Original Research Article

Government spending on infrastructure and private investment: A disaggregated analysis

Abstract

Limited empirical studies have disaggregated the government spending into infrastructure and consumption expenditures in this thematic area. More so, Kenya has witnessed a tremendous increase in spending on infrastructural projects such as highways, road, ports, fiber optic, standard gauge railway, and massive investment in road management and maintenance. All these efforts are meant to accelerate the realization of the Kenya Vision 2030 as well as the 'Big Four' agenda of the Kenyan government. The objective of this study was to examine the role of infrastructure sector spending on private investment in the country. The study used secondary data for 1963 to 2018 from annual statistical abstracts and economic surveys report. To achieve the outlined objective, the study adopted Autoregressive Distributed Lag (ARDL) model and the Error Correction Model (ECM) estimation approach. Infrastructure outlay in health, agriculture and roads was found to positively impact private investment in the long run. On the contrary, defense and education development spending influence private investment negatively in the long run. This paper concludes that public sector infrastructure outlays are key in determining private investment and that different public spending component affect investment differently in both short run and long run. This study recommends that the government should consider increasing and sustaining spending on infrastructure development projects like roads, highways maintenance, agriculture mechanization, health facilities, ports, fiber optic and railways to stimulate further the economy.

Keywords: Infrastructure spending; private investment; Roads; Capital formation

1 Introduction

The relation between infrastructure spending, investment and economic growth is strong and incontestable. Economists generally agree that capital accumulation positively influence

economic growth and development (Barro, 1990). Infrastructure investment, which is a key driver of economic growth, is broadly classified into private and public investment. The former which is the gross capital formation of the private sector is the spending by private entities to acquire fixed assets to enhance the production of capital goods whose demand and consumption increase income (Maingi, 2017). Both financial and empirical evidence backs private investment as a superior engine of economic growth. Government infrastructure expenditure as a policy tool can be used to give impetus to private investment and has been emphasized in developing countries considering the significant achievements realized by newly industrialized economies such as Malaysia, Japan, China (Maingi, 2017).

The fiscal policy school opined that increased government expenditure in providing essential amenities such as roads, communication, security, health and education enhances the private investment in developing countries hence spurring economic growth. In contrast, Neo-classical economists argues that when the economy is at full employment, government expenditure financed by debts as well as spending in some infrastructural projects will obstruct private investment (Blejer & Khan, 1981; Babu et al., 2014). This is because there will be competition for available loanable funds between the public and the private sector leading to high-interest rates, public debts as well as rising taxes (Ifeakachukwu et al., 2015). The result is reduced liquidity in the economy and a high cost of financing private investment.

Although private investment is an essential driver of economic growth, sustainable development, alleviation of unemployment, poverty, and wealth creation, the ratio of private investment to Gross Domestic Product (GDP) has remained comparatively low in sub-Saharan countries. During the 1990s, this ratio in sub-Saharan-Africa, Latin America, and Asia stood at 17, 22.5,and 28 percent respectively (Ifeakachukwuet al., 2013). Kenya recorded a ratio of 10.91 % which is lower than the sub-Saharan Africa ratio of 17% and the recommended level of 30% in the same period (Oyieke, 2011).

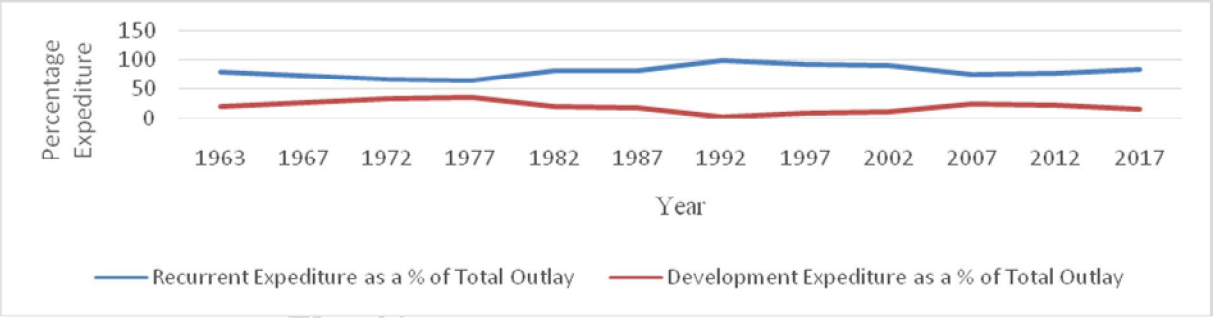
1.1 Overview and Tendencies of Government Spending

