Which investment (private or public) does contribute to economic growth more? a case study of South Africa

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Which investment (private or public) does contribute to economic growth more? A case study of South Africa

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Abstract

Economic growth is an important driver for the well-being of the citizens of a country. Despite a common view that investment is a key driver of economic growth, there are conflicting views on whether it is Public investment which drives Private Investment, or whether it is the other way around. Both theoretical views as well as empirical studies tend to have divergent views on this matter, and it is therefore important to try to understand which causes which, in order to help the policymakers.

Using the standard time-series techniques, this study uses annual data and tests the relationship between Investment and economic growth, and also the direction of any causal link between Public and Private investment.

This study contributes to the existing studies on the effects of Public and Private investment, with particular reference to South Africa, which is classified as a developing economy. The contribution of this study to the general body of empirical studies is important because, to date, there is no clear answer with regard to the causal link between public and private investment in developing countries. This paper attempts to provide further clarity on the issue.

The findings of this study are that both Public and private Investment play a significant role in enhancing economic growth. As to which of these two plays a greater role, this study tends to indicate that Private Investment plays relatively a greater role in explaining economic growth than Public Investment.

Key words: *Economic growth, Public investment, Private Investment, Crowding-out, Crowding-in*

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1. INTRODUCTION: ISSUE AND MOTIVATION

In order to have a sustained economic growth, Investment is important. It has been shown in studies that the countries which have a high rate of Investment show a higher rate of growth (Akomolafe, 2015). Therefore, it is important for Investment to take place to grow an economy, and thereby to present the people with opportunities to better their lot in life.

Investment can take place in two forms: it is either done by the Private Sector (Private Investment), or by the Public Sector (Public Investment).

a. Theoretical controversy:

There are two different views in explaining the relationship between government and private sector investment:

a. The traditional view asserts that as government increases its expenditure, it will lead to a lower level of private investment because there appears a competition between public and private sectors in utilizing the limited resources in the factor and financial markets.
b. the non-traditional view argues that if the government spending can increase the marginal productivity of private investment - spending on human capital development, airport, water system and transportation and communication system - then, a significant positive relationship should be existing between these variables." (Choonga, 2015)

These divergent views are explained by Khan (Khan, 1997) as follows: "In general, some components of public investment may be complementary to private investment and so would be beneficial for growth, while others may be substitutes and have a less positive, or even negative, effect on growth. The complementarity may arise in the case of public investment in infrastructure which increases the marginal product of private capital. This is most likely to be true in those developing countries where the existing stock of infrastructure capital is inadequate."

We see therefore, that Public investment plays many competing and offsetting roles in its effect on the investment activities of the private sector, so the net effect of public investment on private investment is an empirical question. (Hacettepe, 2006)

b. Empirical Controversy:

There has been a growing body of literature that investigates whether public investment leads to an increase in output growth and/or the productivity of private capital. The hypothesis has been tested either directly, using a neoclassical production function where public capital enters as a separate input, or indirectly by looking at the productivity of private capital and labor, and the rate of return to private capital derived from the production function.

Overall, the empirical evidence from the US and from developing countries suggests that private capital is more productive than public investment, and that although public investment contributes to the productivity of private capital, it does not explain the major part of the

variation in output growth.

According to Mustefa Seraj (Seraj, 2014), there is no clear consensus on empirical evidence from both developed and developing countries with regard to whether public or private investment has a superior effect on economic growth. Most researchers claim that the contribution of private investment to economic growth is larger than that of public investment, based on the contention that the marginal productivity of the former is greater than that of the latter (Khan and Reinhart, 1990; Serven and Solimano, 1992), although some studies have shown a possibly larger contribution of public capital to economic growth (Ram, 1996).

c. Major questions or issues

Since it is uncertain from both the theoretical as well as the empirical literature whether Public Investment plays a positive or a negative role in increasing economic growth, the objective of this study is to determine whether Public investment or Private investment play a greater role in enhancing economic growth. Such an analysis is of importance from both theoretical as well as policy perspectives, because it will tell policymakers where to focus their attention in stimulating growth in the economy. For example, Khan points out that "Insofar as policy is concerned, if private investment does have a markedly stronger impact on growth, it would further underscore the need to rationalize public investment." (Khan, 1997).

d. Major contribution of this study:

Despite the fact that this study is similar to other studies on the issues raised, it is submitted that this study will add to the existing literature on the issue by attempting to find further clarity on the issue. In addition to this, because this study is conducted on South Africa, which is a developing country, this study is of further importance because the empirical studies to date find that developing countries tend to show conflicting effects of public investment on private investment than developed countries.

e. Summary of findings:

In summary, the findings of this study are that both Public and private Investment play a significant role in enhancing economic growth. As far as which of the two play a greater role, this study tends to indicate that Private Investment plays relatively a greater role in economic growth than Public Investment.

f. Structure of the paper:

This paper is structured as follows: section 1 deals with the introduction and motivation, Section 2 provides a literature review, Section 3 deals with the methodology and data, Section 4 will discuss the empirical findings, Section 5 and 6 will provide conclusions and policy recommendations.

