Public and private investment and economic growth in Zimbabwe: An empirical test

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Abstract: This study performs an examination on the impact of public and private investment on economic growth and the crowding effect of public investment on private investment in Zimbabwe from 1970 to 2014. The study utilised the newly developed autoregressive distributed lag-bounds testing approach with better small sample properties than the traditional cointegration techniques. The results show that public investment has a higher short-run growth impact, but in the long run the private investment-led growth is more important. In addition, while gross public investment crowds out private investment, infrastructural public investment has a long-run crowding in effect. A non-infrastructural public investment was also reported to have a short-run crowding out effect on private investment. The results suggest that the productivity of public and private investment in Zimbabwe can be improved by cutting back on non-infrastructural public investment to basic minimum level while stimulating the growth in infrastructural public investment.

1. Introduction

In recent years, the academic and policy making circles have been seized with discussions centered on whether public investment and private investment are related and on establishing their relative contribution to economic growth. Theoretically, public investment can be beneficial to economic growth when it is confined to the core infrastructural projects that crowd in private investment growth such as in transport, health, water and education (Berndt & Hanson, 1992). On the negative side, public investment can crowd out private investment when: it is debt financed in the face of scarce resources; it produces goods and services that compete directly with the private sector when it is established that the latter is more efficient in their provision; and it is undertaken by the inefficient and subsidised state enterprises (Devarajan et al., 1996). Thus, for policymakers concerned with improving economic growth rates, it is not just the level of investment that matters but its composition between the public and private components.

The empirical literature on the relationship between public and private investment and their differential impacts on economic growth is mixed and inconclusive. For instance, there is growing body of empirical literature in support of a public investment-led economic growth process (see, among others, Aschauer, 1989; Belloc & Vertova, 2004; Be'dia, 2007). In particular, Aschauer (1989) concluded that non-military public investment stimulated private investment productivity and economic growth for the USA during the 1949 to 1985 period. Yet there are also studies that ascribe to the private

investment-led economic growth (Khan & Reinhart, 1990; Countinho & Gallo, 1991; Ghura, 1997; Hague, 2013, among others). The empirical evidence from these studies underscores the need to eliminate public investment in commercial activities and maintain the minimum level of public investment enough to sustain the full working of a market economy.

In addition, the majority of the studies that have examined the relative contribution of public and private investment on economic growth are limited in a number of ways. Firstly, most of the previous studies on the subject have only estimated the modified production model in which public and private investment are independent variables among others; the empirical results thereof are susceptible to the simultaneous bias problem since private investment is an endogenous variable. Simultaneous estimating the private investment model is, therefore, necessary in establishing the important crowding effect of public investment on private investment. Secondly, some previous studies on the subject have examined the impact of only public investment or its subcomponents on economic growth. An empirical study on the differential impacts of public and private investment has important policy implication in creating an investment mix that can best grow the economy. Lastly, majority of the studies on the subject at developing countries level are based on cross sectional analysis. Yet it is now agreed that the cross sectional grouping of countries that have different structural features may impede the prescription of the country based policy implications.

Against this backdrop, this study attempts to examine the relative impact of public and private investment on economic growth, while simultaneously estimating the crowding effect of public investment on the private investment in Zimbabwe from 1970 to 2014 - using the newly proposed Autoregressive Distributed Lag (ARDL) - bounds testing approach.

FIGURE 1. GROSS FIXED CAPITAL FORMATION (% OF GDP)
AND GDP (% ANNUAL GROWTH) FROM 1970 TO 2014
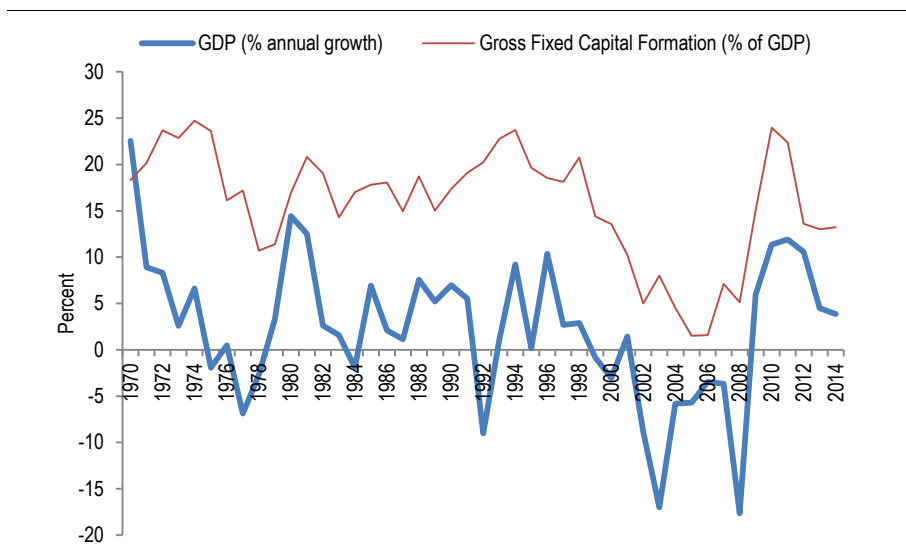
SOURCE: World Bank (2015).