According to the Government of Kenya (GoK, 2003), recurrent expenditure has been higher than the infrastructure expenditure in Kenya since independence. However, in the early years of

independence, infrastructure expenditure was relatively more compared to the last two decades and it is during that period when the country recorded a notable performance of the private investment. An increase in development expenditure was mainly attributed to government spending on infrastructural projects such as ports expansion, roads, electricity supply, telecommunication, schools, etc. This spending was sustained at an average of 32% between 1972 -1979 before declining to 19% between 1982 and 1996. Further, between 1999 and 2001 there was a drastic drop in infrastructure expenditure to 9% attributed to conditions attached by WB and IMF on SAPs (Amanja *et al.*, 2005; GoK, 2017). The ERS infrastructural projects such as the rehabilitation of ports, telecommunications, education, and health revitalized the infrastructure expenditure between 2003 and 2009 (Karumba, 2009).

The Figure 1 below illustrates the composition of the broad classification of government expenditure as a proportion of the total outlay in Kenya between 1963 and 2017.

Figure 1: Government Spending (Recurrent and Infrastructure)



Source: Karumba (2009); GoK (2018).

It is evident from Figure 1 that the consumption expenditure has been greater than the infrastructure expenditure since independence. According to Oyieke (2011), this spending behavior of the government can be attributed to the adoption of African socialism which sought to eradicate poverty, illness, and illiteracy in the country immediately after independence. Further, the emergence of SAPs, corruption, government bloated wage bill, as well as wastefulness have exacerbated the development expenditure in Kenya (Oyieke, 2011).

1.2 Statement of the Problem

Studies by Blejer and Khan (1981), Barro (1990), and Majeed and Khan (2013) claim that government infrastructure outlays serves to promote the accumulation of investment by the private sector while Buiter (1977) and Argenor (2005) avows that it crowds-out private investment. These juxtaposed findings among others paint an inconclusive debate on the linkage between government infrastructure expenditures and private capital formation especially in developing countries where infrastructure development is poor and debt burden is increasing (Blejer & Khan, 1981).

1.3 Objective of the Study

To explore how public infrastructure spending impact private investment in Kenya

2 A Review of Theoretical Literature

Available literature indicates conflicting empirical results among researchers on the link between private investment and government infrastructure expenditure. According to Njuru (2012), the outcome of any government fiscal intervention majorly rests on its design and implementation. This study will adopt this position and use the flexible accelerator framework which is based on the Keynesian investment theory. The model will be reconstructed to feature additional dynamics influencing private capital e.g. institutional as well as structural characteristics and the resource gap experienced in developing countries (Blejer & Khan, 1984). The model is stated in mathematical terms as:

$$K_t = \mu Y_t \quad (3.1)$$

In the above relationship, the appropriate inventory of capital by the private sector at a given duration is (K_t) and it is anticipated to be proportional to the projected productivity level (Y_t) with μ representing the unchanging capital-output ratio. To get the change in capital stock over a given period, we differentiate equation 3.1 with respect to time and obtain:

$$\Delta K_t = \mu \Delta Y_t \quad (3.2)$$

We now introduce the equation of capital accumulation to link investment and the level of preferred capital inventory. The equation is specified as:

$$K_t = (1- d)K_{t-1} + I_t \quad (3.3)$$

Where; K_t=current capita level, K_{t-1} =historical stock of capital, I_t =investment level at present and d represents the rate at which the installed capital depreciates. By Expanding equation 3.3, assuming that there is no depreciation (i.e d=0) and expressing it in terms of investments (I) we get:

$$I_t = K_t - K_{t-1} \quad (3.4)$$

From equation 3.2, $K_t - K_{t-1} = \Delta K_t = \mu \Delta Y_t$, thus we can rewrite equation 3.4 as simple investment equation:

$$I_t = \mu \Delta Y_t \quad (3.5)$$

We can introduce lagged values of both investments (I) and productivity(Y) in the simple investment equation above due to the delays that are associated with the installation of new capital. This way, both the present and the preferred capital stock will be taken care of according to Nerlove's partial adjustment framework:

$$I_t = \alpha I_{t-1} + \beta_1 \Delta Y_t + \beta_2 \Delta Y_{t-1} + \varepsilon_t \quad (3.6)$$

Where $I_{t-1,}$ $\Delta Y_{t-1,}$ β, and ε_t indicate the level of investment of the previous period, the output of the previous period, coefficients of respective variables, and the error term respectively.

The flexible accelerator framework according to Blejer & Khan (1981) allows economic factors such as the interest levels, savings, inflation, profit projections, government policies, trade openness, debt repayments, etc to affect private sector investment decisions and hence the adjustment speed (John, 2022). To account for this adjustment speed, we introduce another variable Z in equation 3.6 to obtain:

$$I_t = \alpha I_{t-1} + \beta_1 \Delta Y_t + \beta_2 \Delta Y_{t-1} + Z_t + \varepsilon_t \quad (3.7)$$

Thus, equation 3.7 takes into accounts all factors that affect the investment decisions of the private sector represented by Z_t.

2.1 Empirical Review

Private investment and public spending topic has attracted researchers' attention world over evidenced by the analysed literature. Interestingly, these studies have posed different results with some supporting and others contradicting the economic theory which recognizes the role of government infrastructure spending in rejuvenating the private investment. To this end, there is no clear and unanimous nexus between public infrastructure and private investment. For instance, Aschauer(1989), Blejer & Khan(1981), and Njuru (2012) argued that government expenditure crowd-in private investment while Oyieke (2011), Beni and Mwakalobo (2009) and Laopodis (2001) found out that the former crowds-out the latter. A good number of studies around this thematic area have aggregated the government expenditure into broad recurrent and capital expenditures rendering the availability of literature on government sector spending limited. This could be the justification for the contradicting results from various researchers.

This study will be designed to contribute to this discussion and bridge the literature gap by disaggregating the government infrastructure expenditures into infrastructure spending in agriculture, defense, education, health, and roads sectors. The debt servicing component which is theoretically expected to impact domestic capital formation will also be used.

3 Research Methodologies

3.1 Data Types, Sources, and Analysis

The research used secondary data from official government reports that is Statistical Abstracts and Economic Surveys of KNBS complimented by Central Bank Publications. Annual data for the year 1963 up to 2018 was used for all the variables. The data was analyzed using STATA version 17.

3.2 Definition and Measurement of Variables

Private Investment (P) – Wealth accumulated by the private sector both firms and individuals in terms of fixed assets. It is measured in Kenya shillings in current market prices. It is proxied by the gross capital formation by the private sector. Demirer et al. (2020) conclude that it has a positive effect when included in growth model.

Infrastructure spending components – This is total government infrastructure outlays in education, health, agriculture, defense and roads to acquire, upgrade and maintain physical assets such as buildings, roads, machinery, communication equipment, etc. it is expected to have a positive sign (Njuru, 2012).

