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PUBLIC AND PRIVATE INVESTMENT AND ECONOMIC GROWTH: AN EMPIRICAL INVESTIGATION

Garikai MAKUYANA[*]
University of South Africa, South Africa

Nicholas M. ODHIAMBO
University of South Africa, South Africa

Abstract: This paper provides new evidence to contribute to the current debate on the relative impact of public and private investment on economic growth and the crowding effect between the two components of investment in South Africa. Using annual data from 1970 to 2017, the study applies the recently developed Autoregressive Distributed Lag (ARDL)-bounds testing approach to cointegration. The study finds that private investment has a positive impact on economic growth both in the long run and short run, while public investment has a negative effect on economic growth in the long run. Further, in the long run, gross public investment is found to crowd out private investment, while its infrastructural component is found to crowd in private investment. The results of the study also reveal that both gross public investment and non-infrastructural public investment crowd out private investment in the short run. Overall, the study finds private investment to be more important than public investment in the South African economic growth process and that the importance of infrastructural public investment in stimulating private investment in the long run cannot be over-emphasized.

JEL classification: E22, O47, P12

Keywords: South Africa; Public Investment; Private Investment; Economic Growth; Crowding Effect.

1. Introduction

While economists and policymakers generally agree that investment is important to the economic growth process, it is still open to debate over which type of investment is more important for driving economic growth and whether the two

[*] Corresponding author. Address: Department of Economics, University of South Africa, P.O Box 392, UNISA, 0003, Pretoria, South Africa, E-mail: grkmakuyana@gmail.com

types of investment crowd in or crowd out each other. The ongoing discussions on the subject have focused on two main issues. The first issue centers on the indirect contribution of public investment to economic growth through its crowding effect on private investment. The second is whether public investment contributes more to economic growth than does the equivalent private investment.

Empirical evidence from previous studies on the above raised concerns is varied and sometimes conflicting. For example, Mitra et al. (2012) reported that public investment in core infrastructure stimulates total factor productivity in the Indian manufacturing sector. This is in contrast to the empirical findings by Dash (2016), who reported the crowding-out effect of public investment on private investment for the Indian economy. The existing empirical studies on developing countries, including South Africa, are scanty and inconclusive.

The need to re-direct economies on the sustainable growth path on one hand and the scanty and inconclusive empirical evidence on the subject on the other hand underscores the need for a further empirical examination. Therefore, this paper empirically examines the relative contribution of public and private investment to economic growth and estimate the crowding effect of public investment on private investment in South Africa. The paper uses the recently developed ARDL bounds testing approach in exploring the long-run and short-run impact of these two components of investment on economic growth.

The paper contributes to the literature on investment and economic growth in South Africa in several ways. Firstly, it is among the first to disentangle investment into public and private components and empirically examine the relative contribution of each investment component to economic growth. The few available studies for South Africa, such as those by Perkins et al. (2005) and Tchouassi (2014), have only examined the impact of public investment or its components on economic growth. Secondly, some of the previous studies on this subject have largely relied on cross-sectional studies. Yet it is agreeable that the cross-sectional data analysis poses some difficulties in prescribing country-based policy implications (see Odhiambo, 2010). This paper addresses this challenge by employing the time series approach, which takes into account country-specific effects in detail. Lastly, unlike most previous studies on the subject which estimated the economic growth model only, this paper also estimates the crowding-out or crowding-in effect of public investment on private investment; and this has important policy implications. For example, if both private and public investments are found to be equally important in stimulating economic growth and when public investment has a crowding-out effect, private investment-led economic growth can be prescribed.

An empirical study on public and private investment and economic growth focusing on the South African economy is important for economies in the Southern African Development Community (SADC). South Africa plays a vital role in the growth of SADC economies in several ways. Firstly, it is the biggest economy in the region with a GDP of USD 426,768 billion in 2017; secondly, it is one of the major sources of the region's foreign direct investment (FDI); and lastly, it is among the major export markets for economies in this community (World Bank, 2017). Thus, through this economic interconnectedness, improved economic growth in South Africa stands to benefit member states in SADC.

The remaining part of the paper is structured as follows: Section two reviews the related literature, while the methodology is presented in section three.

The empirical results for the study are presented in section four, while section five discusses the previous empirical studies on public and private investment and economic growth. Lastly, section six concludes the paper.

2. Literature review

Studies on the relative importance of public and private investment on economic growth have generally been centered on the crowding effect of public investment on private investment. Theoretically, public investment can stimulate private investment growth when it is confined to the provision of core infrastructure such as water, communications, health, energy, transport and education (Berndt and Hansson, 1992). The justification for public investment in such projects is that they are typically lumpy, they have widespread positive externalities and they do not compete with the private sector as the private sector cannot undertake such investment to the same degree (Nazmi and Ramirez, 1997). Public investment can also retard private investment growth and slow down economic growth if: (i) it is debt financed, which crowds out the potentially more efficient private sector projects; (ii) it produces goods that pose direct competition with the private sector when is it established that the latter is more productive; and (iii) it is undertaken by state enterprises that are inefficient and are heavily subsidized by the state (Devarajan et al., 1996).

Thus, the effect of public investment on private investment and its resultant impact on economic growth is uncertain and can only be empirically determined. Yet economists and policymakers are generally in agreement that private investment is more efficient than public investment in the economic growth process. This consensus rests on the early empirical study by Khan and Reinhart (1989) which reported the superiority of private investment over public investment for a sample of 24 developing countries. The follow up studies on the subject also have agreed with the findings. For instance, Khan and Kumar (1997) re-examined the relative contribution of public and private investment on economic growth using an expanded sample of 95 developing countries. Their findings confirmed the earlier results from Khan and Reinhart (1989) that while both components of investment are crucial to economic growth, private investment contributes more. Several other studies also reported similar results (Phetsavong, Ichihashi, 2012; Hague, 2013; Ponce, Navarro, 2016; Yovo, 2017).

However, there are some empirical studies that reported evidence to the contrary (see, Bèdia, 2007; Sahoo et al., 2010; Abiad et al., 2015; Fournier, 2016). For example, Sahoo et al. (2010) reported that the high Chinese economic growth rates were achieved against a backdrop of high public investment in core physical infrastructure which promoted private investment growth – which points to the superiority of public investment over private investment in the growth process.

The empirical evidence on the crowding effect of public investment also varied across economies. Studies reporting the crowding-in effect of public investment on private investment are quite extensive (Bom, Ligthart, 2014; Calderón et al., 2015; Kalyvitis, Vella, 2015; Beifert, 2016; Tong et al., 2016). In particular, Bom and Ligthart (2014) found public investment in core infrastructures to have a stimulating effect on private investment growth in the organization for economic co-operation and development (OECD) countries. This was also consistent with the findings by Beifert (2016), who reported that government investment in airports promotes private investment growth in the Baltic Sea Region through enhancing the movement of raw materials and access to the regional and international markets for the finished goods.