2. LITERATURE REVIEW

(i) Economic growth theory models:

According to Phetsavong: "Economic Growth Theory Growth models are fundamentally of two folds; the neoclassical growth model, also known as the exogenous growth model developed primarily by Solow (1956) and the new growth theory, also known as the endogenous growth model, pioneered by Romer (1986), Lucas (1988), Barro (1990), and Rebelo (1991).

In neoclassical growth models government policy cannot have sustained effects on growth rate of per capita income, although government can even influence the population growth which is assumed to affect the growth rate. In these models, if incentives to save or to invest in new capital are affected by fiscal policy, there will be a change in equilibrium capital output ratio and therefore the output path will change, leaving the steady state growth rate unchanged. The long-run growth rate is driven by exogenous factors of population growth and technological progress while public policy can only influence the transition path of the economy towards steady state growth rate.

According to the economists supporting 'endogenous growth models' (Barro 1990, King and Rebelo 1990, Lucas 1990, Mendoza et al. 1997, Stokey and Rebelo 1995, and Easterly and Rebelo 1993), the share of public expenditure in output or the composition of expenditures and taxation affects the steady state growth rate. This is in contrast to the neoclassical growth theory where only investment in physical and human capital affects the steady state growth rate.

Regarding to the endogenous growth model, the long-run growth rate depends on the stable environment of business, specifically, government policies and actions on taxation, law and order, provision of infrastructure services, protection of intellectual of property rights, regulation of an international trade, financial markets, and other aspect of the economy. Therefore, long-run growth rate has also guided by the government (Barro 1997).

In the endogenous growth model, investment is also treated as a significant factor. As noted, neoclassic growth theory assumes that the investment has a limited role in boosting economic growth. (Phetsavon, 2012)

(ii) Investment as a driver of economic growth:

According to Seraj Mustafa (Seraj, 2014), Coen and Eisher (1992), define investment as follows:

"*Investment is capital formation-the acquisition or creation of resources to be used in production. In capitalist Economies much attention is focused on business investment in physical capital building, equipment and inventories. But investment is also undertaken by government, non-profit institutions and households, and it includes the acquisition of human and intangible capital as well as physical capital (Coen and Eisher, 1992; 508).*"

Investment is one of the most important bases for economic growth theoretically and empirically (Levine and Renelt, 1992). Scott (1976) defines investment for proper growth process understanding as 'all expenditures which would not be made in a stationary state'. He further explained that such expenditures consist of new production capital such as new machinery and vehicles, building and construction, research and development, expenditure on marketing, planning et cetera.

We see therefore, that, Investment is an important component of aggregate demand and a leading source of economic growth. Changes in investment not only affect aggregate demand but also enhance the productive capacity of an economy. The investment plays an essential and vital role in expanding the productive capacity of the economy and promoting long term economic growth (Jongwanich and Kohpaiboon, 2008). Higher investment rate triggers the fast economic growth. Levine and Renelt (1992) have argued that investment in capital goods is the most robust and vital determinant of economic growth (Seraj, 2014).

(iii) The relationship between Public Investment, Private Investment and Economic Growth:

There exists a divergence of opinion on the role that Public Investment plays in the growth strategy of an economy. The debate really centres around what would be the optimal fiscal policy to be adopted by a government if it wanted to stimulate economic growth. The issue in question is whether Public Investment operates as a mechanism for achieving growth (crowding-in) or whether it operates as a mechanism that inhibits economic growth (crowding-out).

While most studies appear to find a relationship between Public Sector Investments and Private Sector Investment, it is unclear whether the relationship is positive or negative. Some argue that Public Investment inhibits (crowds-out) Private Sector Investment (Voss, 2002) (Biza, 2013), while other argue that Public Sector Investment actually stimulates (crowds-in) Private Investment, arguing for the "Keynesian view that implies that an expansionary fiscal policy promotes Private Investment by raising the level of economic activity" (Tugcu, 2015, p. 1). Still other studies suggest that the relationship is different in the short-run and the long-run (Belloc, 2002).

Previous literature suggests that public investment crowding out private investment more often in developed economies. Voss (2002) studied on both data from US and Canada concludes that there is no evidence to prove that public investment complements private investment. In fact, innovations to public investment tend to crowd out private investment. Meanwhile in developing economies public investment is seen tend to complement the private investment. By examining a panel of developing economies from 1980 to 1997, Elden and Holcombe (2005) find a 10 percent increase in public investment would increase private investment by about 2 percent. On the other hand, Cavallo and Daude (2011) investigate that in average for 116 developing countries the public investment crowd out private investment. Ang (2009) analyzing the determinants of private investment in Malaysia suggest that public investment have a complementary effect on private investment.

