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IMPACT OF PUBLIC INFRASTRUCTURAL INVESTMENT ON PRIVATE INVESTMENT IN KENYA

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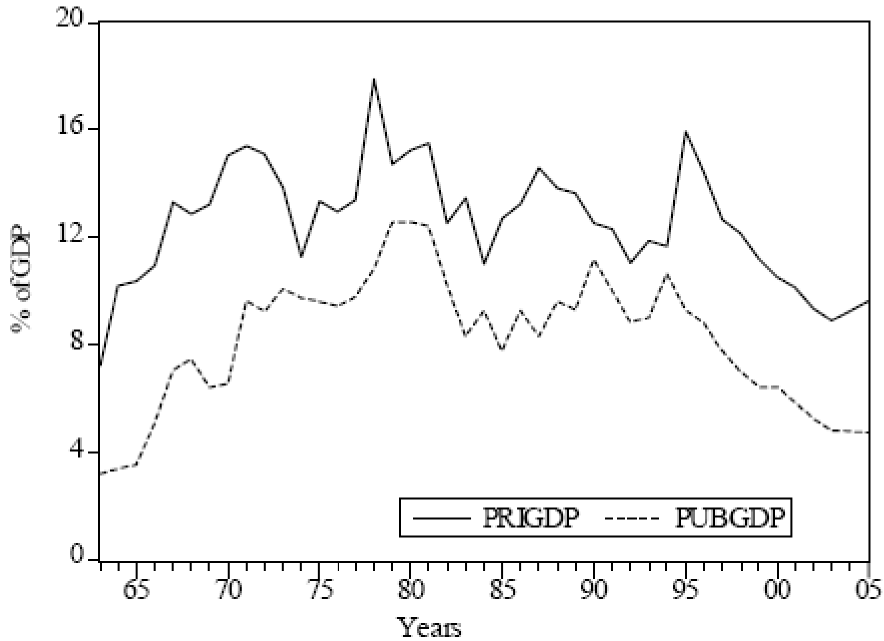
Abstract
This study explored the impact of public investment in infrastructures on private investment over the period of 1970-2007.The variables were first tested for unit root using the Dickey-Fuller (1979) and Philips-Perron (1988) techniques. The study employed the Multivariate Cointegration Technique developed in Johansen (1988) to test the long run relationship of the variables and the Error correction model was used to determine the short run relationship of the variables. A long-run model stability test was undertaken using CUSUM test and CUSUM of squares test (Brown et al. 1975). The unit root test revealed that all the variables under investigation are cointegrated of order one, that is I(1), in the short- run and are also cointegrated in the long run. The long-run model was found to be stable. The major hypothesis of this paper is that public infrastructural investment crowds in/out private investment. The result from the study was that Central Government Infrastructural Investment and Private Investment are complementary. The study recommends policy intervention measures that will improve private investment which includes increasing central government infrastructural investment.

Keywords: private investment, public investment, infrastructure, crowd in/out

INTRODUCTION

The study sought to establish the effect public expenditure in infrastructure on private investment in Kenya. The Physical infrastructure sector consists of Roads and Public Works including roads and airstrips in national parks and reserves, Water and sanitation services, Transport, Energy, Local Government and Housing. The Government has continued to commit more resources for infrastructural development in the last 5 years. In development expenditure for example, resource allocation increased from Kshs. 13.8 billion in 2002/03 FY to Kshs. 56.5 billion in 2006/07 FY. This rose to Kshs 86.4 billion in the 2007/08 FY and is expected to stand at Kshs. 76.7 billion during the FY 2008/09. (KNBS Abstracts)

Figure 1: Private and Public Investments as percentage of GDP, 1963-2005



Private investments as percentage of GDP (PRIGDP) have moved from lowest of 7.25% in 1963, the highest of 17.90% in 1978, to 9.66% in 2005. Public investments as percentage of GDP (PUBGDP) registered a 3.22% in 1963, 12.60% in 1980, and 4.75% in 2005. The figure shows that investments have declined gradually since 1995. (Central Bank of Kenya Annual Report, 2006).