Zimbabwe has a mixed economic management system - in which there is a significant presence of state owned enterprises in as much as the private sector enterprises. Initially before independence, the high growth in infrastructural public investment stimulated

growth in private enterprises and economic growth (Government of Zimbabwe, 1982). However, at the dawn of independence in 1980, growth in public investment crowded out private investment growth as the new government created a strong state economic management system through a combination of private enterprise takeovers and the creation of new state enterprises (Government of Zimbabwe, 1982). In the 1990s, the adopted International Monetary Fund (IMF) backed economic structural adjustment programme (ESAP) which was centered on privatisation marked the end of the state economic management system in Zimbabwe (Government of Zimbabwe, 1991). Though few state enterprises were successfully privatised during ESAP, the subsequent adopted market economy based policies, such as the Zimbabwe programme for economic and social transitional (ZIMPREST) from 1996 to 2000 and the enhanced privatisation through the created privatisation agency of Zimbabwe (PAZ) from 2000, established an enabling environment for a vibrant private enterprise growth (Government of Zimbabwe, 1998; Privatisation Agency of Zimbabwe, 2002). Figure 1 summarises the growth trends of gross fixed capital formation and gross domestic product (GDP) in Zimbabwe for the period 1970 to 2014 in response to various economic policies implemented.

As Figure 1 illustrates, gross fixed capital formation co-moved with GDP during the entire sample period from 1970 to 2014. The high gross fixed capital formation in Zimbabwe before 1980, which peaked at about 25% of GDP in 1975, was propelled by high infrastructural public investment as the government sought to self-sustain the economy which was under international economic isolation. After 1980, the gross fixed capital formation maintained a steady growth rate after which it increased to the peak in 1994 during the privatisation programmes under the Economic Structural Adjustment Programmes (Government of Zimbabwe, 1998). The low levels of both gross capital formation and economic growth from 2002 to 2008 were experienced at a time when the Zimbabwean economy was underperforming (Kaminski & Ng, 2011). From 2009, gross fixed capital formation and GDP steadily recovered in the backdrop of private investment promotion policies that were adopted (Nyarota et al., 2015). Though gross fixed capital formation was positively associated with GDP from 1970 to 2014 in Zimbabwe, what is still uncertain are the relative impacts exerted by public and private investment components to economic growth.

The rest of this paper is structured as follows: Section 2 highlights the theoretical and empirical literature on public and private investment and economic growth. The methodology is presented in Section 3, the empirical results are presented in Section 4. Section 5 concludes the paper.

2. Literature review

In the studies that examined whether public investment contributes to economic growth more than does an equivalent amount of private investment, two strands of literature can be identified. The first is based on the assumption that public and private investments are independent of each other and hence their contribution is separate and additive to economic growth. Empirical evidence reported in this regard is still far from being conclusive. For example, there is an argument that is gaining acceptance that private investment is more superior to economic growth than public investment based on the early works of Khan & Reinhart (1990) and Countinho & Gallo (1990). In particular, the study by Khan & Reinhart (1990) was based on 24 developing countries in which private investment was reported to have a positive effect on economic growth while public investment was negatively associated with growth. However, how robust the empirical evidence reported from a small sample of 24 data points remains an open question; especially when the data do not cover all the different groups of developing countries, given that there was no African country covered. Thus, follow up studies - such as Khan & Kumar (1997), Ghura (1997), Beddies (1999), Yang Zou (2006) and Hague (2013),

among others - that either expanded the cross sectional sample size or used time series data, reported evidence in support of a private investment-led economic growth.

Yet there is also a growing body of empirical evidence in support of a public investment led economic growth process (see, among others, Crowder & Hamarios, 1997; Mallick, 2002; Belloc & Vertova, 2004; Be′dia, 2007). Empirical evidence from these studies pointing to the superiority of public investment over private investment in the growth process can be explained in the context of the infrastructural public investment deficits in most developing economies.

The second strand of literature on the impact of public and private investment on economic growth is based on the assumption that public and private investment are related in a crowding in and crowding out relationship; and thus the contribution of public investment to economic growth is indirect through private investment. Empirical evidence on the crowding effect of public investment on private investment is extensive and yet also inconclusive. The studies on the subject were stimulated by the early works of Aschauer (1989) and Munnell (1990). In their studies, they concluded that public investment (non-military) crowded in private investment and hence stimulated economic progress in the USA economy. In particular, Munnell (1990) reported that for every 10% increase in public investment in economic infrastructure, GDP increased by 1.4% for the USA economy. Similar evidence of the crowding in effect of infrastructure public investment on private investment was supported in studies such as Cullison (1993), Ramirez (1996), Pereira (2001), Erden & Holcombe (2005), Samake (2008) and Sahoo et al. (2010), Xiaoming Xu & Yanyang Yan (2014), among others.

Empirical evidence of the crowding out effect of public investment on private investment growth is extensive (Evans & Karras, 1994; Nazmi & Ramirez, 1997; Odedokun, 1997; Ghali, 1998; Zou, 2003; Eduardo & Christian, 2011; Xiaoming Xu & Yanyang Yan, 2014). For instance, Eduardo & Christian (2011) found out that a 1% increase in public investment is associated with a 0.22% decline in private investment in the short run from a sample of 116 countries over 1980 to 20006 period. According to Eduardo & Christian (2011), such public investment crowding out effect was brought by the displacement of the private sector enterprises in resource allocation.

Therefore, although studies on the subject are extensive, empirical evidence that have been brought to bear on whether public investment adds to economic growth more than private investment and on the crowding effect of public investment on private investment is still inclusive.