Yet there are also some economies where public investment has been less beneficial to economic growth as it has had a crowding-out effect on private investment (Cavallo and Daude, 2011; Afonso and Aubyn, 2016; Mallick, 2016; Dash, 2016). In the case of Mallick (2016), government investment had a crowding effect on private investment growth in India mainly as a result of the prevalence of a high non-infrastructural public investment component.

3. Methodology

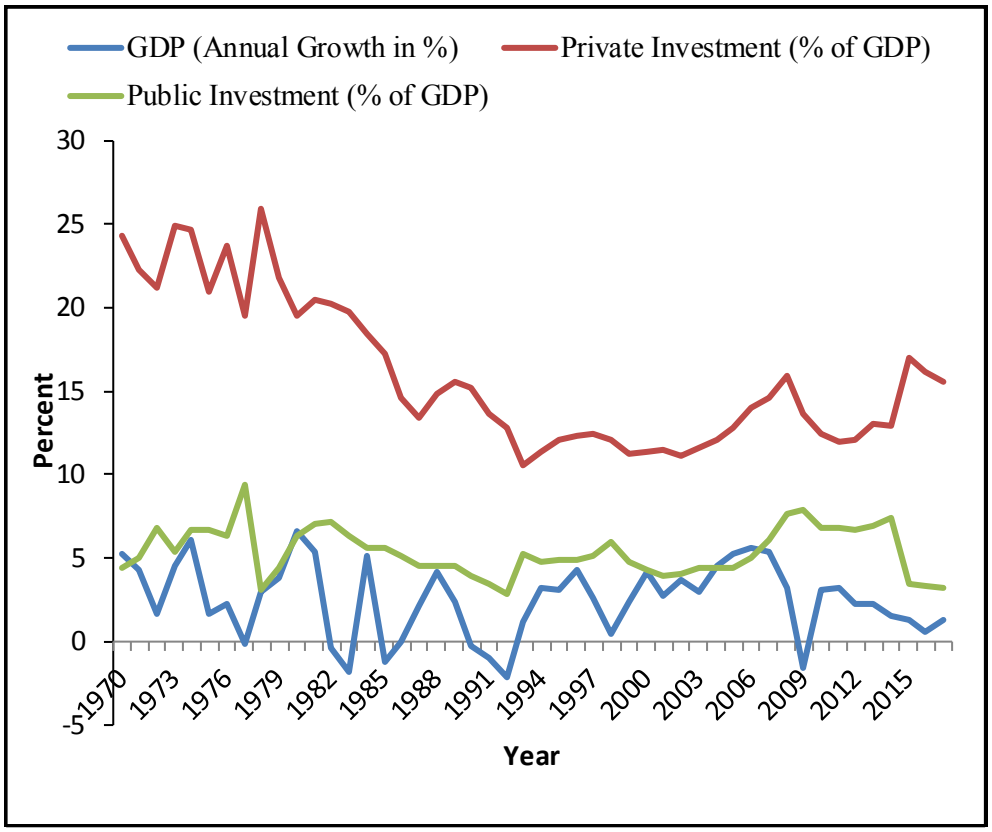
3.1. An overview of investment and economic growth trends in South Africa

During the Apartheid period in South Africa before 1994, the economy was sustained by high public investment in physical infrastructure. Initially, to support an economy based on mining, agriculture, railways and ports, construction became important. Later, a number of state enterprises were formed in order to add value on available natural resources. These included Eskom and Sasol in the energy sector and Iscor in the manufacturing sector (Department of Public Enterprise (DPE), 2012). Cumulatively, this resulted in the creation of a strong state economic management system during the Apartheid years.

Nevertheless, private investment during the period grew to unprecedented levels, especially in the 1960s and 1970s, taking advantage of the presence of public investment in core infrastructure. Growth in private investment also benefited from growing domestic absorption as a result of the inward-looking economic policy adopted by the Apartheid government. However, a limit to this buoyant growth was reached at the height of the international economic isolation of the regime (Clark, 1994). Partly for this reason, coupled with the growing inefficiency of state enterprises, the government initiated the neoclassical economic policies which were centered on privatization.

In 1994, the new government initiated a privatization programme, as enshrined in the Reconstruction and Development Programme (RDP) and the Growth, Employment and Redistribution (GEAR) strategy in 1996. The privatization programme was later focused on the four largest state enterprises – Eskom for energy, Denel for defence, Telkom for communications and Transnet for transport. As a result, private investment grew sharply from its low in 1994 to economic dominance in 2004 (DPE, 2012). To sustain the adopted market economy, state enterprises were once again repositioned to provide the necessary physical infrastructure. This was also aimed to absorb labor in the spirit of the creation of a developmental agenda and to address market failure (DPE, 2012).

The economic growth strategies, among others the Accelerated and Shared Growth Initiative for South Africa (ASGISA), the New Growth Path Framework and the National Development Plan 2030, also underscored the need for a concurrent growth in public investment in sectors such as communications, water, energy, transport, health and education (National Planning Commission, 2011). This economic philosophy has been credited with the growth in private sector business and high economic growth rate in South Africa. Figure 1 presents a summary of public and private investment and economic growth trends in response to the various economic policies implemented.



Source: Own processing based on World Bank (2017) databank

Fig. 1. Trends in public and private investment and economic growth in South Africa (1970 - 2017)

As can be seen in Figure 1, private investment growth maintained economic dominance from 1970 to 2017. The growth in private investment benefited especially from the high infrastructural public investment that was initiated before 1970. The economic growth rates, however, oscillated between -2% and 5% during the 1970 to 2017 period (DPE, 2012; World Bank, 2017).

Although private investment maintained economic dominance over public investment during the review period, it is still not certain which investment component had the higher contribution to economic growth; and this can be determined empirically.

3.2. Cointegration-ARDL bounds testing procedure

In this study, the newly proposed ARDL bounds testing procedure introduced by Pesaran and Shin (1999) and later popularized by Pesaran et al. (2001) is used to examine the relative contribution of public and private investment on economic growth

and the crowding effect of public investment on private investment in South Africa. The approach has several advantages over the traditional cointegration procedures such as the residual-based approach by Engle and Granger (1987) and the full maximum likelihood approach by Johansen and Juselius (1990). Firstly, the variables of interest are not restricted to being integrated of the same order – a mixture of the order of integration up to a maximum of 1 can be employed. Secondly, unlike the traditional cointegration approaches that are sensitive to sample size, the ARDL procedure can be applied even when dealing with small samples. Thirdly, the ARDL procedure can determine a long-run relationship using a reduced form equation, unlike the traditional cointegration procedures which use a system of equations (Shrestha and Chrowdhury, 2007). Lastly, the ARDL procedure gives valid t-statistics and unbiased long-run estimates (Pesaran, Shin, 1999; Odhiambo, 2008).

