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A DYNAMIC APPROACH

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PUBLIC AND PRIVATE INVESTMENT AND ECONOMIC GROWTH IN ZAMBIA:

A DYNAMIC APPROACH

Garikai Makuyana[1] and Nicholas M. Odhiambo

Abstract

This paper investigates the dynamic contributions of public and private investment to economic growth in Zambia during the period from 1970 to 2014. In the analysis, the paper also estimated the important indirect contribution of public investment to economic growth through its crowding effect on private investment. The study employs the newly proposed Autoregressive Distributed Lag (ARDL)-bounds testing approach in estimating the economic growth and private investment models. The empirical evidence from the study shows that private investment contributes more to economic growth than public investment in Zambia in the short run and the long run. In addition, gross public investment, infrastructural and non-infrastructural public investment were found to crowd out private investment in the short run; while non-infrastructural public investment also had a crowding out effect on private investment in the long run. The results imply that the long-run contributions of both private and public investment to economic growth in Zambia can be improved by raising the infrastructural public investment to a threshold level that stimulates private investment growth while reducing non-infrastructural public investment to the basic minimum level.

Key Words: Zambia; Public Investment; Private Investment; Economic Growth; Crowding in effect; Crowding out effect; ARDL-bounds testing approach

JEL Classification Codes: E22, O47, P12

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1. Introduction

The relative contributions of public and private investment to economic growth have been at the centre of discussion in debate and policy making circles in recent years. The focus of the discussion has been guided by two main issues: the first concern is whether public investment adds more to economic growth than does an equivalent amount allocated to private investment; and the second, which is related to the first, is the crowding effect of public investment on private investment.

Previous studies on the above raised issues are extensive, though most are at developed country level (see, Aschauer, 1989; Lighthart, 2000; Aubyn and Afonso, 2008; among others). The few available studies on the subject on developing countries have reported mixed and sometimes conflicting evidence (Khan and Reinhart, 1990; Khan and Kumar, 1997; Ghali, 1998). In particular, the dynamic relationship between public and private investment and their relative contribution to economic growth in Zambia has not been fully examined.

There are two main limitations prevalent in the previous studies on the subject. First, a number of the previous studies that have empirically examined the relative impacts of public and private investment on economic growth have used cross sectional data in the analysis (Khan and Reinhart, 1990; Khan and Kumar, 1997). Yet, it is now generally accepted that the cross-sectional grouping of countries that have adopted different economic management system may not fully take into account the important country-specific features. Second, in the analysis, the majority of the previous studies on the subject estimated the economic growth model only in which public and private investment are explanatory variables, among others. The empirical

evidence reported from this approach suffers from simultaneous and variable omission bias since private investment is an endogenous variable.

The objective of this study, therefore, is to empirically examine the dynamic contributions of public and private investment to economic growth in Zambia from 1970 to 2014 - using the ARDL approach. The study utilises two sets of empirical models. In the first set, the relative roles of public and private investment on economic growth process are explored in an economic growth equation in which the two components of investment are regressors, among others. In the second set, the important indirect contribution of public investment to economic growth through private investment is examined. Three private investment models are estimated in which gross public investment, infrastructural public investment and non-infrastructural public investment would each enter separately as a regressor, among others.

The rest of the paper is structured as follows: Section 2 briefly discusses the dynamics of public and private investment in Zambia from 1970 to 2014. Section 3 reviews the theoretical and empirical literature on public and private investment and economic growth while Section 4 presents the methodology and empirical analysis. Section 5 concludes the paper.

2. Dynamics of Public and Private Investment and Economic Growth in Zambia: 1970 to 2014

For the few years after independence in 1964, Zambia perpetuated the inherited market economy, restricting public investment to state enterprises in railway, electricity and agriculture (Kaunda, 1968). Public investment was focused on the provision of the basic infrastructure that