3. Methodology

3.1. Cointegration: ARDL-bounds testing approach

To examine the cointegrating relationship between public and private investment and economic growth in Zimbabwe, this study employs the newly introduced ARDL-bounds testing approach (Pesaran & Shin, 1999; Pesaran, Shin & Smith, 2001). The approach has been increasingly used in empirical research in recent years owing to its advantages over the traditional cointegration techniques such as the Engle & Granger (1987) residual based approach and the Johansen (1991) full maximum likelihood technique. Some of the advantages of the ARDL-bounds testing approach to cointegration are: (i) the variables used in the analysis are not restricted to be integrated of the same order - they can be of any order of integration up to a limit of 1; (ii) the approach gives consistent and unbiased long-run coefficient estimates and reliable t-statistics even when dealing with small sample (Odhiambo, 2011); and (iii) it uses the simple reduced form equation to establish the long-run relationship among variables (Pesaran & Shin, 1999).

3.2. The relative contribution of public and private investment to economic growth

Based on the assertion that public and private investment are independent of each other and they contribute directly to economic growth process, this study extends the modified Solow (1956) production function as previously was used by Khan & Reinhart (1990), Ghali (1998), Yang Zou (2006) and Be'dia, (2007). In the modified model, it is now possible to examine the individual contribution of public and private investment to economic growth as they enter separately as explanatory variables among others. The adopted model (Model 1) in the ARDL expression is as follows:

Model 1

$$
\begin{aligned}
\Delta GDP_t = \alpha_0 &+ \sum_{i=1}^{n} \alpha_{1i}\Delta GDP_{t-i} + \sum_{i=0}^{n} \alpha_{2i}\Delta PLC_{t-i} + \sum_{i=0}^{n} \alpha_{3i}\Delta PVT_{t-i} \\
&+ \sum_{i=0}^{n} \alpha_{4i}\Delta LAB_{t-i} + \sum_{i=0}^{n} \alpha_{5i}\Delta CD_{t-i} + \sum_{i=0}^{n} \alpha_{6i}\Delta TERM_{t-i} \\
&+ \beta_1 GDP_{t-1} + \beta_2 PLC_{t-1} + \beta_3 PVT_{t-1} + \beta_4 LAB_{t-1} \\
&+ \beta_5 CD_{t-1} + \beta_6 TERM_{t-1} + \mu_t \qquad\qquad (1)
\end{aligned}
$$

Where *GDP*, the dependent variable, is economic growth; *PLC* is public investment; *PVT* is private investment; *LAB* is labour; *CD* is private sector credit; *TERM* is the terms of trade; α_0 is the intercept; $\alpha_1 - \alpha_6$ and $\beta_1 - \beta_6$ are respectively short-run and long-run elasticities of output with respect to the 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:

$$
\begin{aligned}
\Delta GDP_t = \alpha_0 &+ \sum_{i=1}^{n} \alpha_{1i}\Delta GDP_{t-i} + \sum_{i=0}^{n} \alpha_{2i}\Delta PLC_{t-i} + \sum_{i=0}^{n} \alpha_{3i}\Delta PVT_{t-i} \\
&+ \sum_{i=0}^{n} \alpha_{4i}\Delta LAB_{t-i} + \sum_{i=0}^{n} \alpha_{5i}\Delta CD_{t-i} + \sum_{i=0}^{n} \alpha_{6i}\Delta TERM_{t-i} \\
&+ \varphi_1 ECM_{t-1} + \mu_t \qquad\qquad (2)
\end{aligned}
$$

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).

3.3. The crowding effect of public investment on private investment

While the primary objective of this study is to empirically examine the relative impact of public and private investment on economic growth in Zimbabwe, estimating the crowding

effect of public investment on private investment is also desirable. Simultaneous estimating the private investment equation (in which public investment is an explanatory variable among the others) addresses the following limitations in the previous studies: (i) it captures the important indirect contribution of public investment to economic growth through its crowding effect on private investment; (ii) it solves the potential simultaneous bias problem given private investment is an endogenous variable; and (iii) insights regarding the crowding in or crowding out effect of public investment have important policy implications. For instance, if public investment is found to be less important than private investment in contributing to economic growth (when it is also reported that public investment crowd in private investment) it is prudent for policymakers to at least maintain public investment expenditures.

The approach adopted in this study to estimate the private investment model follows the lead of Blejer & Khan (1984) which was also extended by Odedokun (1997). Three separate private investment models are estimated, in which gross public investment, infrastructural public investment and non-infrastructural public investment each, in turn, enters the private investment model, among other explanatory variables. The ARDL expressions of the adopted private investment models are expressed as Model 2 - Model 4.