3.3. Relative contribution of public and private investment to economic growth

This study uses the empirical model based on Khan and Reinhart (1989), Phetsvavong and Ichihashi (2012), Ponce and Navarro (2016) and Yovo (2017), among others, to explore the relative impact of public and private investment on economic growth in South Africa. The ARDL expression of the model (Model 1) in this study is as follows:

Model 1

$$\begin{aligned}\Delta EGRO_t = {} & \alpha_0 + \sum_{i=1}^{n} \alpha_{1i} \Delta EGRO_{t-i} + \sum_{i=0}^{n} \alpha_{2i} \Delta GI_{t-i} + \sum_{i=0}^{n} \alpha_{3i} \Delta PI_{t-i} \\ & + \sum_{i=0}^{n} \alpha_{4i} \Delta LBR_{t-i} + \sum_{i=0}^{n} \alpha_{5i} \Delta CRED_{t-i} + \sum_{i=0}^{n} \alpha_{6i} \Delta TOT_{t-i} \\ & + \beta_1 EGRO_{t-1} + \beta_2 GI_{t-1} + \beta_3 PI_{t-1} + \beta_4 LBR_{t-1} \\ & + \beta_5 CRED_{t-1} + \beta_6 TOT_{t-1} + \mu_{1t}\end{aligned} \tag{1}$$

Where EGRO, the dependent variable, is economic progress; GI is public investment; PI is private investment; LBR is labour; CRED is private sector credit; TOT 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 of output with respect to above identified variables; μ_{1t} 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:

$$\begin{aligned}\Delta EGRO_t = {} & \alpha_0 + \sum_{i=1}^{n} \alpha_{1i} \Delta EGRO_{t-i} + \sum_{i=0}^{n} \alpha_{2i} \Delta GI_{t-i} + \sum_{i=0}^{n} \alpha_{3i} \Delta PI_{t-i} \\ & + \sum_{i=0}^{n} \alpha_{4i} \Delta LBR_{t-i} + \sum_{i=0}^{n} \alpha_{5i} \Delta CRED_{t-i} \\ & + \sum_{i=0}^{n} \alpha_{6i} \Delta TOT_{t-i} + \varphi_1 ECM_{t-1} + \mu_{2t}\end{aligned} \tag{2}$$

Where φ_1 is the coefficient of the *ECM*; ECM_{t-1} is the error correction term lagged by one period; μ_{2t} is the error term and the other variables are defined as in equation (1).

3.4. The crowding effect of public investment on private investment

While the impact of public and private investment on economic growth can be estimated as in Model 1, it is also important to determine the public investment's indirect contribution to economic growth through its effect on private investment. Firstly, estimating the crowding effect of public investment on private investment addresses the potential simultaneous bias in estimation since private investment is an endogenous variable. Previous studies such as Bèdia (2007) are prone to such bias. Secondly, estimates of the crowding effect of public investment have important policy implications. For instance, if the two components of investment have an identical contribution to economic growth when the crowding out relationship between them is determined, a market economy can be prescribed.

In estimating the crowding effect of public investment, this study follows the approach by Blejer and Khan (1984) and later Odedokun (1997). Three separate private investment models are estimated where gross public investment, infrastructural public investment and non-infrastructural public investment would each enter separately as independent variables, one at a time. The private investment models in the ARDL are expressed as follows:

Model 2: Private investment and gross public investment

$$\begin{aligned}\Delta PI_t = \alpha_0 &+ \sum_{i=0}^{n}\alpha_{1i}\Delta GI_{t-i} + \sum_{i=0}^{n}\alpha_{2i}\Delta INFL_{t-i} + \sum_{i=0}^{n}\alpha_{3i}\Delta EGRO_{t-i} \\ &+ \sum_{i=0}^{n}\alpha_{4i}\Delta CRED_{t-i} + \sum_{i=0}^{n}\alpha_{5i}\Delta TOT_{t-i} + \sum_{i=1}^{n}\alpha_{6i}\Delta PI_{t-i} \\ &+ \beta_1 GI_{t-1} + \beta_2 INFL_{t-1} + \beta_3 EGRO_{t-1} \\ &+ \beta_4 CRED_{t-1} + \beta_5 TOT_{t-1} + \beta_6 PI_{t-1} + \varepsilon_{1t}\end{aligned} \tag{3}$$

Model 3: Private investment and infrastructural public investment

$$\begin{aligned}\Delta PI_t = \alpha_0 &+ \sum_{i=0}^{n}\alpha_{1i}\Delta INFRA_{t-i} + \sum_{i=0}^{n}\alpha_{2i}\Delta INFL_{t-i} \\ &+ \sum_{i=0}^{n}\alpha_{3i}\Delta EGRO_{t-i} + \sum_{i=0}^{n}\alpha_{4i}\Delta CRED_{t-i} \\ &+ \sum_{i=0}^{n}\alpha_{5i}\Delta TOT_{t-i} + \sum_{i=1}^{n}\alpha_{6i}\Delta PI_{t-i} + \beta_1 INFRA_{t-1} \\ &+ \beta_2 INFL_{t-1} + \beta_3 EGRO_{t-1} + \beta_4 CRED_{t-1} \\ &+ \beta_5 TOT_{t-1} + \beta_6 PI_{t-1} + \varepsilon_{2t}\end{aligned} \tag{4}$$

Model 4: Private investment and non-infrastructural public investment

$$\begin{aligned}\Delta PI_t = \alpha_0 + \sum_{i=0}^{n}\alpha_{1i}\Delta NONINFRA_{t-i} + \sum_{i=0}^{n}\alpha_{2i}\Delta INFL_{t-i} \\ + \sum_{i=0}^{n}\alpha_{3i}\Delta EGRO_{t-i} + \sum_{i=0}^{n}\alpha_{4i}\Delta CRED_{t-i} \\ + \sum_{i=0}^{n}\alpha_{5i}\Delta TOT_{t-i} + \sum_{i=1}^{n}\alpha_{6i}\Delta PI_{t-i} \\ + \beta_1 NONINFRA_{t-1} + \beta_2 INFL_{t-1} + \beta_3 EGRO_{t-1} \\ + \beta_4 CRED_{t-1} + \beta_5 TOT_{t-1} + \beta_6 PI_{t-1} + \varepsilon_{3t}\end{aligned} \quad (5)$$

Where PI is private investment; GI is public investment; INFL is the inflation rate; EGRO is economic progress; CRED is private sector credit; TOT is the terms of trade; INFRA and NONINFRA 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 model representations of the private investment models are expressed as follows:

Based on Model 2

$$\begin{aligned}\Delta PI_t = \alpha_0 + \sum_{i=0}^{n}\alpha_{1i}\Delta GI_{t-i} + \sum_{i=0}^{n}\alpha_{2i}\Delta INFL_{t-i} + \sum_{i=0}^{n}\alpha_{3i}\Delta EGRO_{t-i} \\ + \sum_{i=0}^{n}\alpha_{4i}\Delta CRED_{t-i} + \sum_{i-0}^{n}\alpha_{5i}\Delta TOT_{t-i} \\ + \sum_{i=1}^{n}\alpha_{6i}\Delta PI_{t-i} + \pi ECM_{t-1} + \varepsilon_{1t}\end{aligned} \quad (6)$$

Based on Model 3

$$\begin{aligned}\Delta PI_t = \alpha_0 + \sum_{i=0}^{n}\alpha_{1i}\Delta INFRA_{t-i} + \sum_{i=0}^{n}\alpha_{2i}\Delta INFL_{t-i} \\ + \sum_{i=0}^{n}\alpha_{3i}\Delta EGRO_{t-i} + \sum_{i=0}^{n}\alpha_{4i}\Delta CRED_{t-i} \\ + \sum_{i-0}^{n}\alpha_{5i}\Delta TOT_{t-i} + \sum_{i=1}^{n}\alpha_{6i}\Delta PI_{t-i} + \rho ECM_{t-1} \\ + \varepsilon_{2t}\end{aligned} \quad (7)$$

Based on Model 4

$$\Delta PI_t = \alpha_0 + \sum_{i=0}^{n} \alpha_{1i} \Delta NONINFRA_{t-i} + \sum_{i=0}^{n} \alpha_{2i} \Delta INFL_{t-i} + \sum_{i=0}^{n} \alpha_{3i} \Delta EGRO_{t-i} + \sum_{i=0}^{n} \alpha_{4i} \Delta CRED_{t-i} + \sum_{i=0}^{n} \alpha_{5i} \Delta TOT_{t-i} + \sum_{i=1}^{n} \alpha_{6i} \Delta PI_{t-i} + \varphi ECM_{t-1} + \varepsilon_{3t} \quad (8)$$

Where PI is private investment; GI is public investment; INFL is the inflation rate; EGRO is economic progress; CRED is private sector credit; TOT is the terms of trade; INFRA and NONINFRA 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*; and ECM_{t-1} is the error correction term lagged by one period.

Following Blejer and Khan (1984) and later Odedokun (1997), this study generates the data on infrastructural and non-infrastructural public investment from gross public investment. According to Blejer and Khan (1984), the main assumption underlying this approach is that infrastructural public investment is more associated than its non-infrastructural counterpart with the long term growth in the ratio of gross public investment to gross domestic product. This emanates from the argument that infrastructural projects undertaken by the government generally have a long completion period and are related to economic growth. Thus, following Blejer and Khan (1984), infrastructural public investment is generated by the following expression:

$$INFRA = GI_0 e^{gt}$$

Where *INFRA* is the infrastructural public investment; *GI* is the gross public investment; *g* is the annual growth rate of gross public investment, GI_0 is the initial value of gross public investment; and *e* is the exponent.

Data on non-infrastructural public investment (NONINFRA) is then given by the difference between gross public investment and infrastructural public investment. While the weaknesses that may arise from using the Blejer and Khan (1984) procedure to generate data on the two components of public investment are acknowledged, the technique has been credited as the most practical option when there is no country data like in this study (see Odedokun, 1997).

The annual time series data for all the variables used in this study is sourced from the World Bank Development Indicators 2017 and the IMF's International Financial Statistics 2017.

4. Empirical results

While the ARDL bounds testing procedure does not require unit root pretesting of the variables, such tests are still necessary to determine whether the approach is applicable. Accordingly, this study conducts the Augmented Dickey-Fuller Generalised Least Squares (ADF-GLS) and the Phillips-Perron (PP) unit root testing procedures. The lag length was automatically selected by the SIC for the ADF-GLS unit root test and for the PP test, the PP truncation lag was also automatically selected on the Newey-West bandwidth. Table 1 presents the ADF-GLS and the 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
EGRO	-3.676***	-4.182***	-	-
PI	-1.522	-0.995	-7.893***	-6.176***
GI	-2.889	-2.738	-6.841***	-7.267***
LBR	-0.112	-1.891	-2.895*	-2.259**
CRED	-1.163	-1.170	-3.087**	-2.856***
TOT	-2.456	-2.123	-6.868***	-6.892***
INFL	-1.609	-2.155	-6.375***	-5.678***
INFRA	-3.702**	-2.476**	-	-
NONINFRA	-4.300***	-3.619***	-	-
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
EGR0	-4.191***	-4.233***	-	-
PI	-1.170	-1.867	-8.813***	-8.093***
GI	-3.031	-3..094	-7.534***	-7.627***
LBR	-2.711	-0.743	-3.956*	-2.667*
CRED	-0.064	-1.285	-3.054**	-3.117**
TOT	-2.293	-2.393	-7.211***	-7.357***
INFL	-2.085	-3.150	-8.880***	-7.234***
INFRA	-3.210**	-3.059**	-	-
NONINFRA	-4.775***	-4.805**	-	-

Note: *, ** and *** denotes stationary at 10%, 5% and1%, respectively
Source: authors' computation by using EViews 9.0 software

As illustrated in Table 1, all the variables are either integrated of order 0 or 1, so the ARDL procedure is applicable. This sets the stage for testing the existence of a cointegrating relationship between the variables in the economic growth and private investment models. For this purpose, the study employs the bounds F-test, with the results reported in Table 2.

Table 2. Bounds F-test for co-integration

Dependent Variable	Function	F-Statistic	Cointegration Status
EGRO	F(EGRO|PI, GI, LBR, CRED, TOT,)	4.88***	Cointegrated
PI	F(PI|GI, INFL, EGRO, CRED, TOT)	3.82**	Cointegrated
PI	F(PI|INFRA, INFL, EGRO, CRED, TOT)	3.87**	Cointegrated
PI	F(PI|NONINFRA, INFL, EGRO, CRED, TOT)	4.50**	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% and 10% level, respectively.
Source: authors' computation by using Microfit 5.0 software

The outcome of the bounds F-test indicates that all the variables in the economic growth and private investment models share a long-run relationship. Following the established cointegration relationship, the long-run and short-run coefficients of the variables in the economic growth and private investment models can now be estimated. Estimating models were chosen based on either the AIC or SBC, guided by the principle of model parsimony. The SBC(2,0,1,0,0,0) based ARDL for Model 1 and the SBC(1,1,0,1,0,2) based ARDL for model 4 were selected, while the AIC(1,1,0,1,1,2) based ARDL for model 2 and the AIC(2,1,0,1,1,2) base ARDL for model 3 were selected. Table 3 gives the long-run and short-run coefficient estimates of the selected models.