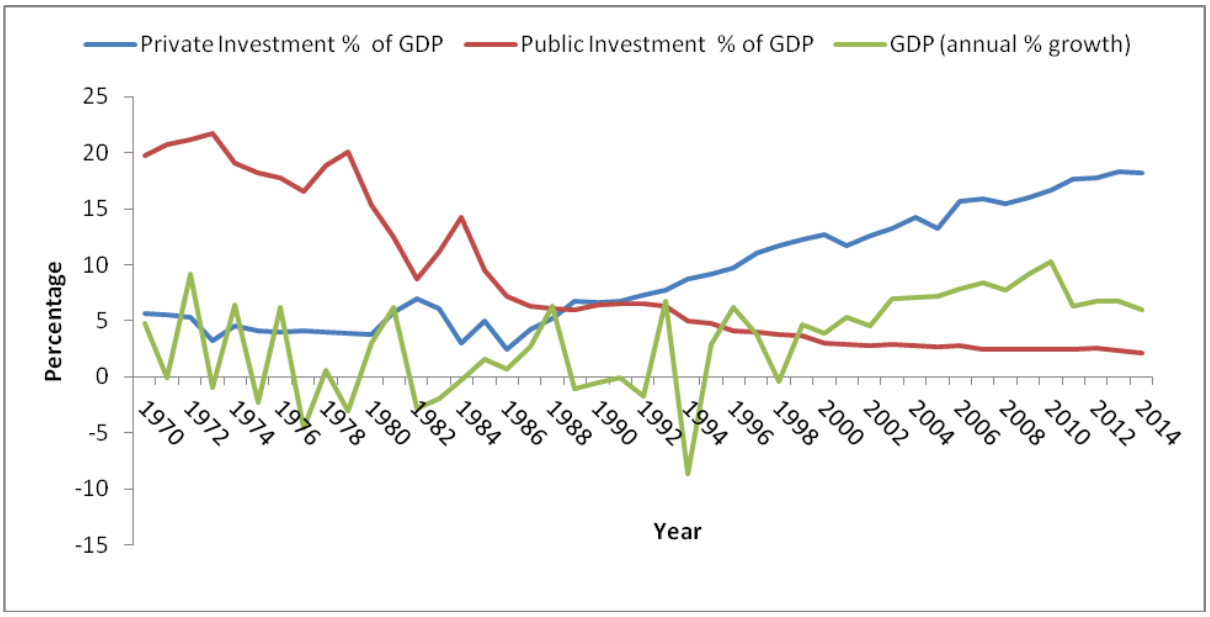
required huge capital outlay more than the private sector can afford (Republic of Zambia, 1979). However, public investment grew to economic leadership from the 1970s following the Mulungushi (1968) and the Matero (1969) reforms. The growth in public investment was mainly through state takeovers of private business across sectors including the copper mining business which was the backbone of the economy (Mudenda, 1984). Resultantly, private investment was greatly eliminated in domestic resource allocation.

The created state economic management system was sustained, for a while, by high economic growth rates that were brought about by the booming world copper prices. Even after the fall in world copper prices in the mid 1970s, the system was maintained through further borrowing - which continued to retard private business growth (Mudenda, 1984). However, when state could no longer sustain public investment growth through borrowing, it adopted the market reforms for a moment in the 1980s and soon reverted back to a command economy in which public investment was deficit financed. This was not long before the state adopted the International Monetary Fund (IMF) sponsored structural adjustment programmes which were centred on privatisation from the late 1980s (Bigsten and Mugerwa, 2000). The reforms resulted in the wholesome privatisation of state enterprises in commercial activities and reduced state investment undertaking to minimum level scarcely enough to provide basic infrastructure which promoted private investment growth from the 1990s to early 2000 (Bigsten and Mugerwa, 2000).

Accordingly, the need to consolidate on the created market economy has been the guiding principle in setting up economic policies from the early 2000. Thus, the economic growth policies adopted from the 2000 aimed to support the continual growth in private investment while in parallel enhancing the growth in public investment is the key enabling basic

infrastructure (Republic of Zambia, 2004). Such policies include the private sector development programme (2004), Fifth National Development Plan 2006-2010; and the Sixth National Development Plan 2011-2015 (Republic of Zambia 2004, 2006, 2011). Figure 1 gives a summary of the growth trends of public and private investment and economic growth from 1970 to 2014 in Zambia.

Figure 1: Trends in Public and Private Investment and Economic Growth in Zambia from 1970 to 2014



Source: World Bank (2015)

As Figure 1 illustrates, public investment growth dominated over private investment growth from 1970 to the end of the 1980s. Economic growth rates were moderate during the period, though oscillating between 7% and -5%. However, soon after 1990, private investment steadily

grew to economic dominance until 2014. Economic growth rates responded so positively to the economic arrangement, assuming a general upward growth trend up to 2014.

3. Literature Review

The contribution that public and private investment has on economic growth depends on the relationship that exists between them. If public and private investments are independent of each other, their contribution to economic growth is separate and additive. However, if there is a crowding effect relationship, the relative dominance of the crowding in or crowding out effect thereof determines the resultant contribution of public and private investment to economic growth. Public investment can crowd in private investment when it is restricted to the provision of basic infrastructure such as in energy, education, transport and health. State investment in such sectors creates an enabling environment which stimulates the establishment and growth of private investment (Berndt and Hanson, 1992). Yet, public investment can also crowd out private investment when (i) it is deficit financed – which raises the cost of capital above the reach of private enterprises; (ii) it produces commodities that pose direct competition with the private sector when the latter has a higher and a growing efficiency in their production; and (iii) it is undertaken by inefficient state enterprises that receives state subsidies (Devarajan et *al*., 1996).

Empirically, evidence brought to bear on the relative importance of public and private investment to economic growth has been mixed and inconclusive. There is a group of evidence that points to the superiority of private investment over public investment in economic growth process from a number of empirical studies. One such a study is the early work of Khan and Reinhart (1989) who found that private investment contributed more to economic growth than public investment from a sample of 24 developing economies. Khan and Kumar (1997) who

questioned the validity of Khan and Reinhart's small sample based evidence reported the same outcome after expanding the sample size to 95 developing economies. There are several follow up studies that gave evidence in support of private investment economic leadership (see, among others, Beddies, 1999; Yang Zou, 2006; Hague, 2013). However, there is also a growing body of empirical evidence reporting higher importance of public investment over private investment in economic growth process (Lynde, 1992; Crowder and Hamarios, 1997; Mallick, 2002; Belloc and Vertova, 2004). Such empirical evidence from developing economies is acceptable given the high marginal returns of public capital emanating from the infrastructural deficit that has to be closed.

