by efficient financial sector through the mechanism of transforming deposits into financial assets (Hamida and Aziz, 2019).

Private sector development is reflected in the growth of domestic credit provided by the financial institutions (Cecchetti and Schoenholtz, 2011). The financial institutions provide credit to the investors thus enhancing private sector investment (Agénor and Montiel, 2015).

Figure 2 provides the trends of domestic credit from 1970 to 2020.

Figure 2: Trend of domestic credit to private sector; source: Author's own



computation

Domestic credit in Kenya rose from 17 percent in 1970 to 29 percent in 1989 mainly due to increased commercial banks liquidity ratios. Between 1991 and 1993, the domestic credit declined to about 15

percent due to quantitative credit controls introduced on commercial banks and the cash ratio requirement of 6 percent which caused commercial banks to cut back lending to the private investors (Republic of Kenya, 1994).

Between 1995 and 2012 domestic credit was, however, unstable with an average of 25 percent. This was mainly due to a number of challenges that included high inflation and the "twin crisis" comprising of the ripple effects of global financial crisis and the Eurozone crisis (Republic of Kenya, 2012). The increase in credit to the national government led to a rise in domestic credit between 2014 and 2015. The reversal or removal of interest rate capping in 2019 led to a decline in domestic credit. Figure 3 gives interest rate trends from 1970 to 2020.

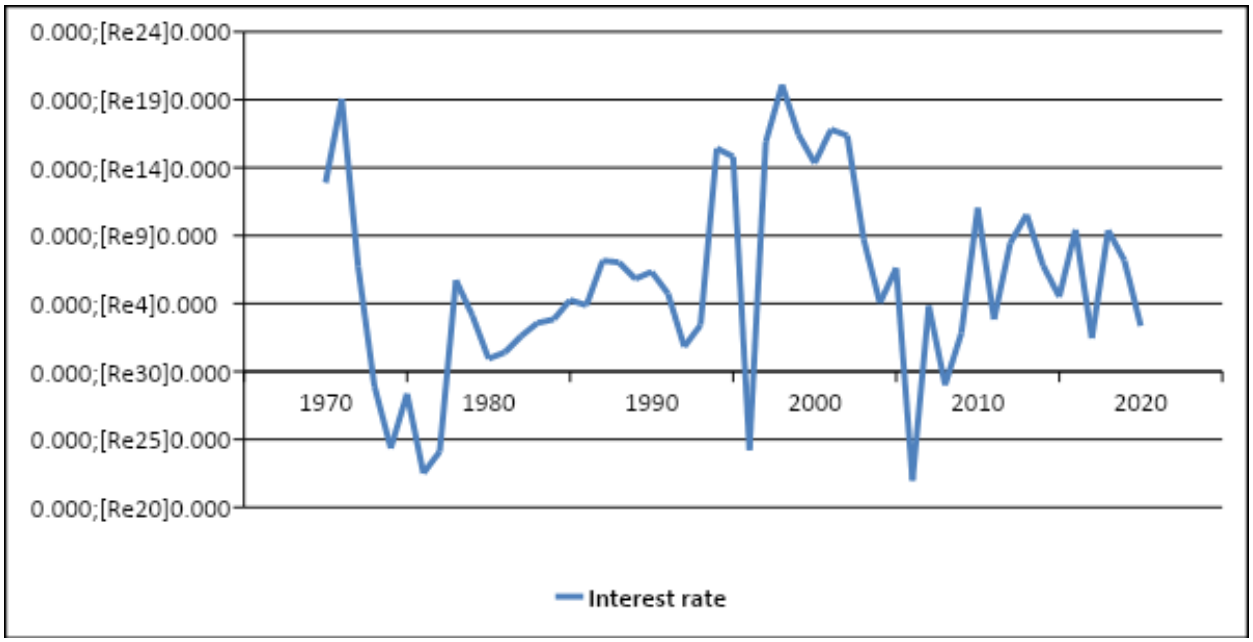


Figure 3: Trend of interest rate; source: Author's own computation

The interest rate averaged 6.5 percent from 1970 to 2020. The interest recorded an all-time high in 1971 and 1998 at 20.1 and 21.1 percent respectively due increased government borrowing to meet the budget deficit. Despite the government effort to allocate substantial resources for public capital formation, which should ultimately complement private investment, this has not been forthcoming. Further, the

public sector investment and how it impacts investment in the private sector has not received much attention in Kenya hence the need for an empirical analysis.

2.1 Theoretical Literature

The mechanisms by which investment occurs in an economy are explained by a number of hypotheses that have developed over time. Keynes (1936) argues that the driver of investment is the anticipated returns investors expect from new investment. Keynes also argued that investment fluctuates due to shifts in demand curve and not its movement. The investment may be volatile since it depends in part on the firm's expectations of the profits the investment would provide, which is a compelling argument for how the business cycle is explained.

The Keynesian method is followed by the accelerator theory of investment, which maintains the fixed-price supposition. Samuelson (1939) applied the principle of acceleration by postulating a linear correlation between investment and output. The theory assumes that investment is enough to maintain the equality of actual and the desired capital stock. The accelerator principle was later modified to the flexible accelerator principle of investment.