Table 3. Estimation of long-run and short-run coefficients

	Model 1 SBC (2,0,1,0,0,0,)	Model 2 AIC (1,1,0,1,1,2)	Model 3 AIC (2,1,0,1,1,2)	Model 4 SBC (1,1,0,1,0,2)
Panel A: Estimated long-run coefficients (Dependent variables: EGRO for Model 1 and PI for Models 2-4)				
Regressors	**Coefficients (t-statistics)**			
C	3.75 (4.013)***	4.672 (6.272)***	5.977 (3.988)***	4.212 (5.023)***
PI	0.1578 (2.448)**	-	-	-
GI	-0.432 (-3.737)***	-0.241 (-1.879)*	-	-
INFRA	-	-	0.721(2.451)**	-
NONINFRA	-	-	-	-0.121 (-1.417)

	Model 1 SBC (2,0,1,0,0,0,)	Model 2 AIC (1,1,0,1,1,2)	Model 3 AIC (2,1,0,1,1,2)	Model 4 SBC (1,1,0,1,0,2)
LBR	-0.103 (-3.911)***	-	-	-
INFL	-	-0.123 (-1.207)	-0.123 (-1.312)	-0.109 (-0.921)
EGRO	-	0.237 (2.317)**	0.103 (1.472)	0.201 (1.872)*
CRED	-0.114 (-0.821)	-0.121 (-3.417)***	-0.027 (-2.321)**	-0.029 (-3.573)***
TOT	-0.132 (-1.317)	-0.375 (-3.371)***	-0.674 (-2.502)**	-0.354 (-2.575)**
Panel B: Estimated long-run coefficients (Dependent variables: DEGRO for Model 1 and DPI for Models 2-4)				
DPI	0.191(1.967)*	-	-	-
DPI(-1)	-	-	-0.231 (-1.402)	-
DGI	0.134(1.412)	-0.175 (-5.754)***	-	-
DINFRA	-	-	-0.028 (-0.210)	-
DNONINFRA	-	-	-	-0.042 (-6.764)***
DINFL	-	-0.010 (-1.201)	-0.062 (-1.411)	-0.023 (-0.894)
DEGRO	-	-0.023 (-1.034)	-0.019 (-0.272)	-0.032 (-0.753)
DEGRO(-1)	0.291 (2.702)**	-	-	-
DLBR	-0.102 (-3.872)***	-	-	-
DCRED	-0.021 (-0.794)	-0.004 (-0.094)	-0.012 (-1.412)	-0.043 (-2.332)**
DTOT	-0.102 (-1.242)	-0.031 (-1.065)	-0.051 (-1.210)	0.083 (2.501)**
DTOT(-1)	-	0.176 (3.471)***	-	-
ECM(-1)	-0.981 (-6.512)***	-0.273 (-3.073)***	-0.376 (-2.572)**	-0.231 (-2.597)**
R-squared	0.843	0.802	0.673	0.863
F-statistic	17.612	18.121	4.977	17.977
Prob(F-statistic)	0.000	0.000	0.000	0.000
DW statistic	2.137	2.098	2.093	1.944

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

Source: authors' computation by using Microfit 5.0 software

The long-run results in Table 3 (Panel A - Model 1) show that the coefficient of private investment (PI) is positive, as expected, and statistically significant at 10%. This indicates that private investment had a positive impact on economic growth in South African during the review period. The results also show that the coefficient of public investment (GI) is negative, as unexpected and statistically significant at 1%. This entails that public investment had a negative impact on economic growth in South Africa.

The other variables show that labour (LBR) negatively affects economic growth, which is unexpected, while credit to the private sector (CRED) and terms of trade (TOT) have no effect on economic progress in the long run in South Africa.

The short–run dynamics of Model 1 are shown in Table 3 Panel B. These results show that the coefficient of private investment is positive and statistically significant at 10%. This entails that an increase in private investment was associated with an increase in economic growth in the short run in South Africa. The short-run results also show that the coefficient of public investment is statistically insignificant, implying that public investment had no immediate effect on economic growth. The other variable that positively affects economic growth in the short run is DEGRO (-1), while DLBR retards growth. The coefficient of the ECM (-1) is negative as expected and is statistically significant at 1%. A coefficient of -0.981 indicates a quick adjustment to equilibrium at an annual rate of 98.1%, when a shock occurs to economic growth in the previous period.

Overall, results from Model 1 show that in South Africa, private investment has a positive impact on economic growth, irrespective of whether the analysis is done in the long run or in the short run. In the long run, public investment was found to have a negative impact on economic growth, but no significant effect in the short run. The results from Model 1 imply that private investment contributes more to economic progress in South Africa than public investment.

Empirical results of Model 2, as shown in Table 3, Panels A and B indicate that the coefficient of gross public investment (GI) is negative and statistically significant both in the long run and short run. This suggests that gross public investment had a crowding-out effect on private investment growth in South Africa under the review period.

The results of Model 3, in Panel A, show that the coefficient of infrastructural public investment (INFRA) is positive as expected and statistically significant. This implies that infrastructural public investment crowds in private investment growth in the long run in South Africa. However, in the short run, as shown in Panel B, the coefficient of infrastructural public investment has no statistically significant effect on private investment growth. Furthermore, estimates from Model 4 reveal that the coefficient of non-infrastructural public investment (NONINFRA) also has no statistically significant effect on private investment in the long run; but in the short run, it crowds out private investment growth.

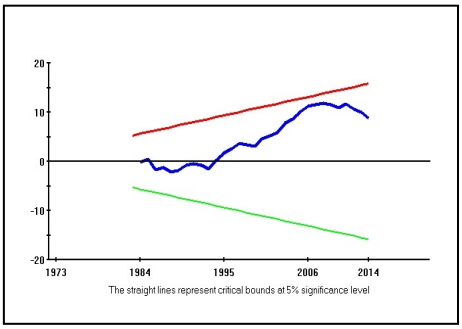
The other variables that affect private investment shown in Table 3 Panel A are EGRO, CRED, and TOT. Economic growth (EGRO) has a positive effect on private investment as expected while credit to the private sector (CRED) and terms of trade (TOT) negatively influence private investment. In the short run, DCRED negatively affect private investment while DTOT and DTOT (-1) are positively associated with private investment. The coefficients of the ECM (-1) terms are negative as expected and are all statistically significant at 1%. This confirms the existence of the long-run relationship between the variables in the private investment models.