Empirical studies on the crowding effect of public investment on private investment have also given varied results. For instance, Aschauer (1989) reported that non-military economic public infrastructure crowded in private investment in the USA from 1949 to 1985. Such public investment crowding in effect was supported by Cullision (1993) who reported that public investment in education has a higher complementarity effect than public investment in physical capital. At developing economies level, the crowding in effect of public investment has been reported by Sahoo *et al*., (2000) and Erden and Holcombe (2005). On the negative side though, public investment has been blamed for the stunted economic progress in some economies. For example Ghali (1998) reported that the contribution of private investment to economic progress was undermined by the crowding out effect of the inefficient and subsidised state enterprises in Tunisia. Later, Aremo (2013) also reported that private investment contributed less to economic growing owing to the crowding out effect of public investment in the community of West African states (ECOWAS).

4. Methodology and Empirical Analysis

4.1 Cointegration - Autoregressive Distributed Lag (ARDL) - bounds testing procedure

This study employs the newly developed ARDL-bounds testing approach to explore the relative impact of public and private investment on economic growth in Zambia (Pesaran and Shin, 1999; Pesaran *et al*., 2001). Empirically, the approach has been credited for its merits over the traditional cointegration techniques such as the Engle and Granger (1987) residual based approach and the Johansen and Juselius (1990) full maximum likelihood approach. Firstly, it can use variables with a mixture of order of integration up to a maximum of 1. Secondly, it can be used in studies with small samples–which is the case in this study. Thirdly, the approach employs a reduced form equation to give long-run relationship, unlike the traditional cointegration techniques that applies a system of equations (Shrestha and Chrowdhury, 2007). In addition, the t-statistics from the ARDL procedure are valid and its long-run estimates are unbiased (Pesaran and Shin, 1999; Odhiambo, 2008).

4.2. The Relative Impact of Public and Private Investment on Economic Growth

To explore the relative impacts of public and private investment on economic growth in Zambia, the study applies the modified version of the Solow (1956) production function. Following Khan and Reinhart (1989), Ghali (1998) and Phetsvavong and Ichihash (2012), the ARDL expression of the model (Model 1) is given as:

Model 1

$$\Delta Y_t = \alpha_0 + \sum_{i=1}^{n} \alpha_{1i}\, \Delta Y_{t-i} + \sum_{i=0}^{n} \alpha_{2i}\Delta G_{t-i} + \sum_{i=0}^{n} \alpha_{3i}\Delta P_{t-i} + \sum_{i=0}^{n} \alpha_{4i}\Delta L_{t-i} + \sum_{i=0}^{n} \alpha_{5i}\Delta CR_{t-i} + \sum_{i=0}^{n} \alpha_{6i}\Delta T_{t-i} + \beta_1 Y_{t-1} + \beta_2 G_{t-1} + \beta_3 P_{t-1} + \beta_4 L_{t-1} + \beta_5 CR_{t-1} + \beta_6 T_{t-1} + \mu_t \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (1)$$

Where *Y* is the annual growth rate of real gross domestic product; *G* is public investment; *P* is private investment; *L* is labour; *CR* is private sector credit; *T* is the terms of trade; α_0 is the intercept; $\alpha_1 - \alpha_6$ and $\beta_1 - \beta_6$ are short-run and long-run elasticities, respectively of output with respect to above identified variables; μ_t is the error term; Δ is the difference operator; and *n* is the lag length.

The error correction model based on Model 1 is expressed as follows:

$$\Delta Y_t = \alpha_0 + \sum_{i=1}^{n} \alpha_{1i}\Delta Y_{t-i} + \sum_{i=0}^{n} \alpha_{2i}\Delta G_{t-i} + \sum_{i=0}^{n} \alpha_{3i}\Delta P_{t-i} + \sum_{i=0}^{n} \alpha_{4i}\Delta L_{t-i} + \sum_{i=0}^{n} \alpha_{5i}\Delta CR_{t-i} + \sum_{i=0}^{n} \alpha_{6i}\Delta T_{t-i} + \varphi_1 ECM_{t-1} + \mu_t \ldots\ldots\ldots\ldots (2)$$

Where φ_1 is the coefficient of the *ECM*; ECM_{t-1} is the error correction term lagged by one period; the other variables are defined as in equation (1).

4.3. The Impact of Public Investment on Private Investment

While the main objective of this study is to empirically examine the relative contributions of public and private investment on economic growth, it is also crucial to estimate the crowding effect of public investment on private investment. Besides capturing the indirect contribution of public investment to economic growth through private investment, estimating the private investment model is also important in two ways. Firstly, it addresses the potential simultaneous bias problem in estimation arising from the endogeneity of private investment. Secondly, the outcome of the crowding effect of public investment on private investment has important policy implications. For example, if private investment is reported to be more important than public investment in the growth process when there is a crowding in relationship between the two components of investment, it is prudent for policy makers not to cut back on public investment.