The importance of this study rests on its attempt to unveil the impact of public infrastructural investment in the determination of private investments in Kenya.

LITERATURE REVIEW

Theoretical Review

Public investment is one of the variables, where account is taken of government spending which affects availability of savings for the private sector. The crowding out effects of government expenditure is reflected in credit availability for the private sector. Public investment can also have a .crowding-in. effect if it involves activities that make the environment conducive for private sector investments (Greene and Villanueva, 1991).

Empirical Review

Three variations of equations were estimated by Blejer and Khan (1994) to capture alternative policy variables. The first equation relates to private investment (PI) as measured by capital formation by the private sector to growth of income (GDP), credit flow to the private sector from investment banks (CRD), public sector investment (PSI), and foreign exchange availability proxied by import capacity (IMPC):

$$PI = \beta_0 + \beta_1 GDP + \beta_2 CRD + \beta_3 PASI + \beta_4 IMPC \qquad (1)$$

Second, a variant of Equation (2) is also estimated by Blejer and Khan (1994). This separates public investment into central government investment (CGI) and parastatal sector investment (PASI). The other explanatory variables are the same as for Equation (1).

$$PI = \beta_0 + \beta_1 GDP + \beta_2 CRD + \beta_3 PASI + \beta_4 CGI + \beta_5 IMPC \qquad (2)$$

In the case of real crowding out the coefficient on central government investment ***(β_4)*** in Equation (2) would be negative and in the case of crowding in it would be positive. Coefficient ***(β_4)*** would be expected to be positive as parastatal and private sector investment are normally complementary.

In a number of studies of this kind the issue of disentangling government investment into infrastructural and non-infrastructural has received great attention. The purpose has been to find out whether government investment in infrastructure is complementary to private investment. Therefore a decomposition of the government investment is carried out and an equation that considers this new relationship is estimated.

$$PI = \beta_0 + \beta_1 GDP + \beta_2 CRD + \beta_3 PASI + \beta_4 INFI + \beta_5 NINFI + \beta_6 IMPC \qquad (3)$$

In studies like that by Blejer and Khan (1994) it was recognized that it would be meaningful to isolate the infrastructural component of public investment from the other and then estimate the independent effects of the categories. In their study the data did not make it possible to make such functional distinction.

They recognized, however, that such distinctions are crucial in understanding the role of public sector investment, and they experimented with various proxies for the infrastructural and non-infrastructural components of public sector investment. They took the trend level of real public sector investment to represent the long-term or infrastructural component. Deviations of real public sector investment from the trend were assumed to correspond to non-infrastructural investment. The infrastructural investment should have a positive effect on gross real private investment, while the non-infrastructural investment would be negative in the case of real crowding out, but positive in the case of crowding in.

The empirical evidence of Moshi and Kilindo (1999) indicates that public investment crowds out private investment, but the effect depends on the way in which public investment is introduced into the model. When a distinction is made between infrastructural investment and non - infrastructural investment, complementarily between infrastructural investment and private investment is evident.

METHODOLOGY

Following from the discussion above, specifically equation (3), developed by Blejer and Khan (1994) and applied by Moshi and Kilindo (1989) in their research entitled "*The impact of policy on macroeconomic variables: A case study of private investment in Tanzania*", the model has been adapted to be used in this study. The model was modified by making it log-linear, introducing a dummy for political stability (**D**) and a subscript '**t**' for time series. It is therefore specified as,

$$LPI_t = \beta_0 + \beta_1 LGDP_t + \beta_2 LCRD_t + \beta_3 LPASI_t + \beta_4 LINFI_t + \beta_5 LNINFI_t + \beta_6 LIMPC_t + D_t + \varepsilon_t$$

(4)

Where:

LPI = Private Investment, ***L***GDP = Gross Domestic Product, ***L***CRD = Credit available to private sector, ***L***PASI = parastatal infrastructural investment, LINFI = central government infrastructural investment, ***L***NINFI = central government non-infrastructural investment, ***L***IMPC = import capacity: Foreign exchange availability proxied by import capacity; measured as log of the ratio of reserves over total import bill, D = dummy for political instability : D = 1 for post-election violence, tribal clashes, attempted coup and D = 0 otherwise and ε = the random term. t = time period, which modifies equation (3) to be a time series model.