Tobin (1969) Q-theory of investment is one of the longstanding theories of investing. Investments are made, according to Tobin, up to the point where the value of the investment is the same as the cost of replacing it. The main tenet of Q-theory is that it emphasizes measuring changes in capital stock. Tobin also proposed that a firm's investment level is determined by Tobin's q, a ratio between the installed capital's current worth and its replacement cost. Additionally, firms' capital stocks will rise if q is greater than one and fall if q is lower. A higher marginal return than the marginal cost implies investment is worth undertaking. If $q>1$, businesses invest more in capital goods because they anticipate making more money, which raises the level of overall investment. If $q<1$, firms will try to cut back on planned

investments since the expenditure incurred is more than the present value of the earnings they will make from additional investment.

Jorgenson's (1963) macroeconomic theory of investment is based on the optimization problem for a firm's profits which is stated as;

$$Y(t) = AK^{\alpha}L^{1-\alpha}$$

The representative firm aims to maximize profit, which depends on capital, output and labor costs. This theory's fundamental premise is K(t) adjusts to K*(t), which implies that capital is immediately adjusted to the appropriate capital stock. According to Jorgenson's (1963) theory of investment, a corporation would behave optimally in terms of investments when it can quickly adjust its capital stock to stay on the right course. However, businesses will consider about altering the capital stock if there is a significant increase in returns on capital, maybe as a result of sudden changes in interest rates.

There are several avenues that link public and private investment (Batool and Godlman, 2021). Public investment, according to Erenburg and Wohar (1995), raises national output, which improves the economy's physical and financial resources. Additionally, a decrease in the cost of manufacturing may result from investments in physical infrastructure including roads, railways, energy, and water systems.

Holcombe (2006) postulated that due to the competition of resources in the economy government investment tends to negatively affect private investment leading to a decline in credit due to an increase in interest rate which raises the cost of financing investment. Moreover, the majority of state economic enterprise investments are either funded by external borrowing or deficit financing, resulting in a significant deficit that further limits credit availability and pushes up interest rates (Qayyum, 2005).

Other significant theories that attempt to elucidate the behavior of private investment are the crowding in and crowding out hypotheses. According to the crowding theory, the economy is out of equilibrium

because in the short-run, aggregate demand and supply are out of balance leading to underemployment of output. The theory also claims that because of the extra capacity the interest rate affects both savings and investment (Sineviciene and Vasiliauskaite, 2012).

In light of this, an expansionary fiscal policy, such as a tax cut, will increase income for individuals and, as a result, encourage private sector investment, which in turn will increase income. According to Keynes, the fiscal multiplier effect will likely cause expansionary fiscal policy which will boost the private sector market and its products (Sineviciene and Vasiliauskaite, 2012; Gerrard, 1996).

The view of the crowding out hypothesis is that when the economy is in full employment in the long run, the interest rate influences savings and investment (Sineviciene and Vasiliauskaite, 2012). According to this theory, increased government participation in the economy through expansionary fiscal policy will increase domestic borrowing to fund budget deficits. Thus, interest rate will rise and the firms' after tax profit income and profits will decline. In this regard, the positive impact of government intervention will be temporary and its fiscal policy ineffective (Mohanty, 2019; Gerrard, 1996).

3.2 Empirical Literature

Hassan and Salim (2011) conducted a study to analyze the primary drivers of private investment in Bangladesh. The authors found that changes in private investment were significantly influenced by government spending. High amounts of crowding-out were also revealed by the data.

Using a panel data from 1980 to 1997, Erden and Holcombe (2006) examined the causal link between public and private investment using the cointegration approach. The findings indicated that government investment programmes influences private investment.

Karagol and Ozdemir (2006) examined the relationship between government expenditure and private investment in Turkey from 1967 to 2001. The study employed cointegration analysis to estimate a multivariate equation. The results suggested that the covariates had a long-term association. Additionally, it was clear that in Turkey, government spending on investments crowds out private investment.

Fatima and Waheed (2011) sought to examine how Private investment in Pakistan was influenced by government expenditure among other macroeconomic factors. The findings showed that although government purchases hindered private investment, development expenditures boosted it. Additionally, it was clear from the findings that uncertainty in an economy resulted in macroeconomic instability, which lowers private investment.

Bucci and Del Bo (2012) analyzed how public capital effects economic growth in endogenous growth framework. In the analysis, government expenditure considered to be productive was specified as stock-variable while public capital was partly used as a factor of production to produce output. The results indicated that given the degree of complementarity government expenditure impacts economic growth positively.

Munthali (2012) tested the crowding in-out hypothesis by conducting a dynamic panel analysis linking governmental and private investment using South African data. The empirical result did not support the evidence of crowding-in. However, the study did reveal that uncertainty and a lack of capital were the primary obstacles to South Africa's private investment.

In another study, Celebi and Akkina (2002) analyzed the determinants of private investment and whether there was any relationship regarding public and private capital using VAR model. The results supported the crowding-out hypothesis.

Using the vector autoregressive approach, Wawire et al. (2014) analyzed the private investment-expenditure nexus in Kenya from 1963 to 2012. The findings showed consumption and expenditure spurs private investment. The findings also demonstrated reforms to public spending discouraged activities in the private sector.