Based on the empirical results from the private investment models, gross public investment crowds out private investment growth in the long run and short run, while infrastructural public investment crowds in private investment growth in the long run in South Africa. In addition, non-infrastructural public investment crowds out private investment growth in the short run. The results imply that although the contribution of public investment to economic growth has been negative, public investment in infrastructure is important to economic growth as it stimulates private investment growth.

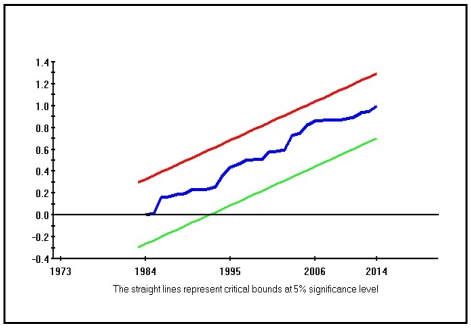
The results of the cumulative sum of recursive residuals (CUSUM) and the cumulative sum of squares of recursive residuals (CUSUMQ) plotted in Figure 2 confirm the stability of both the economic growth and private investment models.

Model 1

Plot of Cumulative Sum of Recursive Residual

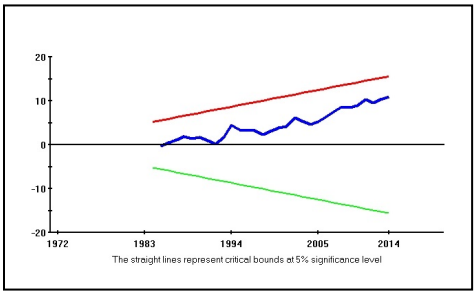


Plot of Cumulative Sum of Squares of Recursive Residual

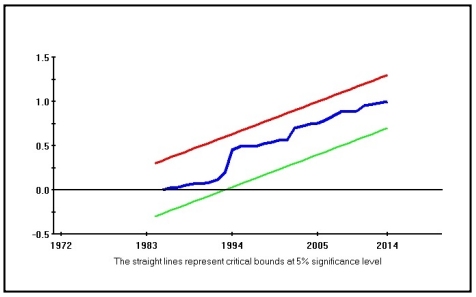


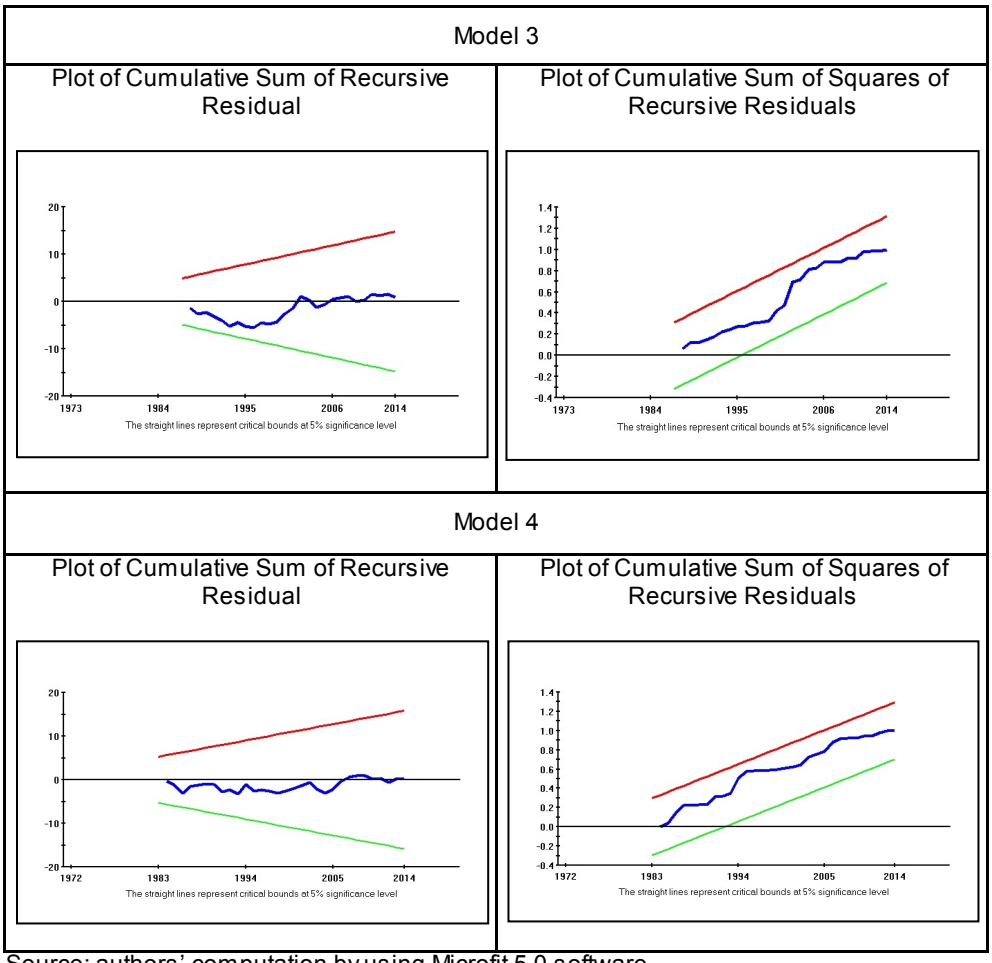
Model 2

Plot of Cumulative Sum of Recursive Residual



Plot of Cumulative Sum of Squares of Recursive Residuals





Source: authors' computation by using Microfit 5.0 software

Figure 2. Plot of CUSUM and CUSUMQ for the economic growth and private investment models

The positive and significant long-run and short-run relationship between private investment and economic growth in South Africa from Model 1 compare favorably with reports from previous studies on the subject, such as those by Khan and Reinhart (1989), Ponce and Navarro (2016) and Yovo (2017). The findings suggest that the various economic policies implemented in South Africa to promote private investment growth have been beneficial to economic growth. Contrary to the results recorded by Perkins et al. (2005) for South Africa, public investment had a significant long-run negative impact on economic growth. The possible factors that could have given rise to this conflicting result are the different sample periods used and the economic infrastructural investment employed by Perkins et al. (2005) as a proxy for public investment. However, this finding is not isolated to this

study only; similar results were reported by Khan and Reinhart (1989) for developing countries, including South Africa, Ghali (1998) for Tunisia and Aremo (2013) for the Economic Community of West Africa States (ECOWAS).

