

Government Spending on Infrastructure and Private Investment: A Disaggregated Analysis

Morris Gitonga ^{a*}, Elizabeth Owiti ^b, Moses Thurairia ^c and Naftaly Mose ^d

^a *Council of Legal Education, Kenya.*

^b *University of Nairobi, Kenya.*

^c *Micro and Small Enterprises Authority, Kenya.*

^d *University of Eldoret, Kenya.*

Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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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 aim of this research was to investigate 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) technique 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 long- run and short- run. This study recommends that the government should consider increasing and sustaining spending on infrastructure development projects like roads, ports, fiber optic, railways, highways maintenance, agriculture mechanization, improving public health infrastructure to stimulate further the economic activities.

*Corresponding author: E-mail: gitongamorris5@gmail.com;

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1 INTRODUCTION

The bond between infrastructure spending, economic development and private investment is well-built and unquestionable. Economic empirical works support the idea that infrastructure development and subsequent increase in gross capital formation is core in promoting economic growth in Africa and other developing countries [1]. In most literature infrastructure investment is divided into public and private investment. Private investment is individual spending to increase production of goods and services whose consumption will increase income further [2]. Empirical works supports the unique role of private investment as engine of economic growth. Public infrastructure development is an important fiscal policy tool that has been used by new industrialized countries and sub-national units to support and complement private investment in order to experience growth [2,3].

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 [4,5,6]. 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 [7]. The result is reduced liquidity in the economy and a high cost of financing private investment.

While the role of private investment is unquestionable as an engine of growth and poverty alleviation, the ratio of economic growth to private investment has remained comparatively low in most developing countries. Kenya recorded a ratio of 10 percent which is lower than the sub-Saharan Africa ratio of 17 percent and the recommended level of 30 percent across the world [8].

1.1 Overview and Tendencies of Government Spending

According to the Government of Kenya [9], consumption spending has been higher than the infrastructure budget in Kenya since independence from colonial rulers. 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 [10] (GoK, 2017). The ERS infrastructural projects such as the rehabilitation of ports, telecommunications, education, and health revitalized the infrastructure expenditure between 2003 and 2009 [11].

The Fig. 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.

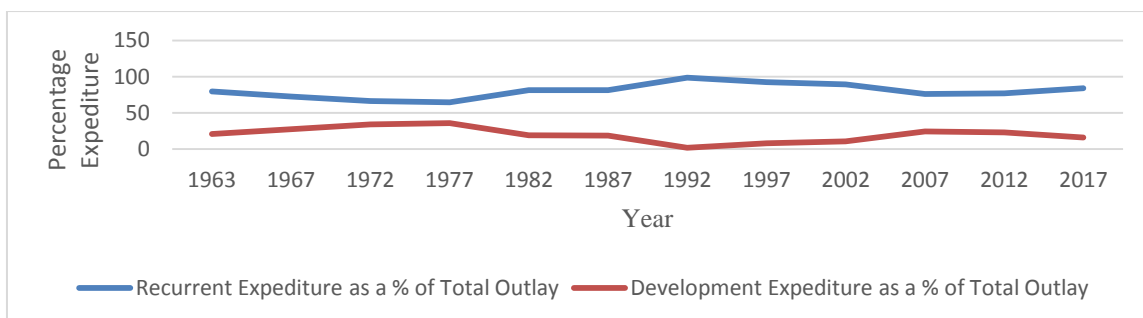


Fig. 1. Government spending trend

Source: Karumba [11]; GoK (2018)

As captured from Fig. 1, in Kenya infrastructure spending has been lower than consumption budget over the years. Oyieke [8,12] attributes this behavior by Kenyan government to bloated wage bill being experienced, wastage and corruption, and adoption of socialism immediately after independence and thus slowing the growth of infrastructure budget and consequently affecting the quality of infrastructure development in Kenya [8].

1.2 Statement of the Problem

Empirical works by Blejer and Khan [4], Barro [1], and Majeed and Khan [13] argue that public infrastructure spending mostly aim to stimulate accumulation of investment by the private investors while Buitter [14] and Argenor [15] affirms that it crowds-out private investment. These contrasting results among others paint an inconclusive debate on the relation between public infrastructure spending and private capital formation especially in developing countries where infrastructure development is poor, private investment is slowing and debt burden is increasing [4].