3.3 Empirical Model

Using disaggregated infrastructure expenditures on education, health, agriculture, roads, defense, and debt repayment data, and the study model is specified as;

$$P = f(ED, HE, AG, DF, RO, DB),$$

$$PI_t = \beta_0 + \beta_1 ED k_t + \beta_2 HE k_t + \beta_3 AG k_t + \beta_4 DF k_t + \beta_5 RO k_t + \beta_5 DB k_t + \varepsilon_t \quad 1$$

Where;

PI_t - Private investment at time t

β_0-β_5 - Vector of parameters for different recurrent spending components

ED_k - Infrastructure expenditure on education at time t

HE_k - Infrastructure expenditure on health at time t

AG_k - Infrastructure spending on agriculture at time t

DF_k - Infrastructure government spending on defense at time t

RO_k - Infrastructure spending on Roads at time t

DB_k - Debt service at time t

ε_t - Error term

3.4 Estimation Method

Most often, in time series data, variables are non-stationary causing spurious results. To ensure stationarity of all the variables, the determination of unit root was undertaken by applying the Augmented Dickey-Fuller (ADF) (Dickey, 2014). To address the unit root issues, non-stationary variables were differenced once.

This study applied the ARDL model. The model is deemed appropriate in time series when the independent variables are integrated of different orders i.e I(0) and I(1) (Pesaran & Shin, 2001; Gisore, 2021). This study decomposed recurrent government expenditure into sector spending and examined their influence on private investment distinctly in Kenya. After conducting the Bound test analysis, the short run ARDL (p, q_1-q_6) model for the ARDL recurrent expenditure equation was specified as below;

$$\Delta \ln PI_t = \alpha_0 + \sum_{i=1}^{p} \alpha 1\ \Delta \ln P_{t-1} + \sum_{i=1}^{q1} \alpha 2\ \Delta \ln ED k_{t-1} + \sum_{i=1}^{q2} \alpha 3\ \Delta \ln HE k_{t-1} + \sum_{i=1}^{q3} \alpha 4\ \Delta \ln AG k_{t-1} + \sum_{t=1}^{q4} \alpha 5\ \Delta \ln DF k_{t-1} + \sum_{t=1}^{q5} \alpha 6\ \Delta \ln RO k_{t-1} + \mu_1 ECT_{t-1} + \varepsilon_t \quad (2)$$

Such that;

$\mu_1 ECT_{t-1}$captures the long run representation.

Δ is the difference operator,α_0 is an intercept, α_1 - $\alpha_7$is the associated coefficients, P is the lags of the dependent variable, q1 –q_6 represents lags for the independent variables, $\ln P_{t-1}$ is the lagged values of P while $\ln ED_{t-1}$, $\ln HE_{t-1}$,$\ln AG_{t-1}$, $\ln DF_{t-1}$,$\ln RO_{t-1,}$ $\ln DT_{t-1}$ are lagged values of repressors and ¥$_t$ is the error term. Following works by Gisore (2021) logs (ln) of the study variables were used during estimation of the model so as to allow for estimation coefficients to be interpreted as elasticities.

Variables are said to be cointegrated if they exhibit both short-run and long-run relationships. Oyieke (2011) notes that cointegration has a cause-effect relationship and variables may move away from each other in the short-term and the same direction over some time. After performing

the Bound cointegration test, short-run ARDL and long-run ECM models were constructed for sectoral spending (Kibet et al., 2019). For reliability of result a number of time series diagnostic tests were applied and reported in next chapter result. The tests included heteroscedasticity limitation using Breusch-Pagan test, autocorrelation using Breusch Godfrey and finally stability test was applied to ensure the applicability and extension of the study findings.

4 Research Findings

4.1 Descriptive Statistics

The study carried out the descriptive statistics to have a feel of the data set and understand the distribution of the data before conducting analysis. The statistics provided the study with information on measures of central tendency, dispersion, and normality. Table 1 presents the descriptive statistics for specific sector development expenditure in Kenya.