The study adopts the Blejer and Khan (1984) approach in estimating the crowding effect of public investment on private investment. The approach uses three separate categories of private investment that are estimated in turn. In the first one, gross private investment is the explanatory variable, among others. The second and third take infrastructural public investment and non-infrastructural public investment, respectively, as an independent variable. The ARDL expression of the private investment models are presented as Models 2 to 4.

Model 2: Crowding Effect of Gross Public Investment

$$\Delta P_t = \alpha_0 + \sum_{i=0}^{n} \alpha_{1i} \Delta G_{t-i} + \sum_{i=0}^{n} \alpha_{2i} \Delta IF_{t-i} + \sum_{i=0}^{n} \alpha_{3i} \Delta Y_{t-i} + \sum_{i=0}^{n} \alpha_{4i} \Delta CR_{t-i}$$
$$+ \sum_{i=0}^{n} \alpha_{5i} \Delta T_{t-i} + \sum_{i=1}^{n} \alpha_{6i} \Delta P_{t-i} + \beta_1 G_{t-1} + \beta_2 IF_{t-1} + \beta_3 Y_{t-1}$$
$$+ \beta_4 CR_{t-1} + \beta_5 T_{t-1} + \beta_6 P_{t-1} + \varepsilon_{1t} \ldots\ldots (3)$$

Model 3: The Crowding Effect of Infrastructural Public Investment

$$\Delta P_t = \alpha_0 + \sum_{i=0}^{n} \alpha_{1i} \Delta INFR_{t-i} + \sum_{i=0}^{n} \alpha_{2i} \Delta IF_{t-i}$$
$$+ \sum_{i=0}^{n} \alpha_{3i} \Delta Y_{t-i} + \sum_{i=0}^{n} \alpha_{4i} \Delta CR_{t-i} + \sum_{i=0}^{n} \alpha_{5i} \Delta T_{t-i} + \sum_{i=1}^{n} \alpha_{6i} \Delta P_{t-i}$$
$$+ \beta_1 INFR_{t-1} + \beta_2 IF_{t-1} + \beta_3 Y_{t-1} + \beta_4 CR_{t-1} + \beta_5 T_{t-1}$$
$$+ \beta_6 P_{t-1} + \varepsilon_{2t} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (4)$$

Model 4: The Crowding Effect of Non-Infrastructural Public Investment

$$\Delta P_t = \alpha_0 + \sum_{i=0}^{n} \alpha_{1i} \Delta NON_{t-i} + \sum_{i=0}^{n} \alpha_{2i} \Delta IF_{t-i} + \sum_{i=0}^{n} \alpha_{3i} \Delta Y_{t-i} + \sum_{i=0}^{n} \alpha_{4i} \Delta CR_{t-i} + \sum_{i=0}^{n} \alpha_{5i} \Delta T_{t-i} + \sum_{i=1}^{n} \alpha_{6i} \Delta P_{t-i} + \beta_1 NON_{t-1} + \beta_2 IF_{t-1} + \beta_3 Y_{t-1} + \beta_4 CR_{t-1} + \beta_5 T_{t-1} + \beta_6 P_{t-1} + \varepsilon_{3t} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (5)$$

Where P is private investment; G is public investment; Y is the annual growth rate of real gross domestic product; CR is private sector credit; T is the terms of trade; IF is the inflation rate; $INFR$ and NON are infrastructural and non infrastructural public investment, respectively; α_0 is the constant; Δ is the difference operator; $\alpha_1 - \alpha_6$ are the short-run slope coefficients; $\beta_1 - \beta_6$ are the long-run slope coefficients; n is the maximum lag length; and $\varepsilon's$ are the white noise error terms.

The error correction representations of the private investment models are expressed as follows:

Based on Model 2

$$\Delta P_t = \alpha_0 + \sum_{i=0}^{n} \alpha_{1i} \Delta G_{t-i} + \sum_{i=0}^{n} \alpha_{2i} \Delta IF_{t-i} + \sum_{i=0}^{n} \alpha_{3i} \Delta Y_{t-i} + \sum_{i=0}^{n} \alpha_{4i} \Delta CR_{t-i} + \sum_{i-0}^{n} \alpha_{5i} \Delta T_{t-i} + \sum_{i=1}^{n} \alpha_{6i} \Delta P_{t-i} + \pi ECM_{t-1} + \varepsilon_{1t} \ldots \ldots \ldots \ldots (6)$$

Based on Model 3

$$\Delta P_t = \alpha_0 + \sum_{i=0}^{n} \alpha_{1i} \Delta INFR_{t-i} + \sum_{i=0}^{n} \alpha_{2i} \Delta IF_{t-i} + \sum_{i=0}^{n} \alpha_{3i} \Delta Y_{t-i} + \sum_{i=0}^{n} \alpha_{4i} \Delta CR_{t-i} + \sum_{i-0}^{n} \alpha_{5i} \Delta T_{t-i} + \sum_{i=1}^{n} \alpha_{6i} \Delta P_{t-i} + \rho ECM_{t-1} + \varepsilon_{2t} \ldots \ldots \ldots \ldots (7)$$