The major sources of data used in the study were National Accounts (GDP); KNBS Economic Surveys and Statistical Abstracts (investment as measured by capital formation with breakdown by type and between private and public).

Annual data for the period 1970-2007 were used in the study. The period was determined by the KNBS Economic Surveys and Statistical Abstracts available at the place and time of research.

EMPIRICAL RESULTS

Unit Roots Results

Unit root tests of the variables in the analysis are shown in Table 1. Two unit root tests have been used, i.e. ADF and PP tests.

Table 1: Unit Roots Test Results

Unit root tests for residuals

Based on OLS regression of LPI on:

C LGDP LCRD LPASI LNINFI LIMPC

38 observations used for estimation from 1970 to 2007

	Test Statistic	LL	AIC	SBC	HQC
DF	-4.2908	39.2553	38.2553	37.6458	38.0862
ADF(1)	-2.6947	39.6777	37.6777	36.4589	37.3397
ADF(2)	-1.7922	40.4341	37.4341	35.6058	36.9270
ADF(3)	-1.8762	40.6678	36.6678	34.2300	35.9917
ADF(4)	-2.1462	41.5626	36.5626	33.5155	35.7175
ADF(5)	-2.3389	42.1367	36.1367	32.4801	35.1225
ADF(6)	-2.3249	42.4046	35.4046	31.1385	34.2213
ADF(7)	-1.8956	42.4281	34.4281	29.5526	33.0759
ADF(8)	-1.4110	42.7647	33.7647	28.2798	32.2435
ADF(9)	-2.2711	46.5590	36.5590	30.4646	34.8686
ADF(10)	-2.9272	48.8637	37.8637	31.1599	36.0043
ADF(11)	-2.1457	48.8748	36.8748	29.5615	34.8464
ADF(12)	-2.2722	49.7359	36.7359	28.8132	34.5385

95% critical value for the Dickey-Fuller statistic = -5.4075

LL = Maximized log-likelihood AIC = Akaike Information Criterion

SBC = Schwarz Bayesian Criterion HQC = Hannan-Quinn Criterion

The ADF and the Phillips-Perron tests, in Table 1, were carried out with a constant and no trend whose critical values were as follows:

1) 1% Critical Value -3.62

2) 5% Critical Value -5.4075

The tests indicate that the value of the statistic is less than the critical value in absolute terms, hence the null hypothesis is rejected and the series are cointegrated. That is, all the variables are integrated of order one (I(1)) and become stationary after differencing once. The decision is clear especially with regard to 1% significance level.

Cointegration Results

The cointegration test results obtained using Johansen (1988) and Johansen and Juselius (1990) are reported in Tables 2.

Table 2: Cointegration Test Results

Cointegration with unrestricted intercepts and unrestricted trends in the VAR
Cointegration LR Test Based on Maximal Eigenvalue of the Stochastic Matrix

38 observations from 1970 to 2007. Order of VAR = 3.
List of variables included in the cointegrating vector:
LPI LGDP LCRD LPASI LINFI
LNINFI LIMPC D
List of eigenvalues in descending order:
.98373 .87042 .79664 .66717 .50550 .38225 .25629 .029276

Null	Alternative	Statistic	95% Critical Value	90% Critical Value
r = 0	r = 1	144.1489	54.1700	51.2600
r<= 1	r = 2	71.5203	48.5700	45.7500
r<= 2	r = 3	55.7464	42.6700	39.9000
r<= 3	r = 4	38.5045	37.0700	34.1600
r<= 4	r = 5	24.6474	31.0000	28.3200
r<= 5	r = 6	16.8583	24.3500	22.2600
r<= 6	r = 7	10.3635	18.3300	16.2800
r<= 7	r = 8	1.0399	11.5400	9.7500