Model 2:
Crowding effect of gross public investment on private investment

$$
\begin{aligned}
\Delta PVT_t = \ &\alpha_0 \ + \ \sum_{i=0}^{n} \alpha_{1i}\Delta PLC_{t-i} \ + \ \sum_{i=0}^{n} \alpha_{2i}\Delta IF_{t-i} \ + \ \sum_{i=0}^{n} \alpha_{3i}\Delta GDP_{t-i} \\
&+ \ \sum_{i=0}^{n} \alpha_{4i}\Delta CD_{t-i} + \ \sum_{i=0}^{n} \alpha_{5i}\Delta TERM_{t-i} \ + \ \sum_{i=1}^{n} \alpha_{6i}\Delta PVT_{t-i} \\
&+ \ \beta_1 PLC_{t-1} \ + \ \beta_2 IF_{t-1} \ + \ \beta_3 GDP_{t-1} \ + \ \beta_4 CD_{t-1} \\
&+ \ \beta_5 TERM_{t-1} \ + \ \beta_6 PVT_{t-1} \\
&+ \ \varepsilon_{1t} \qquad\qquad\qquad\qquad\qquad\qquad\qquad\qquad\qquad (3)
\end{aligned}
$$

Model 3:
Crowding effect of infrastructural public investment on private investment

$$
\begin{aligned}
\Delta PVT_t = \ &\alpha_0 \ + \ \sum_{i=0}^{n} \alpha_{1i}\Delta INFRAST_{t-i} \ + \ \sum_{i=0}^{n} \alpha_{2i}\Delta IF_{t-i} \\
&+ \ \sum_{i=0}^{n} \alpha_{3i}\Delta GDP_{t-i} \ + \ \sum_{i=0}^{n} \alpha_{4i}\Delta CD_{t-i} \\
&+ \ \sum_{i=0}^{n} \alpha_{5i}\Delta TERM_{t-i} \ + \ \sum_{i=1}^{n} \alpha_{6i}\Delta PVT_{t-i} \\
&+ \ \beta_1 INFRAST_{t-1} \ + \ \beta_2 IF_{t-1} \ + \ \beta_3 GDP_{t-1} \\
&+ \ \beta_4 CD_{t-1} \ + \ \beta_5 TERM_{t-1} \ + \ \beta_6 PVT_{t-1} + \varepsilon_{2t} \qquad (4)
\end{aligned}
$$

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Model 4:

Crowding effect of non-infrastructural public investment on private investment

$$
\begin{aligned}
\Delta PVT_t \;=\; & \alpha_0 \;+\; \sum_{i=0}^{n} \alpha_{1i}\Delta NONINFRAST_{t-i} \;+\; \sum_{i=0}^{n} \alpha_{2i}\Delta IF_{t-i} \\
& +\; \sum_{i=0}^{n} \alpha_{3i}\Delta GDP_{t-i} \;+\; \sum_{i=0}^{n} \alpha_{4i}\Delta CD_{t-i} \\
& +\; \sum_{i=0}^{n} \alpha_{5i}\Delta TERM_{t-i} \;+\; \sum_{i=1}^{n} \alpha_{6i}\Delta PVT_{t-i} \\
& +\; \beta_1 NONINFRAST_{t-1} \;+\; \beta_2 IF_{t-1} \;+\; \beta_3 GDP_{t-1} \\
& +\; \beta_4 CD_{t-1} \;+\; \beta_5 TERM_{t-1} \;+\; \beta_6 PVT_{t-1} \;+\; \varepsilon_{3t} \quad (5)
\end{aligned}
$$

Where PVT is private investment; PLC is public investment; **IF is the inflation rate;** GDP is economic growth; CD is private sector credit; $TERM$ is the terms of trade; $INFRAST$ and $NONINFRAST$ 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 models of the private investment models are expressed as follows:

Based on Model 2:

$$
\begin{aligned}
\Delta PVT_t \;=\; & \alpha_0 \;+\; \sum_{i=0}^{n} \alpha_{1i}\Delta PLC_{t-i} \;+\; \sum_{i=0}^{n} \alpha_{2i}\Delta IF_{t-i} \;+\; \sum_{i=0}^{n} \alpha_{3i}\Delta GDP_{t-i} \\
& +\; \sum_{i=0}^{n} \alpha_{4i}\Delta CD_{t-i} \;+\; \sum_{i-0}^{n} \alpha_{5i}\Delta TERM_{t-i} \\
& +\; \sum_{i=1}^{n} \alpha_{6i}\Delta PVT_{t-i} \;+\; \pi ECM_{t-1} \;+\; \varepsilon_{1t} \quad\quad (6)
\end{aligned}
$$

Based on Model 3:

$$\Delta PVT_t = \alpha_0 + \sum_{i=0}^{n} \alpha_{1i}\Delta INFRAST_{t-i} + \sum_{i=0}^{n} \alpha_{2i}\Delta IF_{t-i}$$
$$+ \sum_{i=0}^{n} \alpha_{3i}\Delta GDP_{t-i} + \sum_{i=0}^{n} \alpha_{4i}\Delta CD_{t-i}$$
$$+ \sum_{i-0}^{n} \alpha_{5i}\Delta TERM_{t-i} + \sum_{i=1}^{n} \alpha_{6i}\Delta PVT_{t-i} + \rho ECM_{t-1}$$
$$+ \varepsilon_{2t} \tag{7}$$

Based on Model 4:

$$\Delta PVT_t = \alpha_0 + \sum_{i=0}^{n} \alpha_{1i}\Delta NONINFRAST_{t-i} + \sum_{i=0}^{n} \alpha_{2i}\Delta IF_{t-i}$$
$$+ \sum_{i=0}^{n} \alpha_{3i}\Delta GDP_{t-i} + \sum_{i=0}^{n} \alpha_{4i}\Delta CD_{t-i}$$
$$+ \sum_{i=0}^{n} \alpha_{5i}\Delta TERM_{t-i} + \sum_{i=1}^{n} \alpha_{6i}\Delta PVT_{t-i} + \varphi ECM_{t-1}$$
$$+ \varepsilon_{3t} \tag{8}$$

Where PVT is private investment; PLC is public investment; **IF is the inflation rate;** GDP is economic progress; CD is private sector credit; $TERM$ is the terms of trade; *INFRAST* and *NONINFRAST* 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; *n* is the maximum lag length; $\varepsilon's$ are the white noise error terms; π, ρ and φ are the respective coefficients of the *ECM*; ECM_{t-1} is the error correction term lagged by one period.