In addition, gross public investment in Model 2 had a crowding out effect on private investment growth in South Africa in the long run. The findings do not support the results by Erden and Holcombe (2005) for developing countries. Although not expected in this study, the results are similar to the findings by Moreno et al. (2003) for the Spain regions. However, when gross public investment was decomposed as infrastructural public investment in Model 3, it was found to stimulate private investment growth in the long run. This finding may be attributable to the initiatives undertaken by the South African government to promote public investment growth in sectors such as energy, communication, water, transport, health and education that are believed to complement private sector growth. The results are in line with various studies on the subject such as Wang (2004), Sahoo et al. (2010) and Pereira and Andraz (2010).

Furthermore, when gross public investment was decomposed as non-infrastructural in Model 4, as expected, it had a significant short-run crowding-out effect on private investment growth in South Africa. This finding may partly be related to the social welfare expenditure that has been growing at an annual rate of 7.3% (Republic of South Africa, 2015). This result is similar to the results that were reported by Mallick (2016) for the Indian economy.

5. Public and private investment and economic growth: Empirical perspectives

Empirical research on public and private investment and economic growth should focus on two related issues. Firstly, whether public investment contributes more to economic growth than private investment and secondly, the crowding effect of public investment on private investment growth. As stated earlier, there is still no consensus in economic empirical literature on the above raised concerns.

Thus, as far back as 1989, Khan and Reinhart argued that private investment is more beneficial to economic growth than public investment for developing countries, including South Africa. This finding was the basis upon which international development institutions such the World Bank and the International Monetary Fund prescribed private sector-led economic growth model for developing countries. Since then, there has been a rapid growth in empirical evidence supporting the market-led growth process. Such literature includes Zou (2006) who confirmed that private investment played a more important role compared to public investment in the USA economic growth. Similarly, Ponce and Navarro (2016) concluded that for the Mexican economy in the period 2006 to 2016, private investment had more impact on economic growth than public investment.

There is also a growing body of empirical studies arguing public investment as having an important role to play in the economic growth process. The literature can be traced to Milbourne et al. (2003) who noted that public investment had a significant impact on economic growth in selected economies, which included South Africa. Until recently, the empirical findings were supported by Sánchez-Juárez and García-Almada (2016) and Nguyen and Trinh (2018), among others. In particular, Nguyen and Trinh (2018) reported that investment by state-owned

enterprises in Vietnam had a leading role in stimulating economic growth during the 1970 to 2016 period. Based on this empirical evidence, most world economies have been persuaded to promote public investment growth to a level enough to stimulate economic growth.

Similarly, empirical literature on the crowding effect of public investment on private investment is extensive, yet inconclusive. There are several studies that have reported the crowding-in effect of public investment on private investment growth. Such studies can be traced to Ramirez and Nazmi (2003) who reported public investment on education and health to have a stimulating effect on private investment growth for nine major Latin American nations for the 1983 to 1993 period. The finding guided policy makers to channel the scarce public sector resources to human capital sectors. Later, Seed et al. (2006) also agreed with this finding when they found that public investment promoted private sector growth in agriculture in case of the Pakistan economy. Even recent studies such as Creel et al. (2015) and Nguyen and Trinh (2018), support the crowding-in effect of public investment on private investment.

However, there is also a growing body of empirical literature supporting the notion that public investment crowd out private investment growth. Such studies include Ramirez and Nazmi (2003) who asserted that public investment growth stifled private investment growth in nine Latin American countries. This unexpected finding could be explained by the aggregation of public investment data which include infrastructural component that, a priori, is expected to stimulate private investment growth. Several recent studies for different economies also reported evidence in support of public investment retarding private investment growth (see Bahal et al, 2015; Creel et al, 2015; Mallick, 2016, among others).

Based on the foregoing discussion, it can be concluded that the debate on public and private investment and economic growth is still not settled. The available empirical evidence on the subject is mixed and varied, and at best inconclusive.

6. Conclusion

The main objective of this study is to empirically examine the relative contribution of public and private investment to economic growth in South Africa from 1970 to 2017. The study attempts to answer two related questions: (i) does public investment spur economic growth more than private investment; and (ii) does public investment crowd in or crowd out private investment? To address the above questions, the study estimates economic growth and private investment models using the recently developed ARDL-bounds testing approach. The empirical results show that private investment positively affects economic growth both in the long run and in the short run. While public investment has a negative effect on growth in the long run, in the short run it has no significant economic growth influence. The results further reveal that in the long run, gross public investment crowds out private investment, while infrastructural public investment crowds in private investment growth. Additionally, both gross public investment and non-infrastructural public investment are found to stifle private investment growth in the short run. Based on these findings, it can be concluded that private investment has a higher contribution to economic growth in South African than public

investment. The empirical results underscore the need to consolidate on the private investment promotion policies in South Africa. However, the importance of infrastructural public investment in stimulating private investment growth can also not be overemphasized.

Lastly, due to the non-availability of data, the study has used the Blejer and Khan (1984) approach to generate infrastructural and non-infrastructural public investment data from gross public investment. While this approach may potentially have some weaknesses, it can reliably estimate the trend and non-trend movements of gross public investment, taken as infrastructural and non-infrastructural public investment, respectively (Odedokun, 1997). When data points for infrastructural and non-infrastructural public investment become available for South Africa, it would be interesting to discover from the future studies on the subject if the results on the crowding-out and crowding-in effects will change significantly.

References

Abiad A., Furceri D., Topalova P. (2015) The macroeconomic effects of public investment: Evidence from advanced economies, International Monetary Fund Working Paper No. WP/15/9

Afonso A., Aubyn M. (2016) Economic growth and public and private investment returns, Department of Economics Working Paper No. WP14/2016/DE/UECE, University of Lisbon

Aremo A.G. (2013) Private investment and sustainable economic growth in economic community of West Africa states (ECOWAS): Panel data cointegration analysis (1986-2011), Journal of Sustainable Development in Africa, 15(7), 142-165

Bahal G., Raissi M., Tulin V. (2015) Crowding-Out or crowding-In? Public and private investment in India, IMF Working Paper WP/15/264, International Monetary Fund

Bèdia A.F. (2007) Relative effects of public and private investment on Còte d'Ivoire's economic performance, Applied Econometrics and International Development, 7(1), 151-158

Beifert A. (2016) Regional airports' potential as a driving force for economic and entrepreneurship development–Case study from Baltic Sea Region, Entrepreneurship and Sustainability Issues, 3(3), 228-243

Berndt E.R., Hansson B. (1992) Measuring the contribution of public infrastructure capital in Sweden, The Scandinavian Journal of Economics, 94, 151-168

Blejer M.L., Khan M.S. (1984) Government policy and private investment in developing countries, IMF Staff Papers, 31(2), 379-403

Bom R.D.P., Ligthart J.E. (2014) What have we learned from three decades of research on the productivity of public capital? Journal of Economic Surveys, 28(5), 889-916