Using the Johansen Cointegration approach, Hassan and Salim (2011) evaluated the factors influencing private investment in Bangladesh. The flexible accelerator theory was confirmed by the empirical findings. The outcomes also showed that national income had a long-term impact. The empirical results revealed that whereas using monetary policy during a recession was ineffective, government spending was a viable instrument to lift the economy out of a slump.

Omojalaibi et al. (2016) used annual data from 1993 to 2014 to investigate how fiscal policy affects private investment in West African nations. Fixed effect modeling and the method of ordinary least squares were used in the investigation. The findings indicated there was a considerable crowding in effect on government capital spending. The findings also demonstrated that private investment was pushed out by non-tax earnings and recurrent expenses. Across all of the nations, the accelerator effect on output growth was negligible.

Ahmed and Miller (2000) Ahmed and Miller (2000) investigated how government spending affected private investment. The study focused on government budget constraints and its effects on private. The results showed that government expenditure affects private investment positively. Specifically, it was evident that expenditures on social security and welfare worsened private investment. Further, the results revealed crowding out effect was more significant among the sample of the developing countries.

3.1Theoretical Framework

The modified flexible accelerator model developed by Blejer and Khan (1984) serves as the foundation for this study as opposed to the neoclassical investment model of Jorgenson (1967) and Hall et al., (1977). The fundamental neoclassical model must be adjusted due to the challenges it faces in terms of the definition and measurement of capital stock.

The theoretical model for this study is, therefore, derived in consistent with the flexible accelerator framework that incorporates an explicit role for public investment. The model expresses the functional relationship between public policy instruments, in this case public investment and private capital accumulation. According to the model, the expected output Y, which relies on the level of capital, is:

$$K^{*}_{pt} = \alpha Y^{e}_{t}, \qquad (3.1)$$

Where K^{*}_{pt} is optimal private sector capital stock in period *t*, while αY^{e}_{t}, is expected output. However, installation of new capital would take time, and, therefore, to address the adjustment process we introduce an adjustment cost function as follows:

$$\beta(K_{pt} - K^{*}_{pt})^{2} + (1 - \beta)(K_{pt} - K_{p,t-1})^{2} \qquad (3.2)$$

K_{pt} is private capital stock. In equation equation (3.2), the first term depicts the disequilibrium cost, whereas the second term indicates the adjustment cost. The disequilibrium cost is minimized with respect to K_{pt} to derive adjustment equation (3.3) given as follows:

$$K_{pt} - K_{pt-1} = \beta\left(K^{*}_{pt} - K_{pt-1}\right) \quad 0 \leq \beta \leq 1 \qquad (3.3)$$

where β =adjustment coefficient.

Equation (3.3) indicates adjustment between required stock of capital in time *t* and the previous one.

This study used gross private investment expressed as:

$$PI_t = \left(K_{pt} - K_{pt-1}\right) + \delta K_{pt-1} \quad (3.4)$$

δ= Depreciation rate

PI = Gross private investment

Rearranging equation (3.4) gives (3.5)

$$PI_t = [1 - (1 - \delta)L]K_{pt} \quad (3.5)$$

The capital adjustment is specified as:

$$PI_t = PI_{t-1} = \beta\left(PI^*_t - PI_{t-1}\right) \quad (3.6)$$

The core of this study's contribution is Equation (3.6) which is modified by assuming that public investment affects the short term adjustment of the existing private investment.

Thus, β is stated as:

$$\beta = \alpha_0 + \left[1/\left(PI^*_t - PI_{t-1}\right)\right]\left(\gamma_1 GI_t + \gamma_2 X_t\right) \quad (3.7)$$

Where, α_0= Constant

GI=Gross public investment

X_t=Other macroeconomic factors.

Plugging (3.7) into (3.6) and rearranging gives equation (3.8) as:

$$PI_t - PI_{t-1} = \alpha_0\left(PI^*_t - PI_{t-1}\right) + \gamma_1 GI_t + \gamma_2 X_t \quad (3.8)$$

The steady state of equation (3.4) is given as:

$$PI^*_t = [1 - (1 - \delta)L]K^*_{pt} \quad (3.9)$$

Putting (3.1) into (3.9) and then what we get put it into (3.8) gives (3.10).

$$PI_t = a_0[(1 - \delta)L]\alpha Y^e{}_t + \gamma_1 GI_t + \gamma_2 X_t + \left(1 - a_0\right) + PI_{t-1} + \varepsilon_t \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (3.10)$$

The coefficient Y^ecaptures the accelerator effect. Equation (3.10) is a reduced-form gross private investment.

3.2 Empirical model specification

In this study, crowding out occurs indirectly through the rate of adjustment rather than directly by altering the targeted real private investment level. Interest rate also influences private investment. For instance, a rise in demand for funds drives the interest rate up and increases credit cost (Laopodis, 2001). Private consumption has an impact on domestic private investment through increased purchasing power brought on by an increase in household demand for commodities. Exchange rate policies affect private capital inflow by increasing or decreasing funds availability to the private sector (Blejer and Khan 1984). The estimated equation is given as follows based on the aforementioned justifications and taking into account the previously mentioned macroeconomic variables:

PI=f (GI, RIR, EXR, PC)…… (1)

Where,

PI = Private fixed investment

GI=Government investment

RIR=Real interest rate

PC = Private consumption

EXR= Effective exchange rate

3.3 Estimation methodology

The reviewed literature showed that public investment is not the only variable that may influence private investment but also other macroeconomic indicators could also have a bearing on private investment. Both economic theory and empirical evidence fall short of providing adequate and clear information about private and public investment interaction. Given this shortcoming, this study applied VECM in line with Sims (1972) and Sims (1980). The justification for using VECM is that all variables are considered endogenous. Secondly, the model shows how the variables gradually evolve from their common starting point in time (Verbeck, 2000; Wesselhoft, 2013).