This study derives the time series data on the infrastructural and non-infrastructural public investment components by decomposing gross public investment. The data generating approach is based on the assertion by Khan & Blejer (1984) and Odedokun (1997) that the time series data on government infrastructural projects which ordinarily have a long gestation period is positively associated with the trend movement of time series data on gross public investment as a percentage of GDP. Thus, extending the Khan & Blejer (1984) technique, infrastructural public investment is derived as:

$$INFRAST = PLC_0 e^{gt}$$

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Where $INFRAST$ is the infrastructural public investment; PLC is the gross public investment; g is gross public investment annual growth rate, PLC_0 is the initial value of gross public investment; and e is the exponent.

The difference between the time series data on gross public investment and infrastructural public investment will then give time series data on non-infrastructural public investment. Data for all the variables utilised in this study are taken from the World Bank Development Indicators 2015 and the IMF's International Financial Statistics 2015.

4. The empirical analysis

To verify if the ARDL-bounds testing procedure is applicable or not, it is important that all the variables used in the economic growth model and private investment models should be subjected to unit root tests. For this purpose, the Augmented Dickey-Fuller Generalised Least Square (ADF-GLS) and the Phillips Perron (PP) unit root testing techniques are used. The unit root tests results are displayed in Table 1.

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
GDP	-4.745***	-5.764***	-	-
PVT	-2.371	-3.530*	-6.724***	-6.733***
PLC	-2.927	-3.725*	-6.430***	-7.227***
LAB	-1.740	-1.750	-5.623***	-6.741***
CD	-2.818	-3.150*	-6.847***	-7.003***
TERM	-1.114	-3.702*	-6.244***	-7.796***
IF	-2.977	-3.162	-6.553***	-7.517***
INFRAST	-2.987	-3.146*	-7.931***	-7.951***
NONINFRAST	-2.536	-3.038*	-6.258***	-7.092***

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
GDP	-5.535***	-5.717***	-	-
PVT	-3.368	-3.463	-9.346***	-9.136***
PLC	-3.030	-3.761*	-9.934***	-11.596***
LAB	-1.639	-1.451	-7.600***	-9.826***
CD	-2.804	-3.007	-10.118***	-10.750***
TERM	-1.314	-3.951*	-9.322***	-9.442***
IF	-1.159	-2.055	-6.113***	-5.525***
INFRAST	-2.666	-4.055*	-9.642***	-9.089***
NONINFRAST	-2.524	-3.159	-8.775***	-10.390***

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

As can be seen in Table 1, all variables used in this study are integrated of order 0 or 1. This implies that the ARDL procedure can be utilised. The next step in the analysis is to test the existence of the cointegration relationship of the variables in the economic growth and private investment models. The bound F-test is used in this study to establish the presence of the long-run relationship of the variables. The cointegration test results are presented in Table 2.

TABLE 2. BOUNDS F-TEST FOR COINTEGRATION

Dependent Variable	Function	F-Statistic	Cointegration Status
GDP	F(GDP|PVT,PLC,LAB,CD,TERM)	6.13***	Cointegrated
PVT	F(PVT|PLC, IF, GDP,CD,TERM)	5.10***	Cointegrated
PVT	F(PVT|INFRAST,IF,GDP, CD,TERM)	5.45***	Cointegrated
PVT	F(PVT|NONINFRAST,IF,GDP,CD,TERM)	3.97**	Cointegrated

Asymptotic critical values

Pesaran et al. (2001). p.300, Table CI (iii) Case III	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.

Table 2 shows that there is cointegration in the economic growth model and private investment. This study, therefore, rejects the null hypothesis of no long-run relationship among variables. Having established the existence of the cointegration relationships of the variables used in the models, the long-run as well as the short-run coefficients can now be estimated. Table 3 presents a summary of the empirical results from the estimated economic growth model and private investment models.