Table 1: Descriptive Statistics Matrix

	Infrastructure Expenditure (KES Millions)						
Variable	**PI**	**ED**	**HE**	**AG**	**DF**	**IF**	**DB**
Mean	128491	4950	4464	5598	487	25417	87064
Median	40560	625	790	1621	240	1854	29753
Std.Dev.	170371	7860	8062	9575	648	60412	124011
Min	637	11.94	2.96	33.52	0.86	29.58	93.2
Max	734522	23048	35769	38058	3818	260421	470920
Variance	2.90e+10	6.18e+07	6.50e+07	9.17e+07	420731.9	3.65e+09	1.54e+10
Skewness	1.614	1.620	2.135	2.034	2.857	2.931	1.842
Kurtosis	5.188	4.354	6.867	5.923	14.145	10.78	5.659
Observations	55	55	55	55	55	55	55

Roads sector has the highest share of infrastructure investment while health and defense are the bottom two sectors respectively. High spending in road has been driven by the government's desire to connect the country with good road networks through construction of highways and rehabilitation of ports to enhance productivity. Moreover, the series also has a high range as shown in Table 1 above which is majorly attributed to increased government infrastructure

expenditure over time. The results of skewness and Kurtosis confirmed normal distribution since they fall within the recommended normality limits (Bryne, 2010).

4.2 Unit Root Test

Stationarity test was paramount to avoid spurious regression results and guarantee meaningful inferences. The unit root tests addressing the study objectives were conducted using the augmented Dickey Fuller (ADF) test as outlined in Table 2 below.

Table 2: Augmented Dickey Fuller (ADF) Unit Root Test

Variable	Tests at levels	t- Statistic	Differenced	Comment
Lneddvl	Constant & Trend	-4.055		Stationary
Lnhedvl	Constant & Trend	-3.699		Stationary
Lnagdvl	Constant & Trend	-4.962		Stationary
Lndedvl	Constant & Trend	-2.213	-5.543	Non stationary
Lnrddvl	Constant & Trend	-2.463	-5.758	Non stationary

Tables 2 present the stationarity results at levels for education, health, roads, agriculture and defense variables and upon first difference of roads and defense which were non-stationary respectively. The H_0 of non-stationary series was accepted for development spending in education and roads only since their absolute values for t-statistics were less than their respective critical values at 5% confidence level as indicated in Table 2. Upon differencing the non-stationary variables once, they all become stationary as confirmed in Table 2.

4.3 Cointegration Analysis

Cointegration analysis was imperative to establish the relationship among variables and to determine whether to estimate the long run or the short-run model. Most often, after conducting the unit root analysis, there are three major outcomes; integration at levels I (0), on first difference I (1) or the series has a combination of both. In our case, the stationarity results indicated a combination of both I (0) and I (1). Thus, a Bound test recommended by Pesaran and Shin (2001) for such series was conducted and result reported in Table 3.

Table 3: Cointegration Analysis

Significance level	10%		5%		2.5%		1%	
Bound	$I_{(0)}$	$I_{(1)}$	$I_{(0)}$	$I_{(1)}$	$I_{(0)}$	$I_{(1)}$	$I_{(0)}$	$I_{(1)}$
F Stat= 4.136	2.12	3.23	2.45	3.61	2.75	3.99	3.15	4.43
t stat=-3.444	-2.57	-4.04	-2.86	-4.38	-3.13	-4.66	-3.43	-4.99

The above Table 3 indicates the estimation output upon issuing the Bound cointegration test command. The F-Statistic value is 4.136 higher than the upper bound values at 10% and 5% level. Thus, the H_1 of the presence of cointegrating equations in the series was accepted. This means that both the long and short-run models should be estimated.

4.4 Models regression Results

The Error Correction Model (ECM) was deemed the appropriate estimation technique due to the long-run association of the variables involved. Table 4 shows the infrastructure expenditure ECM outcome after running the regression. The long-run results are displayed in the upper panel and the short-run results on the lower panel.

Table 4: Error Correction Model (ECM) Results

	Variable		**Coefficient**	**t-value**	**p-value**
	Lnpi				
Adjustment	L1 lnpi		-0.212	-3.44	0.001
Long run					
	Lneddvl		-0.425	-1.29	0.205
	Lnhedvl		0.546	2.76	0.009
	Lnagdvl		0.135	0.99	0.328
	lndedvl2		-0.090	-1.07	0.292
	Lnrddl		0.031	0.29	0.771
	Lndebt		0.509	4.91	0.000
Short run	Lnpi	LD	-0.230	-1.79	0.082
	Lneddvl	D1	0.120	2.58	0.014
		LD	0.060	1.50	0.142
	Lnagdvl	D1	-0.053	-2.40	0.022
		LD	-0.027	-1.24	0.223
	lndedvl2	D1	0.050	1.36	0.183
	Lndebt	D1	-0.169	-2.41	0.021
		LD	-0.083	-1.32	0.195
	Constant		1.043	4.01	0.000
	R^2		=0.502	AdjustedR^2	=0.4600
	Log likelihood		=55.925	Observations	=53