Based on model (4)

$$\Delta P_t = \alpha_0 + \sum_{i=0}^{n} \alpha_{1i} \Delta NON_{t-i} + \sum_{i=0}^{n} \alpha_{2i} \Delta IF_{t-i} + \sum_{i=0}^{n} \alpha_{3i} \Delta Y_{t-i} + \sum_{i=0}^{n} \alpha_{4i} \Delta CR_{t-i} + \sum_{i=0}^{n} \alpha_{5i} \Delta T_{t-i} + \sum_{i=1}^{n} \alpha_{6i} \Delta P_{t-i} + \varphi ECM_{t-1} + \varepsilon_{3t} \dots \dots (8)$$

Where *P* is private investment; *Y* is the annual growth rate of real gross domestic product; *G* is public investment; *CR* is private sector credit; *T* is the terms of trade; IF is the inflation rate; $INFR$ and NON are infrastructural and non infrastructural public investment, respectively; α_0 is the constant; Δ is the difference operator; $\alpha_1 - \alpha_6$ are the short-run slope coefficients; π, ρ and φ are the respective coefficients of the *ECM*; ECM_{t-1} is the error correction term lagged by one period; *n* is the maximum lag length; and $\varepsilon's$ are the white noise error terms.

Annual time series data on variables used in this study is sourced from the World Bank's Development Indicators (World Bank, 2015) and the International Monetary Fund Financial Statistics ((International Monetary Fund, 2015). Data on infrastructural and non-infrastructural public investment is generated by decomposing the gross public investment data. The approach is informed by Blejer and Khan (1984) and later Odedokun (1997) who argued that infrastructural public investment is more related to the trend movement of the gross public

investment as a percentage of GDP than non-infrastructural public investment. The basis of their argument was that government infrastructural projects are associated with economic progress and have a long gestation period. Thus, following Blejer and Khan (1984), infrastructural public investment is extracted as follows:

$$INFR = G_0 e^{gt}$$

Where, g is the annual growth rate of public investment, G_0 is the initial value of public investment; and *e* is the exponent; *t* is the time period; *G* and *INFR* is gross public investment and infrastructural public investment, respectively.

After extracting the data on infrastructural public investment, subtracting data of this variable from gross public investment gives the data on non-infrastructural public investment. While the study is aware of the possible limitation of this approach in generating data on infrastructural and non-infrastructural public investment, as Odedokun (1997) also argued, it is the most feasible alternative given the absence of country data as is the case in this study.

4.4. Empirical Analysis

All the variables used in this study are subjected to stationarity tests before undertaking the empirical analysis. This is important in order to ascertain whether the ARDL- bounds testing approach is applicable or not. For this purpose, the study applies the Augmented Dickey-Fuller Generalised Least Square (ADF-GLS) and the Phillips Perron (PP) unit root testing techniques. The lag length for the ADF-GLS unit root test was automatically selected by the SIC and the PP truncation lag was also automatically selected on the Neway-West bandwith for the PP unit root test. Table 1 gives the results of the ADF-GLS and PP unit root tests.

Table 1: Stationarity Tests of all Variables

Dickey-Fuller Generalised Least Square (DF-GLS)				
Variable	**Stationarity of all Variables in Levels**		**Stationarity of all Variables in First Differences**	
	Without Trend	With Trend	Without Trend	With Trend
Y	-6.361***	-7.001***	-	-
P	-1.529	-1.957	-2.771***	-8.805***
G	-2.899***	-3.351**	-	-
L	-0.746	-1.565	-1.815*	-2.976*
CR	-1.722	-1.787	-5.869***	-5.261***
T	-2.060	-2.817	-6.481***	-6.016***
IF	-1.218	-4.765	-3.171***	-10.236***
INFR	-2.966***	-3.563**	-	-
NON	-4.016***	-4.336***	-	-
Phillips Perron (PP)				
Variable	**Stationarity of all Variables in Levels**		**Stationarity of all Variables in First Differences**	
	Without Trend	With Trend	Without Trend	With Trend
Y	-6.564***	-7.156***	-	-
P	-4.086***	-4.655***	-	-
G	-2.782	-3.478	-10.717***	-10.830***
L	-0.341	-3.353	-3.227**	-3.430*
CR	-1.523	-1.274	-5.680***	-6.088***
T	-2.751	-2.807	-7.652***	-9.306***
IF	-5.698***	-5.742***	-	-
INFR	-2.897	-3.751	-11.090***	-11.022***
NON	-5.698***	-5.742**	-	-

Note: ***, ** and * denotes stationarity at 1%, 5% and 1%, respectively

As Table 1 shows, all variables are integrated of order 0 or 1. This implies that the ARDL-bounds testing procedure is applicable and this sets the stage for the cointegration test. The bounds F-test is used in this study to test the existence of the long-run relationship of the variables in the economic growth and private investment models. Table 2 presents the results of the bounds F-test for cointegration.

Table 2: Bounds F-test for Cointegration

Dependent Variable	**Function**				**F-Statistic**	**Cointegration Status**
Y	F(Y|P, G, L, CR, T)				4.85***	Cointegrated
P	F(P|G, IF, Y, CR, T)				3.46*	Cointegrated
P	F(P|INFR, IF, Y, CR, T)				3.72*	Cointegrated
P	F(P|NON, IF, Y, CR, T)				3.91**	Cointegrated
Asymptotic Critical Values						
Pesaran *et al*. (2001). P.300, Table CI(iii) CaseIII	1%		5%		10%	
	I(0)	I(1)	I(0)	I(1)	I(0)	I(1)
	3.41	4.68	2.62	3.79	2.26	3.35

Note: ***, ** and * denotes statistical significance at 1%, 5% and 10% level, respectively.