TABLE 3. LONG-RUN AND SHORT-RUN COEFFICIENTS

	Model 1 AIC (4,4,3,2,1,2)	Model 2 AIC (2,2,3,3,2,3)	Model 3 AIC (4,4,4,4,2,1)	Model 4 AIC (1,3,3,3,3,1)
Panel A: Estimated long-run coefficients (Dependent variables: GDP for Model 1 and PVT for Models 2-4)				
Repressors	Coefficients (t-statistics)			
C	5.535 (3.167)***	-6.678 (-1.445)	-2.917 (-0.969)	-10.938 (-2.461)**
PVT	0.394 (4.802)***	-	-	-
PLC	0.299 (1.725)*	-0.443 (-2.036)*	-	-
INFRAST	-	-	0.151 (1.831)*	-
NONINFRAST	-	-	-	-0.017 (-0.032)
LAB	0.134 (2.214)**	-	-	-
IF	-	0.002 (0.005)	0.110 (0.309)	-0.481 (-1.081)
GDP	-	0.366 (4.682)***	0.358 (3.969)***	0.190 (3.702)***
CD	-0.512 (-2.862)***	-0.359 (-2.696)**	0.343 (0.852)	-0.508 (-4.030)***
TERM	-0.687 (-1.414)	0.812 (0.834)	-0.532 (-0.811)	0.305(2.572)**
Panel B: Estimated short-run coefficients (Dependent variables: DGDP for Model 1 and DPVT for Models 2-4)				
DGDP		0.359 (1.137)	0.600 (2.034)*	0.391(1.163)
DGDP(-1)	0.572 (1.724)*	-0.446 (-6.114)***	-0.441 (-3.449)***	-0.395 (-5.087)***
DGDP(-2)	0.321 (1.207)	-0.426 (-3.835)***	-0.097 (-0.196)	-0.181 (-4.150)***
DGDP(-3)	0.255 (1.698)	-	0.693 (2.375)**	-
DPVT	0.160 (1.865)*	0.235 (1.269)	0.880 (4.186)***	-
DPVT(-1)	-0.530 (-4.796)***	-	0.436 (2.307)**	-
DPVT(-2)	-0.385 (-4.639)***	-	0.536 (3.292)***	-
DPVT(-3)	-0.266 (-3.018)***	-	-	-
DPLC	0.571 (2.701)**	-0.699 (-1.320)	-	-

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TABLE 3. LONG-RUN AND SHORT-RUN COEFFICIENTS

	Model 1 AIC (4,4,3,2,1,2)	Model 2 AIC (2,2,3,3,2,3)	Model 3 AIC (4,4,4,4,2,1)	Model 4 AIC (1,3,3,3,3,1)
DPLC(-1)	-0.376 (-1.560)	0.398 (3.093)***	-	-
DPLC(-2)	-0.496 (-1.949)*	-	-	-
DLAB	0.454 (1.445)	-	-	-
DLAB(-1)	0.086 (1.949)	-	-	-
DINFRAST	-	-	0.700 (-1.612)	-
DINFRAST(-1)	-	-	0.338 (0.820)	-
DINFRAST(-2)	-	-	-0.122 (-2.664)**	-
DINFRAST(-3)	-	-	-0.460 (-1.547)	-
DNONINFRAST	-	-	-	0.250 (0.723)
DNOINFRAST (-1)	-	-	-	-0.503 (-1.245)
DNONINFRAST (-2)	-	-	-	-0.207 (-3.281)***
DIF	-	0.075(0.316)	-0.174 (-0.880)	-0.150 (-0.560)
DIF(-1)	-	0.546 (1.910)*	0.265 (0.868)	0.483 (1.806)*
DIF(-2)	-	0.363 (1.358)	-0.129 (-0.407)	0.501 (2.111)**
DIF(-3)	-	-	-0.462 (-1.847)*	-
DCD	0.172 (0.864)	0.526 (1.172)	0.938 (2.162)**	0.380 (0.993)
DCD(-1)	-	0.712 (4.146)***	0.533 (1.292)	0.203 (3.184)***
DCD(-2)	-	-	-	0.591(1.516)
DTERM	-0.353 (-0.367)	0.261 (3.218)***	0.196 (2.385)**	0.416 (3.802)***
DTERM(-1)	0.265 (2.240)**	0.433 (1.271)	-	-
DTERM(-2)	-	0.954 (1.349)	-	-
ECM(-1)	-0.960 (-4.339)***	-0.850 (-6.824)***	-1.153 (-5.568)***	-0.812 (-7.498)***
R-squared	0.943	0.857	0.935	0.860
F-statistic	17.402	8.374	12.057	9.624
Prob(F-statistic)	0.000	0.000	0.000	0.000
DW statistic	1.997	1.867	1.791	1.785

Notes: 1. ***, ** and * denote statistical significance at the 1%, 5% and 10% levels, respectively. 2. Δ=first difference operator.

The results reported in Table 3 (Panel A for Model 1) indicate that the coefficient of private investment, with a magnitude of 0.394, is positive as expected and statistically significant at 1%. Similarly, the coefficient of public investment, with a magnitude of 0.299, is positive and statistically significant at 10%. This means that both public and private investments are positively related with economic growth in the long run in Zimbabwe. The results suggest that the economic policies adopted in Zimbabwe to promote public and private investment growth were beneficial to the long-run economic growth. The findings compare well with the empirical results by Ramirez (1996), Odedokun (1997), Ramirez & Nazmi (2003), Yang Zou (2006) and Sahoo et al. (2010).

The short-run results of Model 1 (Table 3, Panel B) shows that the coefficient of DPVT is positive as expected and statistically significant at 10%; while the coefficients of DPVT (-1), DPVT (-2) and DPVT(-3) are negative and statistically significant at 1%. Further, the coefficient of DPLC is positive and statistically significant at 5%, while the coefficient of DPLC (-2) is negative and statistically significant at 10%. The results imply that while the current changes in private and public investment are positively associated with economic growth in the short run in Zimbabwe, the private investment is lagged by periods 1 to 3 and public investment is lagged by two periods.

The results from other variables show that labour (LAB) is positively related with the long-run economic growth and credit (CD) to the private sector is negatively related with economic growth in the long run in Zimbabwe. In addition, economic growth (DGDP)

and terms of trade (DTERM) contributes positively to economic growth in the short run. The coefficient of the ECM (-1) term is negative as expected and statistically significant at 1%. The coefficient of -0.966 indicates a quick adjustment to equilibrium of about 1 year one month should there be a shock to economic growth.