Calderón C., Moral – Benito E., Serven L. (2015) Is infrastructure capital productive? A dynamic heterogeneous approach, Journal of Applied Econometrics, 30(2), 177-198

Creel J., Hubert P., Saraceno F. (2010) An empirical analysis of the link between public and private investment in four OECD countries, 17th Banca d' Italia workshop, Perugia

Cavallo E., Daude C. (2011) Public investment in developing countries: A blessing or a curse? Journal of Comparative Economics, 39(1), 65-81

Clark N.L. (1994) Manufacturing apartheid: State corporations in South Africa, Yale University Press
Dash P. (2016) The impact of public investment on private investment: Evidence from India, The Journal for Decision Makers, 41(4), 288-307
Department of Public Enterprises. (2012) Restructuring of state owned enterprises in South Africa, Presidential Review Committee, Ministry of Public Enterprises, Republic of South Africa
Devarajan S., Swaroop V., Zou H. (1996) The composition of public expenditure and economic growth, Journal of Monetary Economics, 37(2), 313-344
Engle R.F., Granger C.W.J. (1987) Cointegration and error correction: Representing, estimation and testing, Econometrica, 55 (2), 251-276
Erden L., Holcombe R.G. (2005) The effects of public investment on private investment in developing economies, Public Finance Review, 33(5), 575-602
Fournier J. (2016) The positive effect of public investment on potential growth, Economics Department Working Paper No. 1347, Organization for Economic Co-operation and Development
Ghali K.H. (1998) Public investment and private capital formation in a vector error correction model of growth, Applied Economics, 30(6), 837-844
Hague T. S. (2013) Effect of public and private investment on economic growth in Bangladesh: An econometric analysis, Research Study Series No-FDRS 05/2013, Ministry of Finance, Bangladesh
Johansen S., Juselius K. (1990) Maximum likelihood estimation and inference on cointegration with applications to the demand for money, Oxford Bulletin of Economics and Statistics, 52(2), 169-210
Kalyvitis S., Vella E. (2015) Productivity effects of public capital maintenance: Evidence form U.S. States, Economic Inquiry, 53(1), 72-90
Khan M.S., Kumar M.S. (1997) Public and private investment and the growth process in developing countries, Oxford Bulletin of Economics and Statistics, 59(1), 69-88
Khan M.S., Reinhart C.M. (1989) Private investment and economic growth in developing countries, IMF Working Paper WP/89/60
Mallick J. (2016) Effects of government investment shocks on private investment and income in India, Indian Council for Research on International Economic Relations Working Paper 315
Milbourne R., Otto G., Voss G. (2003) Public investment and economic growth, Applied Economics, 35(5), 527-540
Mitra A., Sharma C., Ve´ganzone`s-Varoudakis M. (2012) Estimating impact of infrastructure on productivity and efficiency of Indian manufacturing, Applied Economic Letters, 19(8), 779-798
Moreno R., López-Bazo E., Artis M. (2003) On the effectiveness of private and public capital, Applied Economics, 35(6), 727-740
National Planning Commission. (2011) National development plan 2030; Our future –Make it work, South African Government
Nazmi N., Ramirez M.D. (1997) Public and private investment and economic growth in Mexico, Contemporary Economic Policy, 15(1), 65-75
Nguyen C.T., Trinh L.T. (2018) The impact of public investment on private investment and economic growth: Evidence from Vietnam, Journal of Asian Business and Economic Studies, 25(1), 15-32

Odedokun M.O. (1997) Relative effects of public versus private investment spending on economic efficiency and growth in developing countries, Applied Economics, 29(10), 1325-1336
Odhiambo N.M. (2008) Financial depth, savings and economic growth in Kenya: A dynamic causal linkage, Economic Modeling, 25(4), 704-713
Odhiambo N. M. (2010) Energy consumption, prices and economic growth in three SSA countries: A comparative study, Energy Policy, 38, 2463–2469.
Pereira A., Andraz J. (2010) On the regional incidence of highway investments in the USA, Annals of Regional Science, Working Papers, No 70, Department of Economics, College of William and Mary, USA
Perkins P., Fedderke J., Luiz J. (2005). An analysis of economic infrastructure investment in South Africa, South African Journal of Economics, 73(2), 211-2282
Pesaran H.M., Shin Y. (1999) An autoregressive distributed lag modeling approach to cointegration analysis. In: Strom S., Holly A., Diamond P. (Eds.), Econometrics and Economic Theory in the 20th Century. The Ragner Frisch Centennial Symposium, Cambridge University Press, Cambridge
Pesaran H.M., Shin Y., Smith R.J. (2001) Bounds testing approach to the analysis of level relationship, Journal of Applied Economics, 16, 289-326
Phetsavong K., Ichihashi M. (2012) The impact of public and private investment on economic growth: Evidence from developing Asian countries, Discussion Paper 2012, International Development and Cooperation, Hiroshima University
Ponce L.B.A., Navarro R.P. (2016) Effect of public-private infrastructure investment on economic growth, Network Industries Quarterly, 18(2), 10-12
Ramirez M.D., Nazmi N. (2003) Public investment and economic growth in Latin America: An empirical test, Review of Development Economics, 7(1), 115-126
Republic of South Africa, (2015) Estimates of national expenditure 2015, National Treasury: Republic of South Africa
Sahoo P., Dash R.K., Nataraj G. (2010) Infrastructure development and economic growth in China, Discussion Paper No. 261, Institute of Developing Economies
Sánchez-Juárez I., García-Almada R. (2016) Public debt, public investment and economic growth in Mexico, International Journal of Financial Studies, 4(6), 1-14
Seed N., Hyder K., Ali A. (2006) The impact of public investment on private investment: A disaggregated analysis, The Pakistan Development Review, 4(2), 639-663
Shrestha M.B., Chrowdhury K. (2007) Testing financial liberalization hypothesis with ARDL modeling approach, Applied Financial Economics, 17(18), 1529-1540
Tchouassi G. (2014) Private capital and investment climate for economic growth: Empirical lessons based on ARDL bound test technique, European Journal of Sustainable Development, 3(2), 17-32
Tong T., Yu E.T., Jensen K., Ugarte D.D.L.T., Cho S. (2016) Impact of public infrastructure on output of U.S. food manufacturing industries: A heterogeneous dynamic panel approach, Agribusiness, 32(4), 439-453
Wang B. (2004) Effects of government expenditure on private investment: Canada empirical evidence, Empirical Economics, 30, 493-504
World Bank. (2017) World development indicators, Washinton, DC, World Bank
Yovo K. (2017) Public expenditure, private investment and economic growth in Togo, Theoretical Economic Letters, 7, 193-209
Zou Y. (2006) Empirical studies on the relationship between public and private investment and GDP growth, Applied Economics, 38(11), 1259-1270