The starting point of VECM is a general VAR model with p number of lags. A VAR(p) with exogenous variables X is expressed as;

$$Y_t = X_0 + A_1Y_{t-1} + \dots + A_pY_{t-p} + B_0X_t + B_1X_{t-1} + \dots + B_sX_{t-s} + \varepsilon_t \qquad (2)$$

Where;

Y_t= vector of K variables

X_t= exogenous parameters.

If the VAR is stable, it is represented as a moving average as follows:

$$y_t = \mu + \sum_{i=0}^{\infty} D_iX_{t-i} + \sum_{i=0}^{\infty} \emptyset_i\mu_{t-i} \qquad (3)$$

Equation (3) is a type of VAR represented as vector moving average (VMA where all the past values of y_t are substituted out. Matrix D_i is a dynamic multiplier function. The coefficient $\emptyset_i$ is the impulse-response functions (IRFs) at horizon *i*. Other diagnostic tests such as residual autocorrelation and normality test were conducted to ensure the VAR model is stable. The estimation of parameters using VAR model presupposes the variables are I(0). VAR models have problems when applied to

non-stationary series. If the variables are I(1) or become stationary after differencing, they can be modeled in a VECM as follows:

$$\Delta y_t = \alpha_1 + \gamma_1 ecm_{1t-1} + \sum_{i=1}^{n} \beta_1 \Delta y_{t-i} + \sum_{i=1}^{n} \delta_1 \Delta x_{t-i} + \varepsilon_{1t} \quad (4)$$

$$\Delta x_t = \alpha_2 + \gamma_2 ecm_{2t-1} + \sum_{i=1}^{n} \beta_2 \Delta y_{t-i} + \sum_{i=1}^{n} \delta_2 \Delta x_{t-i} + \varepsilon_{2t} \quad (5)$$

Where,

β_1, β_2, δ_1, δ_2 =short run coefficients

γ_1 andγ_2= error correction term coefficients

ε_{1t} and ε_{2t}= residuals.

3.4 Unit root test

The study applied KPSS and DF-GLS method to check unit root. The regression equation for KPSS is a langrage multiplier (LM) statistic defined as:

$$LM = \sum_t S(T)^2 / \left(T^2 f_0\right) \quad (6)$$

Where;

f_0= estimator of the residual at zero frequency

$S(T)$= cumulative residual function defined as:

$$S(T) = \sum_{r=1}^{t} v_t$$

The Elliot et al. (1996) suggested DF-GLS unit root test is essentially an ADF test. However, DF-GLS test has a notably higher power than the ADF test. The regression equation is analogous to the ADF and is specified as

$$\Delta y_t = \alpha + \beta y_{t-1} + \delta_t + \sum_{j=1}^{p} \psi_j \Delta y_{t-j} + \varepsilon_t \quad (7)$$

where Δy_{t-j} is the lagged difference term, p is the lag order.

3.5 Co-integration

The Johansen test for cointegration (Johansen and Juselius, 1990) was used to identify the cointegrating vectors which is specified as;

$$\Delta y_t = \alpha_0 + \pi y_{t-1} + \sum_{i=1}^{p-1} \Gamma_i \Delta y_{t-i} + \varepsilon_t \quad (8)$$

Where π and Γ= coefficient matrixes

Δ= difference operator

P= lag order

ε_t= error term.

The study used Johansen's trace test and the maximum eigenvalues to obtain the number of cointegrating vectors as given in equations (9) and (10).

$$\hat{\lambda}_{trace}(r) = -T \sum_{i-r+1}^{n} \ln ln \left(1 - \hat{\lambda}_i\right) \quad (9)$$

$$\lambda_{max}(r, r+1) = -Tln\left(1 - \hat{\lambda}_{r+1}\right) \quad (10)$$

Where

$\hat{\lambda}$ = estimated eigenvalues

T= number of observations.

Trace tests in equation (9) *r* cointegrating vector against the alternative *n* cointegrating vectors while the maximum Eigenvalue tests in equation (10) investigates *r* cointegrating vectors against *r+1* (Dasgupta, 2016).

3.6 Vector error correction model

The long-run equilibrium is examined by applying the VECM.