Based on the results from Model 1, although the two components of investment are beneficial to economic growth, it is the private investment that contributes more to economic growth than the public investment does in the long run. However, in the short run, public investment tends to have a higher impact on growth than private investment. The results imply that the short-run economic efficiency of private investment can be improved while at the same time the economic efficiency of public investment can also be improved in the long run in Zimbabwe.

Empirical results from Model 2 (Table 3, Panel A and Panel B) indicate that gross public investment in the long run has a negative coefficient which is statistically significant at 10%. In the short run, gross public investment (DPLC (-1)) has a positive coefficient that is statistically significant at 1%. This suggests that while public investment crowds out private investment in the long run, in the short run the one period lagged public investment crowds in private investment in Zimbabwe.

The findings from Model 3 (Table 3 Panel A) shows that the sign of infrastructural public investment coefficient is positive as expected and is statistically significant at 10%. In the short run (Panel B), however, the coefficient of infrastructural public investment (DINFRAST (-2)) is negative and statistically significant at 5%. The results imply that infrastructural public investment crowds in private investment growth in the long run; but in the short run it has a crowding out effect on private investment.

In addition, the findings from Model 4 (Table 3, Panel A and Panel B) indicate that non-infrastructural public investment has no statistical significant impact on private investment in the long run. However, the coefficient of non-infrastructural public investment (DNONINFRAST (-2)) is negative and statistically significant at 1% in the short run. This suggests that non-infrastructural public investment crowds out private investment in the short run.

The results of other variables for the private investment models shows that in the long run the credit to the private sector (CD) is negatively related with private investment in Models 2 and 4; while economic growth (GDP) in Models 2-4 and terms of trade (TERM) only in Model 4 are positively associated with private investment growth. The short-run results show that DGP (-1) in Models 2-4, DGP (-2) in Models 2 and 4 and DIF (-3) in Model 3 slow down private investment growth; but DGDP in Models 2-4, DGP (-3) in Model 3, DPVT in Model 3, DPVT (-1) in Model 3 , DPVT (-2) in Model 3, DIF (-1) in Model 2 and 4, DIF (-2) in Model 4, DCD in Model 2, DCD (-1) in Model 2 and 4 and DTERM in Models 2-4 promote private investment growth. The ECM (-1) terms for all the private investment models are negative as expected and statistically significant at 1%. This confirms the existence of the cointegration relationship in the private investment models.

Overall, the results from the private investment models point to the long-run crowding-out effect of gross public investment and the crowding in effect of infrastructural public investment on private investment in Zimbabwe. In the short run, infrastructural and non-infrastructural public investment crowds out private investment while gross public investment crowds in private investment. This could suggest that the positive contribution that public investment has on economic growth in the long run is achieved at the expense of its crowding out effect on private investment. Nevertheless, the infrastructural component of gross public investment is important as it promotes the long-run private investment growth. Further, the lower contribution of private investment than public investment to economic growth in the short run can be attributable to the short-run crowding-out effect of infrastructural and non-infrastructural public investment on private investment.
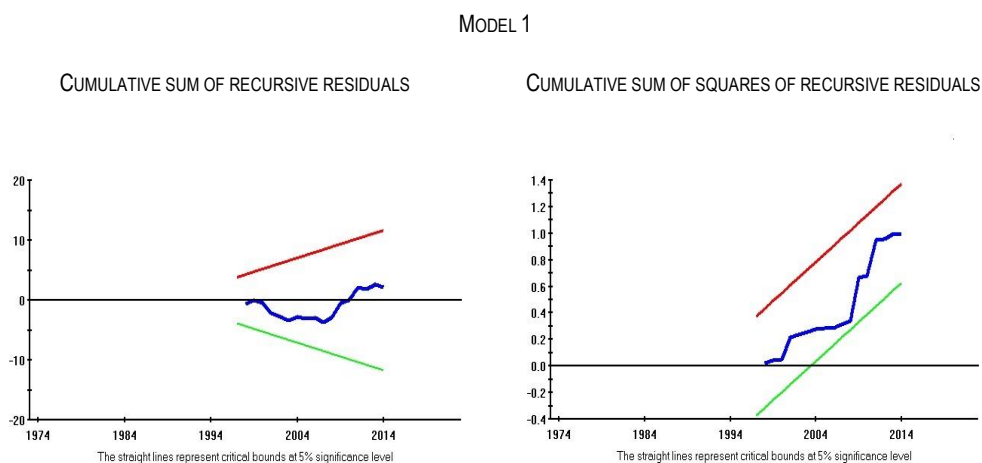
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Finally, the estimates from the economic growth and private investment models are subjected to the diagnostics tests to check their reliability and stability. The result of these tests is presented in Table 4.