The results in Table 2 indicate that the variables in the economic growth and private investment models have a cointegrating relationship. In other words, the null hypothesis of no long-run relationship is rejected. This allows the estimation of the long-run coefficients and the associated

error correction models. Table 3 presents the long-run and short-run coefficients for the economic growth and private investment modes.

Table 3: Estimation of Long-Run and Short-Run Coefficients

	Model 1 AIC (1,0,2,1,0,2)	**Model 2 SBC (1,1,0,0,0,0)**	**Model 3 AIC (2,1,0,2,0,2)**	**Model 4 SBC (1,0,2,0,1,1)**
	Panel A: Estimated long-run coefficients (Dependent variables: Y for Model 1 and P for Models 2-4)			
Regressors	**Coefficients (t-statistics)**			
C	6.423(2.925)***	31.069(1.655)	-10.715(-0.927)	3.309 (3.461)***
P	0.085(2.181)**	-	-	-
G	-0.339 (-3.076)***	-0.788(-1.096)	-	-
L	0.169(3.601)***	-	-	-
CR	0.236(2.136)**	-0.227(-0.718)	0.196(0.990)	-0.678 (-2.595)***
T	0.063(0.840)	-0.268(-0.748)	0.450(1.426)	0.681(2.791)**
IF	-	-0.684 (-1.864)*	-0.201(-1.330)	-0.106 (-7.412)***
INFR	-	-	0.091(0.203)	-
NON	-	-	-	-0.147(1.794)*
Y	-	0.654(1.400)	0.195(1.876)*	0.054 (3.523)***
	Panel B: Estimated short-run coefficients (Dependent variables: DY for Model 1 and DP for Models 2-4)			
DP	0.115(2.514)**	-		-

DP(-1)	-	-	0.341(2.676)**	
DG	-0.773 (-3.484)***	-0.866 (-5.660)***	-	-
DG(-1)	-0.336 (-2.209)**	-	-	-
DL	-0.139 (-3.362)***	-	-	-
DCR	0.319(2.051)**	0.632(0.886)	-0.080(1.197)	0.359(1.186)
DT	0.061(0.986)	-0.074(-0.920)	-0.142(-1.859)*	-0.362(-1.323)
DT(-1)	-1.900 (-2.690)**	-	-0.186 (-3.002)***	-
DIF	-	-0.190 (-3.058)***	-0.082(-1.359)	-0.670 (-6.434)***
DIF(-1)	-	-	-	0.221(2.565)**
DY	-	0.182(1.344)	-0.142(-1.008)	0.065 (3.796)***
DY(-1)	-	-	-0.274 (-2.254)**	-
DINFR	-	-	-0.364 (-6.704)***	-
DNON	-	-		-0.177(-1.843)*
ECM(-1)	-0.935 (-6.528)***	-0.278 (1.938)*	-0.408 (-2.931)***	-0.921 (-9.921)***
R-squared	0.827	0.822	0.879	0.812
F-statistic	18.558	23.069	20.973	16.696
Prob(F-statistic)	0.000	0.000	0.000	0.000
DW statistic	1.949	1.914	2.107	1.792

Notes: 1. ***, ** and * denote statistical significance at the 1%, 5% and 10% levels, respectively.

2. Δ=first difference operator.

The long-run results in Table 3 (Panel A-Model 1) illustrates that the coefficients of private (*P*) investment is positive, as expected and statistically significant at 5%. The long-run coefficient of public investment (*G*) is negative and statistically significant at 1%.This could suggest that the privatisation programme and the private investment policies implemented in Zambia are beneficial to economic growth. However, the negative coefficient of public investment implies that investment undertaken by the state in Zambia is detrimental to economic progress. The results compare favourably with empirical evidence from other studies on the subject such as Khan and Kumar (1997), Ghali (1998), Yang Zou (2006), among others.

The results from other variables shows that labour (*L*) and credit to the private sector (*C*), as expected, are positively related to economic growth in the long run.

The short-run results for economic growth model are shown in Table 3 Panel B (Model 1). As is the case with long run results, the short-run dynamics in Table 3 Panel B shows that *DP* is positively related to economic growth; while *DG* and *DG (-1)* are negatively associated with economic growth process. This entails that an increase in private investment leads to an increase in economic growth in the short run while the immediate effect of an increase in public investment is a reduction in economic growth rate. The other variables, *DL* and *DT (-1)* are negatively related with economic growth in the short run while *DC* positively affects economic growth in the short run. The coefficient of the error correction term (*ECM (-1)*) is negative, as expected and statistically significant at 1%.

The empirical results reported in model 1 indicates that private investment is positively related to economic growth in the long run and short run. In contrast, public investment is negatively

associated with economic growth in the long run and short run. The results of Model 1 imply that private investment is more beneficial to economic growth in Zambia than public investment.