The econometric equations derived from equation (1) are specified as follows:

$$\Delta PI = \alpha_1 + \sum_{i=1}^{k-1} \beta_i \Delta PI_{t-i} + \sum_{j=1}^{k-1} \varphi_j \Delta GI_{t-j} + \sum_{n=1}^{k-1} \phi_n \Delta EXR_{t-n} + \sum_{m-1}^{k-1} \gamma_m \Delta RIR_{t-m} + \sum_{p=1}^{k-1} \delta_p \Delta PC_{t-p} + \lambda_1 ECT_{t-1} + \varepsilon_{1t} \quad (11)$$

$$\Delta GI = \alpha_2 + \sum_{i=1}^{k-1} \beta_i \Delta PI_{t-i} + \sum_{j=1}^{k-1} \varphi_j \Delta GI_{t-j} + \sum_{n=1}^{k-1} \phi_n \Delta EXR_{t-n} + \sum_{m-1}^{k-1} \gamma_m \Delta RIR_{t-m} + \sum_{p=1}^{k-1} \delta_p \Delta PC_{t-p} + \lambda_2 ECT_{t-1} + \varepsilon_{2t} \quad (12)$$

$$\Delta EXR = \alpha_3 + \sum_{i=1}^{k-1} \beta_i \Delta PI_{t-i} + \sum_{j=1}^{k-1} \varphi_j \Delta GI_{t-j} + \sum_{n=1}^{k-1} \phi_n \Delta EXR_{t-n} + \sum_{m-1}^{k-1} \gamma_m \Delta RIR_{t-m} + \sum_{p=1}^{k-1} \delta_p \Delta PC_{t-p} + \lambda_3 ECT_{t-1} + \varepsilon_{3t} \quad (13)$$

$$\Delta RIR = \alpha_4 + \sum_{i=1}^{k-1} \beta_i \Delta PI_{t-i} + \sum_{j=1}^{k-1} \varphi_j \Delta GI_{t-j} + \sum_{n=1}^{k-1} \phi_n \Delta EXR_{t-n} + \sum_{m-1}^{k-1} \gamma_m \Delta RIR_{t-m} + \sum_{p=1}^{k-1} \delta_p \Delta PC_{t-p} + \lambda_4 ECT_{t-1} + \varepsilon_{4t} \quad (14)$$

$$\Delta PC = \alpha_5 + \sum_{i=1}^{k-1} \beta_i \Delta PI_{t-i} + \sum_{j=1}^{k-1} \varphi_j \Delta GI_{t-j} + \sum_{n=1}^{k-1} \phi_n \Delta EXR_{t-n} + \sum_{m-1}^{k-1} \gamma_m \Delta RIR_{t-m} + \sum_{p=1}^{k-1} \delta_p \Delta PC_{t-p} + \lambda_5 ECT_{t-1} + \varepsilon_{5t} \quad (15)$$

Where; *PI* = private fixed investment

GI= Public investment

PC = Private consumption

RIR=real interest rate

EXR= exchange rate

K-1 = lag length which is reduced by 1

ECT_{t-1}= lagged error correction term.

$\beta_i, \varphi_j, \phi_n, \gamma_m \; and \; \delta_p$ = short run coefficients

$\lambda_1, \lambda_2, \lambda_3 \; \lambda_4$ and λ_5= Speed of the adjustment parameter

$\varepsilon_{1t} \; \varepsilon_{2t} \; \varepsilon_{3t} \; \varepsilon_{4t}$ and ε_{5t}= error terms.

Estimating VECM involves testing the order of integration whereby if the series are not cointegrated the unrestricted VAR model is estimated. However, if the series are cointegrated the VECM is estimated.

3.7 Impulse Response Analysis (IRF)

The IRFs measure the effect of a shock directed to the dependent variable and other exogenous variables. The estimated coefficients were used to derive impulse responses. The IRFs were used to regulate the magnitude of the shocks in private investment attributed to the macroeconomic variables. Computation of IRF requires the VECM to be stable. Therefore, the stability of the model was performed before computing the IRF.

3.8 Data sources and measurement

The study used time series data derived from the World Bank database from 1970 to 2020. Table 1 offers variable description and measurements.

Table 1: Description and measurement of the variables

Variable	Abbreviation	Description	Unit of Measurement
Private investment	PI	The amount spent by the private sector to add to fixed assets. Fixed capital formation is used as proxy for private investment.	% of GDP

Public investment	GI	This include plant, machinery, construction of roads, railways. Gross fixed capital formation is used for the analysis.	% of GDP
Exchange rate	EXR	The price of one currency in terms of another.	Measured as a local currency unit relative to the U.S. dollar.
Real interest rate	RIR	The interest rate adjusted for inflation as measured by the GDP deflator.	Annual percentage
Private consumption	PC	Is the market value of all goods and services purchased by the households.	% of GDP

4 EMPIRICAL RESULTS AND DISCUSSION

Descriptive statistics

Table 2: Descriptive statistics

Variable	Obs	Mean	Std. Dev.	Min	Max
Private investment	51	10.129	2.97	4.77	16.206
Public investment	51	19.423	2.955	15.388	29.789
Real Interest rate	51	7.975	5.422	0.943	21.096
Exchange rate	51	49.049	35.306	7.000	106.451
Private consumption	51	70.302	7.959	55.648	82.496

Unit Root test

The study used KPSS and DF-GLS to ascertain the unit root at 5 percent significance as provided in table 3.