Use the above table to determine r (the number of cointegrating vectors)
Cointegration with unrestricted intercepts and unrestricted trends in the VAR
Cointegration LR Test Based on Trace of the Stochastic Matrices

The trace statistic rejects the null hypothesis of the existence of zero or one cointegrating relationships in the private investment logarithmic equation, but accepts the alternative existence of five cointegrating relationships at least at the 5% significance level. The long run relationship is guaranteed by the existence of at least one cointegrating vector.

The Long-Run Equilibrium

In table 3 below, we report the estimates of the cointegrating vectors normalized on the velocities and which gives the long-run equilibrium condition.

The long-run responses are hypothetically satisfactory for real GDP growth rates (LGDP), central government infrastructural investment (LINFI), and import capacity (IMPC). However, the t statistics for credit available from commercial banks (LCRD) and for dummy on political instability (DU) are not significant. Parastatal infrastructural investment (LPASI) and central government non-infrastructural investment in Kenya do not favour private investment. Central government infrastructural investment (LINFI) significantly crowds-in private investments in the long-run.

Table 3: The Over-Parameterized Estimation of the Error Correction Model

Error Correction Representation for the Selected ARDL Model
ARDL(0) selected based on Akaike Information Criterion

Dependent variable is dLPI
37 observations used for estimation from 1971 to 2007

Regressor	Coefficient	Standard Error	T-Ratio[Prob]
dC	1.5855	.020395	77.7387[.000]
dLPII	.078941	.0010696	73.8030[.000]
dLGDP	.0024378	.0013861	1.7587[.090]
dLCRD	-.5739E-3	.9341E-3	-.61436[.544]
dLPASI	-.0076314	.0025976	-2.9379[.007]
dLINFI	.011337	.0055932	2.0269[.053]
dLNINFI	-.0036851	.9878E-3	-3.7305[.001]
dLIMPC	.0068685	.0028652	2.3972[.024]
dD	-.3567E-4	.0020858	-.017102[.986]
ecm(-1)	-.997341	.3657231	-2.727[000]

ecm = LPI -1.5855*C -.078941*LPII -.0024378*LGDP + .5739E-3*LCRD + .0076314*LPASI -.011337*LINFI + .0036851*LNINFI -.0068685*LIMPC + .3567E-4*D

R-Squared	.69751	R-Bar-Squared	.63679
S.E. of Regression	.0056969	F-stat. F(9, 27)	1243.9[.000]
Mean of Dependent Variable	-.0038494	S.D. of Dependent Variable	.10059
Residual Sum of Squares	.9087E-3	Equation Log-likelihood	143.8656
Akaike Info. Criterion	134.8656	Schwarz Bayesian Criterion	127.6164
DW-statistic	2.1328		

R-Squared and R-Bar-Squared measures refer to the dependent variable dLPI and in cases where the error correction model is highly restricted, these measures could become negative.

Diagnostic Tests:

Serial Correlation (Breusch-Godfrey LM Test, F-Statistic)	0.512[0.645]
ARCH Test (F-Statistic)	0.008[0.893]
Normality (JarqueBera, X2 statistic)	1.449[0.539]
RESET F (Ramsey Test, F-Statistic)	0.179[0.686]

Note: diagnostic test probability values are shown in the parenthesis. No terms were significant at 1% or 5% levels.

The lagged error correction term is negative, significant and the coefficient is less than unity. This means that the error correction model is well specified and also confirms our earlier findings on the cointegration of the variables.