The empirical results of Model 2 as shown in Table 3 (Panel A and B) indicates that gross public investment has no statistical significant impact on private investment in the long run; while in the short run, the coefficient of gross public investment is negative and statistically significant at 1%. This implies the short-run crowding-out effect of gross public investment on private investment in Zambia.

Similarly, the empirical results of model 3 in Table 3 (Panel A and B) shows that infrastructural public investment in Zambia has no significant long-run effect on private investment; while in the short run, the coefficient of infrastructural public investment is negative and statistically significant. The results suggest that while infrastructural public investment crowds out private investment in the short run, it has fallen below the minimum level enough to crowd in private investment in the long run in Zambia.

In addition, the results from model 4 in Table 3 (Panel A and B) indicates that coefficient of non-infrastructural public investment is negative and statistically significant in the long run and short run. This implies that non-infrastructural public investment is crowds out private investment growth in Zambia, regardless of whether the analysis is done in the long run and short run.

The results of other variables (Table 3-Panel A) indicate that inflation (IF) and credit (CR) negatively affect private investment while economic growth (Y) and terms of trade (T) are positively related to private investment growth in the long run.

The short-run results in Table 3 Panel B shows that the coefficients of *DP(-1)*, *DIF(-1)* and *DY* are positive and statistically significant; implying that private investment lagged by one period and inflation rate lagged by one period as well as the current change in economic growth rate, respectively all have a positive impact on private investment growth in the short run. The variables *DT*, *DT (-1)* and *DIF* are negatively associated with private investment growth in the short run. The *ECM (-1)* terms for the private investment models are all negative and statistically significant – which confirms the existence of the long-run relationship of all variables in the models.

Based on the results from Table 3, private investment contributes more to economic growth in Zambia more than public investment. The negative effect that public investment has on economic growth can be explained in the context of the crowding out effect that non-infrastructural public investment has on private investment in the long run and the short-run crowding out effect of gross public investment, infrastructural and non-infrastructural public investment on private investment in Zambia. The inability of infrastructural public investment to promote private investment especially in the long run, as expected can suggest that investment on core infrastructural projects by the government has fallen below the minimum required to crowd in private investment.

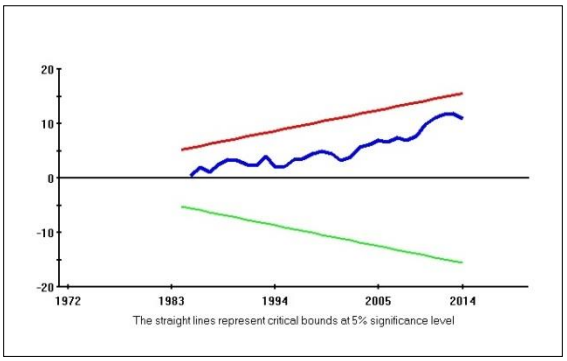
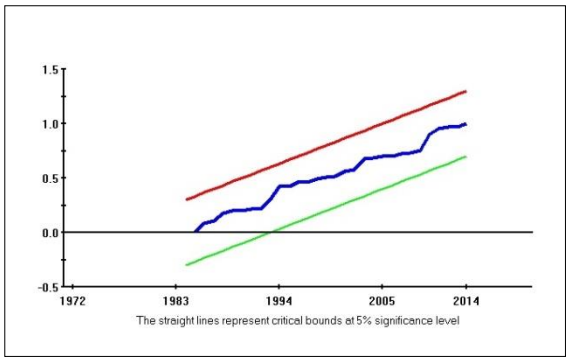
To check on the reliability of the results on economic growth and private investment models, diagnostic tests were carried and the results are reported in Table 4.

Table 4: ARDL – VECM Diagnostic Tests

LM Test Statistic	Results [Probability]			
	Model 1	**Model 2**	**Model 3**	**Model 4**
Serial Correlation: CHSQ(1)	0.273 [0.864]	0.071 [0.791]	0.354 [0.552]	0.602 [0.438]
Functional Form: CHSQ(1)	4.144 [0.042]	5.378 [0.020]	0.003 [0.958]	1.503 [0.220]
Normality: CHSQ (2)	5.127 [0.077]	7.387 [0.025]	0.406 [0.816]	6.214 [0.045]
Heteroscedasticity: CHSQ(1)	1.310 [0.252]	0.922 [0.761]	0.105 [0.745]	1.359 [0.244]

The results in Table 4 show that all models pass the diagnostic test on serial correlation and heteroscadasticity. Models 1 and 2 fail on the functional form test and on the normality test, it is only Model 3 that passed. All the models, however, pass the stability test as revealed by cumulative sum of recursive residuals (CUSUM) and cumulative sum of squares of recursive residuals (CUSUMQ) plots (see Figure 2), implying that the estimated results are valid.