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 [16], 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:

$$K_t = \mu Y_t \tag{1}$$

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:

$$\Delta K_t = \mu \Delta Y_t \tag{2}$$

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

$$K_t = (1 - d) K_{t-1} + I_t \tag{3}$$

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. The study assuming no depreciation and expanding equation 3.3 and further expressing it in terms of investment we derive

$$I_t = K_t - K_{t-1} \tag{4}$$

From model 3.2, $K_t - K_{t-1} = \Delta K_t = \mu \Delta Y_t$, thus model 3.4 can represent a simple investment equation:

$$I_t = \mu \Delta Y_t \tag{5}$$

According to Nerlove's partial adjustment equation we can use lags on productivity (Y) and investments (I) to represent the delays associated with new investments.

$$I_t = \alpha I_{t-1} + \beta_1 \Delta Y_t + \beta_2 \Delta Y_{t-1} + \epsilon_t \tag{6}$$

Where I_{t-1} , ΔY_{t-1} , β , and ϵ_t represent past level of investment, past period output, coefficients of = variables, and the error term respectively.

The flexible accelerator model according to Blejer & Khan [4] allows economic factors such as the interest levels, savings, inflation, policies, trade, debt repayments, etc to affect private sector investment decisions and hence the adjustment speed [17]. To account for this adjustment speed, we introduce another variable Z in equation 3.6 to obtain:

$$I_t = \alpha I_{t-1} + \beta_1 \Delta Y_t + \beta_2 \Delta Y_{t-1} + Z_t + \epsilon_t \tag{7}$$

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

To this end, the empirical findings on the relationship between infrastructure spending and growth have been mixed or inconclusive. For example, Aschauer [18], Blejer & Khan [4], and Njuru [16] maintained that public infrastructure spending crowd-in private investment while Oyieke [8], Beni and Mwakalobo [19] and Laopodis [20] observed that the former crowds-out the latter. A good number of empirical studies around this topic have aggregated the public spending into broad consumption and infrastructure budgets rendering the availability of literature on public sector spending limited. This could be the justification for the contradicting findings 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. Sector spending in infrastructure is theoretically expected to impact domestic capital formation positively.

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. [21] 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 [16].

3.3 Empirical Model

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

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

$$PI_t = \beta_0 + \beta_1 EDk_t + \beta_2 HEk_t + \beta_3 AGk_t + \beta_4 DFk_t + \beta_5 ROk_t + \varepsilon_t$$

Where;

PI_t - Private investment at time t

β_0 - β_5 - Vector of parameters for different capital 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

ε_t - Error term of the model

3.4 Model Estimation

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 using the Augmented Dickey-Fuller. To address the unit root issues, non-stationary variables were differenced once [22].

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) [23,24]. This study decomposed infrastructure government budget into sector spending and examined their influence on private investment distinctly in Kenya. After conducting the Bound test analysis, the short run ARDL (p, q₁-q₆) model for the ARDL infrastructure spending equation was specified as below;

$$\Delta \ln PI_t = \alpha_0 + \sum_{i=1}^p \alpha_1 \Delta \ln P_{t-1} + \sum_{i=1}^{q_1} \alpha_2 \Delta \ln EDk_{t-1} + \sum_{i=1}^{q_2} \alpha_3 \Delta \ln HEk_{t-1} + \sum_{i=1}^{q_3} \alpha_4 \Delta \ln AGk_{t-1} + \sum_{i=1}^{q_4} \alpha_5 \Delta \ln DFk_{t-1} + \sum_{i=1}^{q_5} \alpha_6 \Delta \ln ROk_{t-1} + \mu_1 ECT_{t-1} + \varepsilon_t$$

Such that;

μ_1ECT_{t-1} captures the long run representation.

Δ is the difference operator, α_0 is an intercept, $\alpha_1 - \alpha_7$ is the associated coefficients, P is the lags of the dependent variable, $q_1 - q_6$ 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 regressors and ϵ_t is the error term. Following works by Gimore [24] 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 [8]. After performing the Bound cointegration test, short-run ARDL and long-run ECM models were constructed for sectoral infrastructure expenditure. For reliability of result a number of time series diagnostic tests were applied and reported in next chapter result [25]. 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. RESULTS AND DISCUSSION

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 matrix for specific sector infrastructure expenditure.

Roads sector had the highest share of infrastructure spending while health and defense are the bottom two sectors respectively. High budget 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, cut cost of production and attract investors from other regions. Moreover, the series also has a high range as shown in Table 1 which is majorly attributed to increased public infrastructure spending over time. The findings of skewness and Kurtosis confirmed normal distribution since they fall within the recommended normality limits [26].

4.2 Unit Root Test

Stationarity test was important to avoid spurious regression findings and solidify meaningful inferences. The unit root estimations addressing the research objectives were conducted using the augmented Dickey Fuller test as outlined in Table 2.

Table 2 present the stationarity findings at levels for education, health, roads and agriculture variables and upon first difference of roads and defense which were non-stationary respectively. However defence and roads were non-stationary 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 approximate the long run or the short-run equation. 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 [23] for such series was conducted and result reported in Table 3.