TABLE 4. ARDL – VECM DIAGNOSTIC TESTS

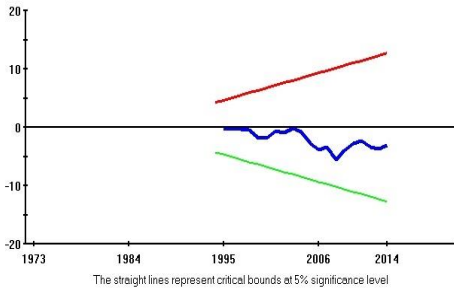| LM Test Statistic	Results [Probability]			
	Model 1	Model 2	Model 3	Model 4
Serial Correlation: CHSQ(1)	0.138 [0.711]	0.252 [0.615]	0.594 [0.441]	0.553 [0.457]
Functional Form: CHSQ(1)	22.103 [0.000]	30.046 [0.000]	26.826 [0.000]	16.472 [0.000]
Normality: CHSQ (2)	0.733 [0.693]	2.369 [0.306]	16.375 [0.000]	1.091 [0.580]
Heteroscedasticity: CHSQ(1)	0.770 [0.380]	0.424 [0.515]	0.287 [0.593]	0.537 [0.464]

The diagnostic test results from Table 4 show that all models pass on serial correlation and heteroscedasticity. On normality test, Models 1, 2, and 4 pass while Model 3 fails. In addition, all the models failed in functional form. However, the inspection of cumulative sum of recursive residuals (CUSUM) and cumulative sum of squares of recursive residuals (CUSUMQ) plots in Figure 2 indicates that the results from the economic growth and private investment models are stable.

FIGURE 2. CUMULATIVE SUMS OF RECURSIVE RESIDUALS AND CUMULATIVE SUM OF SQUARES OF RECURSIVE RESIDUALS PLOTS

MODEL 1

CUMULATIVE SUM OF RECURSIVE RESIDUALS   CUMULATIVE SUM OF SQUARES OF RECURSIVE RESIDUALS

The straight lines represent critical bounds at 5% significance level

The straight lines represent critical bounds at 5% significance level
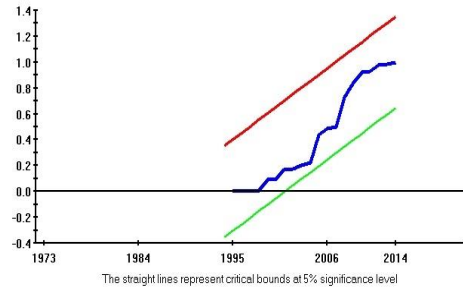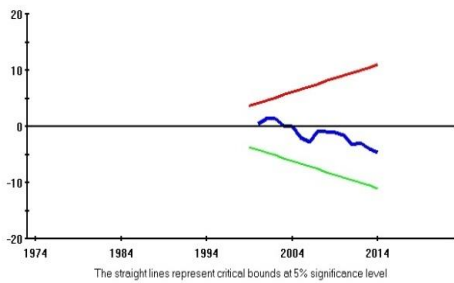
MODEL 2

CUMULATIVE SUM OF RECURSIVE RESIDUALS

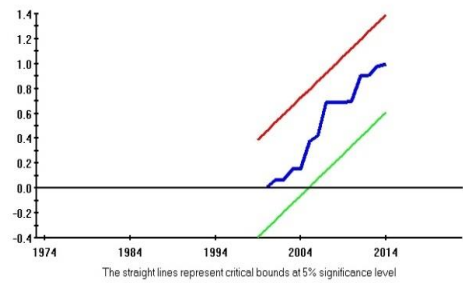CUMULATIVE SUM OF SQUARES OF RECURSIVE RESIDUALS

MODEL 3

CUMULATIVE SUM OF RECURSIVE RESIDUALS
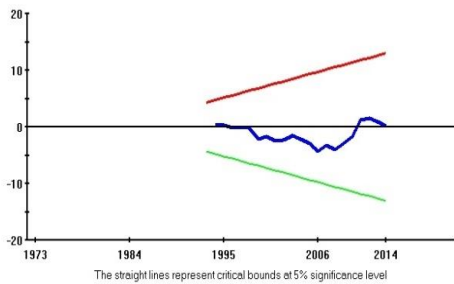
CUMULATIVE SUM OF SQUARES OF RECURSIVE RESIDUALS

MODEL 3

CUMULATIVE SUM OF RECURSIVE RESIDUALS
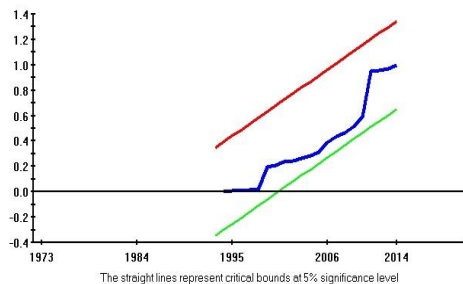
CUMULATIVE SUM OF SQUARES OF RECURSIVE RESIDUALS

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5. Conclusion

This study has examined the impact of public and private investment on economic growth in Zimbabwe from 1970 to 2014. In addition to estimating the economic growth model in order to ascertain the direct contribution of the two components of investment to economic growth, this study also estimated the crowding effects of public investment on private investment in Zimbabwe. Unlike most previous studies that have employed the traditional cointegration techniques (which requires large sample sizes to produce valid results) this study used the newly developed ARDL-bounds testing approach with better small sample properties. The empirical findings from the study suggest four clear conclusions. First, though the two components of investment have a positive impact on economic growth in the long run, private investment has a higher contribution than public investment. Second, in the short run the public investment is more beneficial to economic growth than the private investment. Third, while gross public investment crowds out private investment in the long run, the infrastructural public investment component has a crowding in effect on private investment. Last, both infrastructural and non-infrastructural public investments crowd out private investment in the short run, while gross public investment has a short-run crowding in effect on private investment. The empirical findings imply that the short-run and long-run productivity of private investment in Zimbabwe can be improved by reducing non-infrastructural public investment to the necessary minimum level while promoting infrastructural public investment growth.

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