Figure 2: Cumulative sum of recursive residuals and cumulative sum of squares of recursive residuals plots

<table>
<tr><th colspan="2">Model 1</th></tr>
<tr><td>Cumulative sum of recursive residuals</td><td>Cumulative sum of squares of recursive residuals</td></tr>
<tr><td> 
</td><td> 
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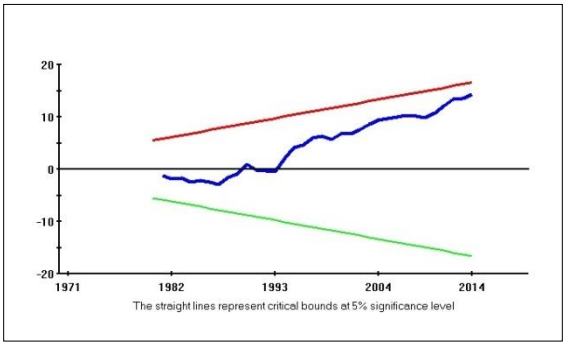
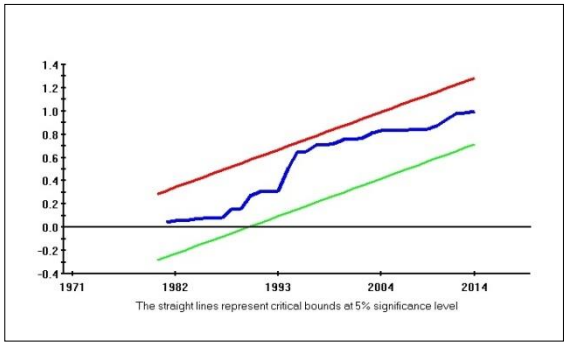
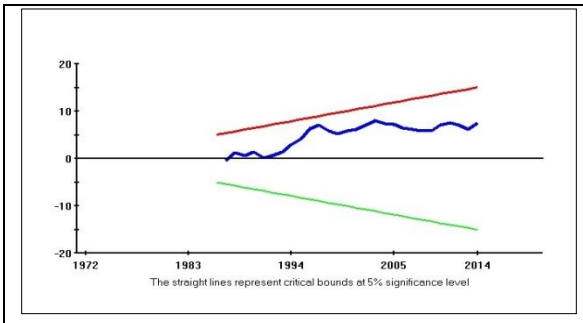
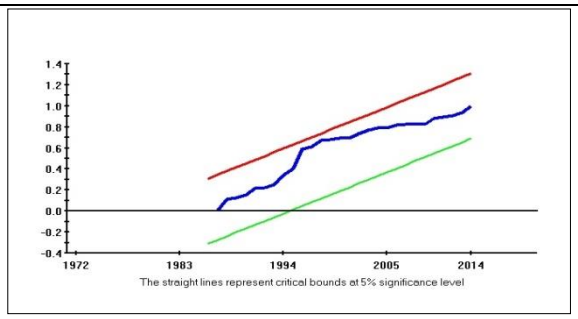
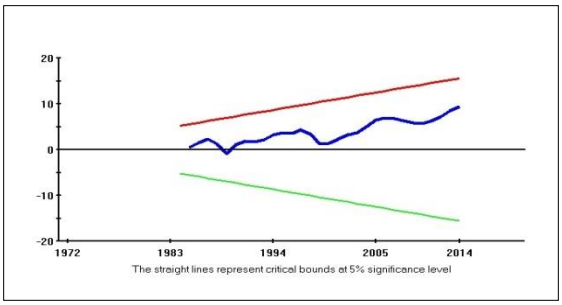
<tr><th colspan="2">Model 2</th></tr>
<tr><td>Cumulative sum of recursive residuals</td><td>Cumulative sum of squares of recursive residuals</td></tr>
<tr><td> 
</td><td> 
</td></tr>
<tr><th colspan="2">Model 3</th></tr>
<tr><td>Cumulative sum of recursive residuals</td><td>Cumulative sum of squares of recursive residuals</td></tr>
</table>



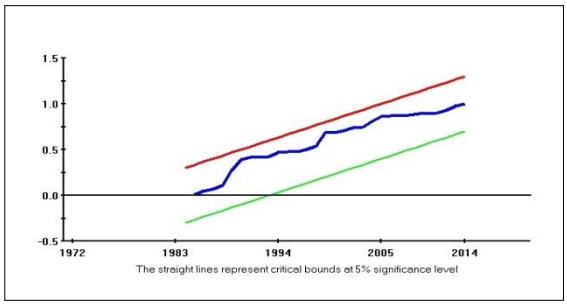


Model 4

Cumulative sum of recursive residuals



Cumulative sum of squares of recursive residuals



5. Conclusion

In this study, the relative impacts of public and private investment on economic growth in Zambia from 1970 to 2014 was examined. While previous studies on the subject are extensive, the empirical evidence that has been reported is mixed and inconclusive. This study is among the first to explore in detail the dynamic impact of public and private investment on economic growth in Zambia – using the newly developed ARDL bounds testing framework. Unlike most previous studies, the study estimates the private investment models in addition to estimating the economic growth model. This addresses the potential simultaneous bias problem in estimation since private investment is an endogenous variable. The empirical results from the study show

that private investment is more important to economic growth in Zambia both in the short run and long run. In addition, the results also indicated the crowding out effect of non-infrastructural public investment on private investment in the long run and the crowding out effect of gross public investment and infrastructural and non-infrastructural public investment on private investment in the short run. This suggests that the long-run contribution of private investment and public investment to economic growth can be improved in Zambia by cutting back on non-infrastructural public investment and raising the infrastructural public investment to a level that promotes private investment.

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