Table3: Unit root test

Stationarity of variables in levels			**Stationarity of variables in first differences**	
Kwiatkowski–Phillips–Schmidt–Shin (KPSS) (5%) H0: the series is trend stationary				
Variable	**Without trend**	**With trend**	**Without trend**	**With trend**
Private investment	1.38	0 .233	0.0415**	0.0378**
Public investment	0 .71	0.294	0.0335**	0.0298**
Real interest rate	0.38**	0.275	0.0334**	0.0335**
Private consumption	2.31	0.155	0.0281**	0.0244**
Exchange rate	2.54	0.216	0.134**	0.0859**
Dickey-Fuller Generalized Least Squares (5%) H0: the series has a unit root				
Private investment	-1.110	-2.789	-5.863**	-5.843**
Public investment	-1.418	-2.519	-7.494**	-7.618**
Real Interest rate	-2.586**	-2.730	-5.252**	-6.722**
Private consumption	-0.602	-2.486	-4.956**	-6.544**
Exchange rate	0.814	-1.902	-4.717**	-4.917**

*Source: Author's own computation using Stata: **p<0.05 significance level*

The unit root test shows that the variables are *I(I)* except interest rate whose outcome is ambiguous. Interest rate shows that the variable is stationary without trend but non-stationary with trend in both KPSS and DF-GLS.

Cointegration Analysis

The unit root test showed that private investment, public investment, exchange rate and private consumption are I(I). The study, therefore, performed co-integration analysis on these variables. Interest rate was also considered as I(I) variable and included in the model since the variable is not trend stationary. The study used Johansen technique of maximum likelihood procedure, which is more advanced as opposed to a single equation.

Johansen approach makes it possible to estimate the number of cointegrating relationships and explores every kind of information available concerning interactions of the variables. The Johansen procedure uses the trace test and the maximum eigenvalues to obtain the number of cointegrating vectors (Odhiambo, 2015).

Table 4: Johansen tests for cointegration; H0: No cointegration

Max Rank	H_0	H_1	Test statistic	5% critical value
(a) Trace statistics				
0	$r = 0$	$r = 1$	88.3164	68.52
1	$r \leq 1$	$r = 2$	50.6157	47.21
2	$r \leq 2$	$r = 3$	19.9677*	29.68
3	$r \leq 3$	$r = 4$	8.7441	15.41
4	$r \leq 4$	$r = 5$	0.0093	3.76
5	$r \leq 5$	$r = 6$	-	-
(b) Maximum eigenvalue statistics				
0	$r = 0$	$r = 1$	37.7006	33.46
1	$r \leq 1$	$r = 2$	30.6481	27.07
2	$r \leq 2$	$r = 3$	11.2235*	20.97
3	$r \leq 3$	$r = 4$	8.7349	14.07
4	$r \leq 4$	$r = 5$	0.0093	3.76
5	$r \leq 5$	$r = 6$	-	-

Source: Author's computation using Stata; No. of lags included=2; trend: constant

Since the trace statistics of 88.3 is greater than 5% critical value, the null hypothesis of zero cointegration equation is rejected. Similarly, one cointegration equation is rejected since the trace

statistic is higher than the critical value at 5%. A maximum of two cointegrating equations can be identified in the model, according to the asterisk on the trace statistics. The maximum statistic

is also larger than the 5% critical value hence zero and one cointegrating equation is rejected.

Dependent/Independent Variables	(1) D. Private investment	(2) D. Public investment	(3) D. Exchange rate	(4) D. Interest rate	(5) D. Private consumption
L. ECT	-0.252***	-0.164	0.00301	-0.856***	0.0974
	(0.0937)	(0.124)	(0.268)	(0.202)	(0.167)
LD. Private investment	-0.0981	-0.134	-0.620	0.280	0.120
	(0.143)	(0.190)	(0.411)	(0.310)	(0.256)
LD. Public investment	0.210**	-0.248*	-0.0364	0.405*	0.384**
	(0.106)	(0.141)	(0.305)	(0.230)	(0.190)
LD. Exchange rate	-0.0229	-0.0285	0.0761	0.354***	-0.0195
	(0.0574)	(0.0761)	(0.164)	(0.124)	(0.102)
LD. Interest rate	0.121**	0.0253	-0.0540	0.0660	0.0231
	(0.0576)	(0.0764)	(0.165)	(0.125)	(0.103)
LD. Private consumption	0.0790	-0.411***	0.226	0.272	-0.0286
	(0.0866)	(0.115)	(0.248)	(0.187)	(0.155)
Constant	0.546*	0.255	1.885**	-0.165	0.336
	(0.306)	(0.406)	(0.878)	(0.662)	(0.547)

Table 5: VECM results

Source: Author's computation: standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

The first row of table 5 has the dependent variables while the first column has the independent variables. The VECM regression is made up of five equations namely private investment, public investment, exchange rate, interest rate and private consumption. The regression results show presence of long run causality at the private investment and interest rate equations as indicated by the negative lagged error correction term coefficients that are significant at one percent. The lagged ECT at the public investment equation is, however, insignificant. The ECT at the exchange rate and private consumption equations are positive and also insignificant implying absence of long run correlation for the two equations.

The short run coefficients indicate the first lag of the first difference government investment has a significant causal effect on private investment, previous public investment, interest rate and private consumption. In the short run, a one percent increase in public investment increases private investment by 0.21 percent and causes the previous public investment to decline by 0.25 percent. In addition, a percentage increase in public investment cause 0.41 and 0.39 percent increase in real interest rate and private consumption respectively.