Breusch-Pagan test	Chi square (1) = 3.53	P-value(F)	=	0.060
Breusch-Godfrey test	Chi square (52) = 53	P-value(F)	=	0.435

The long run results revealed that the first lag of private investment, infrastructure spending in health, and the debt were significant at one percent level. This is supported by the absolute values of their respective t-values which are all greater than two (2). These coefficients indicate that increasing the health infrastructure expenditure by one percent will result to a corresponding increase of private investment by 0.546 percent ceteris paribus in the long run while a unit increase in debt charge will result to 0.509 units investment increase in the long run ceteris paribus. The model's constant of 1.044 was significant at one percent level. Other variables in the model were statistically insignificant in the long run. Although statistically insignificant, both defense and education spending hurt private investment in the long run.

Similar to this study, Oyieke (2011) found out that infrastructure expenditure influences private capital significantly. Mohib *et al.* (2015) conducting a similar study in Pakistan concluded that health and defense spending compliments and demotes private investment respectively and Laopodis (2001) confirmed the same results for military expenditures. On the other hand, these results contradicts Njuru (2012) and Oyieke (2011) on the role of debt charge in private capital formation. Essentially, these results demonstrate mixed effects of sector capital outlays on private investment just like the above findings on recurrent model. Infrastructure spending in providing health care, agriculture and improving the infrastructure such as roads, highways and ports has proved to stimulate the private sector in the long the run (Babu et al., 2014). This is in line with the Vision 2030 aspirations and the 'Big Four' Agenda of the government.

Basically the sign of the adjustment term means that the errors of the previous period will be adjusted in the current period hence the series convergence in the long run. The long-run results are displayed in the upper panel and the short-run results on the lower panel.

From the result, heteroscedasticity was not a problem in this research. However, autocorrelation was a problem but the study used robust standard error to correct it. Based on analysis results, the CUSUM graphs were within the 5% boundary indicating that the models were stable. The model adjustment term is -0.212 which is statistically significant at 1% level and it is within the

theoretically accepted range of -1 and 0. Our R^2 is 0.502 implying that 50.2% of private investment variations were explained by the model regressors. This indicated that the overall goodness of fit was satisfactory.

5 Conclusions and Recommendations

This paper aimed at establishing the role of public infrastructure expenditure in promoting or and demoting private investments in Kenya. The descriptive statistics of both models mirrored normal distributions with a high range of distribution occasioned by increasing government infrastructure spending in sectors over time. The cointegration analysis revealed that there is long-run and short-run relationship between private investment and infrastructure spending in Kenya.

The ECM was used to establish the relationship between sector capital spending and private investments in Kenya. Econometric results indicated that 50.2% of private investment variation was explained by the dependent variables in the model. Infrastructure outlay in health, agriculture and roads was found to positively impact private investment in the long run. On the contrary, defense and education development spending influence private investment negatively in the long run.

This paper concludes that public sector outlays are key in determining private investment and that different public spending component affect investment differently in both short run and long run. Infrastructure spending in health, agriculture, and infrastructure should be enhanced since they all have a positive correlation with private investment. This endorsement is timely and in line with the Vision 2030 aspirations, the government's "Big 4 Agenda" and the Post COVID-19 ERS whose aim is to rejuvenate the economy through infrastructure investment to achieve a double digit growth in Kenya. Strategic infrastructure investment in agriculture to stimulate the economy should be given priority since the contribution of this sector to GDP is significant. Infrastructure investment in roads and highway should be given precedence to enhance transport and communication which eases the cost of doing business in the country.

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