Table 1. Descriptive statistics matrix

Variable	PI	ED	HE	AG	DF	RO
Mean	128491	4950	4464	5598	487	25417
Median	40560	625	790	1621	240	1854
Std.Dev.	170371	7860	8062	9575	648	60412
Min	637	11.94	2.96	33.52	0.86	29.58
Max	734522	23048	35769	38058	3818	260421
Variance	2.90e+10	6.18e+07	6.50e+07	9.17e+07	420731.9	3.65e+09
Skewness	1.614	1.620	2.135	2.034	2.857	2.931
Kurtosis	5.188	4.354	6.867	5.923	14.145	10.78
Observations	55	55	55	55	55	55

Table 2. Augmented dickey fuller unit root results

Variable	t-Statistic	Differenced	Comment
Lneddvl	-4.055		Stationary
Lnhedvl	-3.699		Stationary
Lnagdvl	-4.962		Stationary
Lndedvl	-2.213	-5.543	Non stationary
Lnrddvl	-2.463	-5.758	Non stationary

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 F-Statistic value is 4.1 higher than the upper bound values at 5 percent level. This confirms the presence of Co integration equations in the series. This means that both the long and short-run equations should be estimated.

4.4 ARDL Models Regression Results

The ARDL and Error Correction Model were deemed the appropriate estimation technique due to the long-run association of the elements involved. Table 4 shows the infrastructure expenditure ECM regression results (long-run and short-run outcomes).

The long-run relationship findings showed that the first lag of private investment and infrastructure expenditure in health were significant at one percent level. This is confirmed 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 0.54 percent ceteris paribus in the long run in Kenya. Good quality infrastructure development in health facilities will raise the productivity of labour and increase the growth of

Table 4. ECM results

	Variable		Coefficient	t-value	p-value
Adjustment	Lnpi				
	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
	Indedvl2		-0.090	-1.07	0.292
	Lnrddl		0.031	0.29	0.771
	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	-	-2.40	0.022
		LD	0.053	-	-1.24
Short run	Indedvl2	D1	0.050	1.36	0.183
		LD	-0.083	-1.32	0.195
	Constant		1.043	4.01	0.000
	R ²		=0.502	AdjustedR ²	=0.4601
	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

national output. Health is one of the important factors that determine the quality of labour and human capital in private sector. This is because a healthy population is productive, which is necessary in increasing both the industrial and the agricultural production. The model's constant of 1.044 was significant at one percent level implying other macroeconomic variables outside the model are able to explain private investment growth in Kenya. 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 and it can be attributed to crowding out of investment. The negative result can be attributed to inefficiency of the public sector especially in the developing countries where a large proportion of public spending is attributed to non development expenditure like defence and interest payments on debt [27]. In addition, fewer development funds are allocated to the educational sector and also can be attributed to brain drain. This insignificance in agriculture and road sector can be attributed to poor funding of these sectors, corruption, wastage and duplication of roles [3].

Similar to this study, Oyieke [8] found out that infrastructure expenditure influences private capital significantly. Mohib et al. [28] conducting a similar study in Pakistan concluded that health and defense spending compliments and demotes private investment respectively and Laopodis [20] confirmed the same results for military expenditures. 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 [5, 12]. This is in line with the Vision 2030 ambitions and the 'Big Four' Agenda of the government.

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 percent boundary indicating that the models were stable. The model adjustment term is -0.21 which is statistically significant at 1 percent level and it is within the theoretically accepted range of -1 and 0. Our adjusted R^2 is 0.46 implying that 46 % of private investment variations were explained by the equation

regressors. This indicated that the overall goodness of fit was satisfactory.

5. CONCLUSIONS AND RECOMMENDATIONS

The study objective was to investigate the core function of public infrastructure expenditure in promoting or demoting private investments in Kenya. The descriptive statistics of both models mirrored normal distributions with a high range of distribution occasioned by increasing public infrastructure expenditures in sectors over time. The cointegration analysis revealed that there is long-run and short-run relationship between private investment and sector 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 46 percent of private investment variation was explained by the dependent variables in the estimation equation. 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 in infrastructure 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 roads should be enhanced since they all have a positive correlation with private investment. This endorsement is timely and in line with the Kenya Vision 2030 ambitions, the government's "Big 4 Agenda" and the Post COVID-19 ERS whose aim is to revitalize the economy through infrastructure investment to achieve a double digit growth. Strategic infrastructure investment in agriculture to stimulate the economy should be given priority since the contribution of this sector to economy is significant. Infrastructure investment in roads and highway was given precedence in the previous political regime (2013-2022) and based on these findings we expect higher economic and social returns. The infrastructure investments should continue to enhance transport and communication which eases the cost of doing business in the country, cut cost in production, increase capital accumulation, complements private sectors factors of production and finally stimulates private investment and economic growth.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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