The short run coefficients also show that a one percent exchange rate revaluation causes interest rate to go up by 0.35 percent. A one percent increase in interest rate is associated with 0.12 percent increase in private investment. It is evident that an increase in private consumption leads to 0.41 percent decrease in public investment. The constant values at private investment and interest rate are also significant at 10 and 5 percent respectively.

The study also evaluated post-estimation of the VECM to determine whether the estimated eigenvalues are less than one. The stability result is given in table 6.

Table 6: VECM stability condition

Eigenvalue stability condition

Eigenvalue	Modulus
1	1
1	1
1	1
1	1
.01663544 + .5804681i	.580706
.01663544 - .5804681i	.580706
-.1069263 + .3481786i	.364227
-.1069263 - .3481786i	.364227
-.3414038	.341404
.3225392	.322539

The VECM specification imposes 4 unit moduli

Source: Author's own computation using STATA

The outcome of stability test shows the VECM is stable since the remaining *r* eigenvalues are less than one. This is also confirmed by the outcome in figure 4 about the stability of the model.

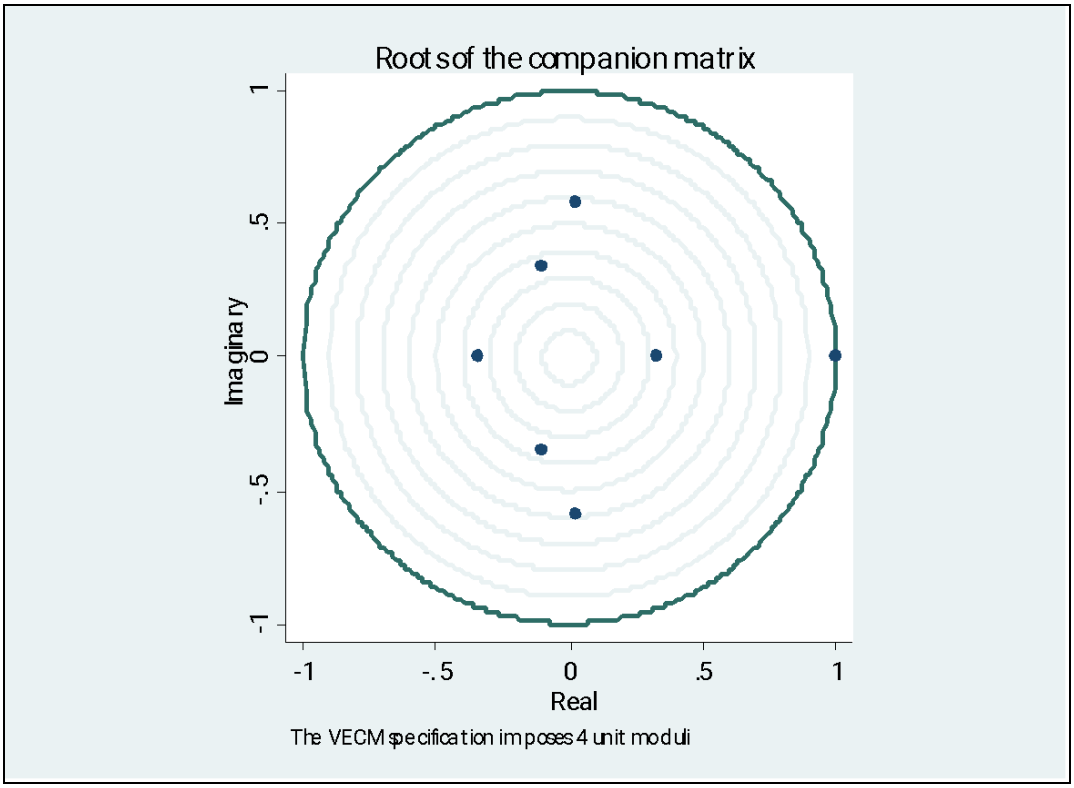


Figure 4: VECM stability condition The eigenvalues meet the stability condition.

Impulse response functions (IRF)

IRFs were used to further ascertain a dependent variable's responsiveness to a shock in an independent variable. Modelling I(I) variables in a cointegrating VECM do not revert back to their mean. Therefore, the unit moduli in the companion matrix suggest that some shock effects won't diminish with time. As a result, a shock to an I(0) variable will only be temporary, whereas a shock to an I(I) variable may both be permanent and temporary. Figure 5 shows the findings from the IRFs.