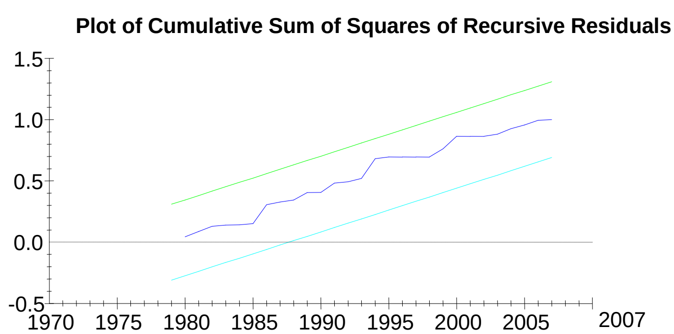
A one period lagged over-parameterized version of the results shown in table 3 above. A one period lagged equation is reasonable for a study using annual data in contrast to a study utilizing monthly or quarterly data where lags can be many. The inclusion of the lagged values of the dependent and explanatory variables is to ensure that lagged effects on the private investment are captured.

Hendry's general-to-specific approach was then utilized where insignificant regressors were sequentially deleted to arrive at the preferred specification reported in Table 3(Campos et al. 2005).

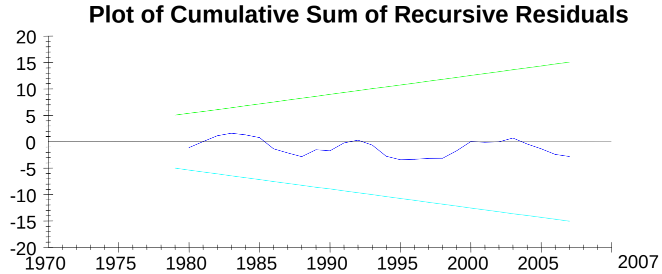
The Stability Test

The plot of the CUSUM test and CUSUM of Squares test (Brown et al, 1975) show that no errors were statistically significant over the study period.

Figure 2: Stability Test



The straight lines represent critical bounds at 5% significance level



The straight lines represent critical bounds at 5% significance level

Instability would have been shown by movement of the residue plot outside the critical lines in any of the two tests. The results are shown in Figure 2 above CUSUM 5% Significance. From the above stability test, we conclude that the stability of the long-run model is remarkable considering the large number of important reforms undertaken during the 1980s and 1990s. This also indicates that the model is well specified.

The Short-Run Model

After the confirmation of the existence of the long-run relationship, the short run dynamics of the relationship were examined. The Engle and Granger (1987) procedure was used where an error correction model was developed. The error correction model involved estimating the model in stationary form of variables and adding an error correction term as another explanatory variable. The residual from the cointegrating regression was taken as valid error correction term, ecm, which was then built into the error correction model in lagged form. The error correction model is in differenced form to ensure stationarity of variables, and is as follows:

$$\Delta RPI_t = \beta_0 + \sum_{i=1}^{7} \beta_{it} \Delta X_{it} + \sum_{i=1}^{7} \alpha_{it} X_{it-1} + \delta \Delta RPI_{t-1} + \phi ecm_{t-1} + \varepsilon_t \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots(5)$$

Where the endogenous variable is the real private investment and exogenous variables x1to x7 are real gross domestic product, real credit available, real parastatal sector infrastructural investment, real central government infrastructural investment, real central government non-infrastructural investment, real import capacity and dummy for political risk. The endogenous variable's lagged stationary value was included as an exogenous variable. ECM is the error correction component while εt is the random error term. All variables are in log form.

Table 4: The Parsimonious Model

Error Correction Representation for the Selected ARDL Model
ARDL(0) selected based on Akaike Information Criterion