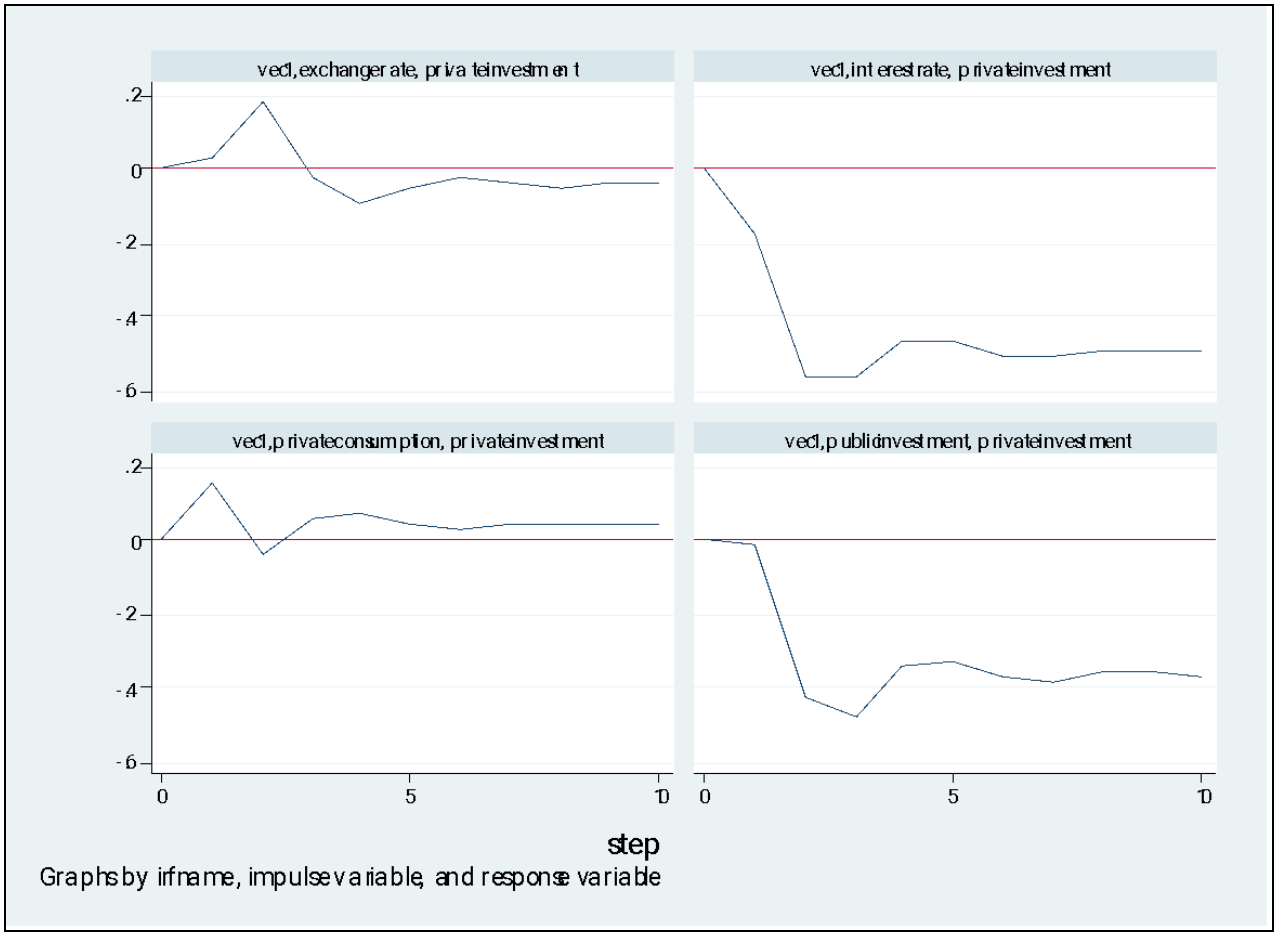


Figure 5: Impulse response functions

Figure 5 shows that an orthogonalized shock to the exchange rate and private consumption has a transitory effect on private investment while an orthogonalized shocks to the public investment and interest rate have a permanent effect on private investment. According to this model, unexpected shock to the exchange rate and private consumption will have a transitory effect on private investment. Similarly, unexpected shock to the public investment and interest rate will have permanent effect to the private investment in Kenya.

5. Conclusions and Policy Implications

The regression findings showed a strong impact of public investment on private investment, as indicated by the quite significant coefficient of public investment. The empirical result supports the claim about government investment in enhancing private investment. The government, therefore, should continue to enhance and pursue investment policies in many economic sectors that might encourage more private investment. Kenya is one of the developing nations that should develop strategies and policies to get rid of the bottlenecks brought along by limited physical capital.

The possibility of public sector to enhance private investment is anchored on the success of new capital formation in promoting private sector productivity. Moreover, maintaining a stable interest rate is important for enhancing private investment. The government should adopt policies that reduce the cost of investment credit thereby enabling investors to venture into diverse investment opportunities. Financial sector liberalization and licensing additional domestic banks to venture in the market could reduce the cost of borrowing. This may, in turn, encourage firms and individuals to take up credit to finance additional investment spending.

The results also showed that the short-term effect of exchange rate on private investment is negative. The policy implication is for the government to adopt measures that would stabilize exchange rate in order to minimize costs incurred due to currency depreciation.

Finally, the empirical finding indicated that in the short-term private consumption has a positive but insignificant effect on private investment. The policy implication is that increasing the household's purchasing power increases private consumption spending. The government should implement policies that will reduce inflationary pressure and hence stimulate private consumption. In addition, well-targeted government spending programs may also be used as a tool to promote private consumption spending

because this will enhance demand for domestic goods. Increases in demand for domestic goods would trigger an increase in sales and hence profits which can be ploughed back for investment to increase firms' production capacities.

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