Dependent variable is dLPI
37 observations used for estimation from 1971 to 2007

Regressor	Coefficient	Standard Error	T-Ratio[Prob]
dC	1.5760	.011991	131.4362[.000]
dLPII	.079144	.9677E-3	81.7887[.000]
dLGDP	.0024552	.0013328	1.8421[.076]
dLPASI	-.0079153	.0024882	-3.1812[.003]
dLINFI	.012958	.0047037	2.7549[.010]
dLNINFI	-.0034194	.8592E-3	-3.9799[.000]
dLIMPC	.0072944	.0026218	2.7821[.009]
ecm(-1)	-.68135	0.1726	-3.9476[000]

ecm = LPI -1.5760*C -.079144*LPII -.0024552*LGDP + .0079153*LPASI -.01295
8*LINFI + .0034194*LNINFI -.0072944*LIMPC

R-Squared	.68747	R-Bar-Squared	.62696
S.E. of Regression	.0055433	F-stat. F(7, 29)	1689.0[.000]
Mean of Dependent Variable	-.0038494	S.D. of Dependent Variable	.10059
Residual Sum of Squares	.9218E-3	Equation Log-likelihood	143.6001
Akaike Info. Criterion	136.6001	Schwarz Bayesian Criterion	130.9619
DW-statistic	2.0945		

R-Squared and R-Bar-Squared measures refer to the dependent variable dLPI and in cases where the error correction model is highly restricted, these measures could become negative.

Diagnostic Tests:

Serial Correlation (Breusch-Godfrey LM Test, F-Statistic)	0.320[0.833]
ARCH Test (F-Statistic)	1.659[0.326]
Normality (JarqueBera, X2statistic)	1.874[0.446]
White Heteroskedasticity Test (F-Statistic)	0.989[0.512]
RESET F (Ramsey Test)	5.42[0.242]

Note: diagnostic test probability values are shown in the parenthesis. No terms were significant at 1% or 5% levels.

The test statistics are satisfactory. The goodness-of-fit variable (R2) show that the exogenous variables account for 68.7% of the variations in private investment in the short run. The DW statistic is slightly greater than two and larger than R2, meaning that the regression is not spurious.

As the variables are expressed in logarithmic form, the coefficients are interpreted as elasticities. The error-correction term (ecm) is negative as expected, and significant (high absolute t-statistic). The strong significance reinforces the argument of the model variables being cointegrated. The adjustment of the model to the previous year's disequilibrium is 68.7%.
In the short-run, gross domestic product, central government infrastructural investment and import capacity rates positively influence private investments. Credit available, parastatal sector investment, central government non- infrastructural investment and political instability negatively influence private investments in Kenya.

INTERPRETATION & DISCUSSION

Factors that significantly and positively influence private investments include central government infrastructural investment, and import capacity. Credit available does not conform to the hypothesis where increased availability is supposed to positively affect the investments. Credit available, parastatal sector investment, political instability and central government non infrastructural investment influence private investments negatively. Therefore the long-run significant determinants of private investments include central government infrastructural investments, import capacity and parastatal sector infrastructural investment.

Central government infrastructural investment positively influences private investment in the short run and long run where a 1% increase in central government infrastructural investment causes a 1.1% increase in private investment. The biggest impact on private investments in the long-run is attributed to central government infrastructural investments. A 1% increase in public investments leads to a 1.1% increase in private investments. Increased Central government infrastructural investments therefore means a crowding-in effect on private investments. In a liberalized environment, government expenditure on capital goods such as basic infrastructure improves investors efficiency and lowers the cost of doing business leading to a higher levels of private investment.

Central government non-infrastructural investment in the long-run has negative relationship with private investments. A 1% increase in central government non-infrastructural investment results in 0.368% decrease in private investment in the long-run and is very significant with an absolute t-value of 3.73.

Another important finding is the negative impact of parastatal sector infrastructural investment and private investments. A 1% increase in parastatal sector investment leads to 0.76% reduction in private investments in the long-run.

CONCLUSIONS

The study was able to establish a direct empirical link between government policy and private capital formation. The evidence indicates that public investment crowds out private investment, but the effect depends on the way in which public investment is introduced into the model. When a distinction is made between infrastructural investment and non-infrastructural investment, complementarily between infrastructural investment and private investment is evident. Given the limited resources available to government, increased private investment can be achieved by reducing government's non-infrastructural investment by encouraging private sector participation in that sector, while government concentrates on infrastructural investment.

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