Neo-classical framework highlights the "crowding out" effect of private investment by public investment when the state decides to increase its investment contribution in the economy

through the issuance of debt or by raising the tax (Kustepeli, 2005). The empirical studies in various country contexts have shown that public investment spending crowds out the amount of private investment (Bairam and Ward, 1993; Voss, 2002; Bende-Nabende and Slater, 2003; Mitra 2006, Blejer and Khan (1984) and Gupta (1984)). It is because the government spending that is financed either by taxes or debt (or both), competes with the private sector in the use of scarce physical and financial resources (Belloc and Vertova, 2006). The shortage of capital will inhibit private investment. This is worse when compounded by the increase of cost of investment, thus make the investment disincentive. The decrease of cost of capital influences positively the private investment (Ghura and Goodwin, 2000). However, the negative impact can be mitigated in higher capital mobility. The inflow of international capital will cause the interest rate to fall (Dehn, 2000). Ahmed and Miller (1999) suggest that tax-financed government expenditure tends to crowd out private investment more often than its debt-financed counterpart.

Credit constraint is seen as more binding than interest rate if its availability is limited in developing countries, hence influences the level of private investment activities (Wai and Wong (1982), Blejer and Khan (1984), Ramirez (1994), Ghura and Goodwin (2000), Erden and Holcombe (2005), Ang (2009), Cavallo and Daude (2011). Credit availability was also empirically shown to be a significant determinant of private investment (Vogel and Buser (1976), Fry (1980), Wai and Wong (1982), Blejer and Khan (1984), Gupta (1984), Garcia (1987), Leff and Sato (1988)), and Oshikoya (1994). Thus, the cost of funding investment projects as well as the availability of credit can be expected to play important roles on private investment in developing countries.

The relationship between public spending and private investment nowadays become more complex (Kollamparambil and Nicolaou, 2010), different impacts might occur by the different components of state spending. Numerous studies done on the impact of infrastructure provision by public capital on private investment decision making have shown the 'crowd in' effect in the private sector (Easterly and Rebelo (1993), Ramirez (1994), Argimón et al. (1997), Galbis (1979), Greene and Villanueva (1991), because it will reduce private costs of production, thus raising profitability, which will stimulate private investment (Ndikumana, (2005), Gjini and Kukeli (2012)). While the non-infrastructure gives the reverse impact (Oshikoya (1994).

Moreover, the possibility of different effect of public investment also can be observed in specific time span. Aschauer (1989b), Mitra (2006) and Serven (1996) investigate the effect of public investment over the long run and the short run time period. They find that the public investment crowding in the private investment in the short run. Meanwhile, in the long run the public investment enhanced the private investment profitability.

Policy is regarded as a particularly important determinant of investment in African countries, which are generally seen as more capital hostile than other regions (Collier, Hoeffler and Pattillo (1999)). South Africa is an emerging market and it is recognized as the second largest economy in Africa region, behind Nigeria. Numerous studies were done to examine the causality relationship between public investment and private investment for this country. P. Perkins and J. M. Luiz (2006) have studied the causality between investments in economic infrastructure and the long run economic growth in South Africa suggest that electricity

generation consistently is shown to impact positively and directly on output. In fact, the public investment which stimulate the aggregate demand of goods and services produced by the private sector will positively effects the private investment in the country (Fielding, 1997).

3. DATA AND METHODOLOGY

This study proposes to test the causal relationship between Private Investment and Public Investment. This will be done by doing a time-series based VAR study using South Africa as the country of study. The study will focus on the period covering 35 years starting from 1980. The variables to be used will be real GDP (GDPR), Public Investment (IG) and Private Investment (IP).

a. Data:

Annual data for each of the variables. The Data for the study have been obtained from World Bank Data (available on DataStream) and from the website of the South African Reserve Bank.

b. Methodology

In this study time series techniques are employed to achieve the stated research objectives, which include the determination of whether there exists a long-run theoretical relationship between the Economic growth and Investment, and between Public Investment and Private Investment, as well as which has a greater impact on economic growth: private or public investment. The study is conducted on a developing country, namely South Africa.

The standard time-series methodology is favored over traditional regression analysis for a number of reasons, which will be discussed below.

In the first place, most economic time series variables tend to be non-stationary in their original 'level' form, thereby implying that any conventional statistical tests carried out on such variables would be invalidated. However, if the variables are non-stationary but cointegrated, then the ordinary regression without the error-correction term(s) derived from the cointegrating equation would be mis-specified. If the variables are non-stationary and not cointegrated, then an ordinary regression with 'differenced' variables (which will be stationary) could be estimated. The difficulty with this, however, is that the conclusions drawn from such an analysis will be valid only for the short run, and no conclusions can be made about the long-run theoretical relationship among the variables. This is because the 'differenced' time-series variables have no information about the long-run relationship between the trend components of the original series as these have, by definition, been removed. The long run co-movement between the variables cannot be captured by 'differenced' variables (Masih et al, 2009).

We see therefore, that on the one hand, if the variables taken are 'non-stationary' in their original 'level' forms, the conventional statistical tests are not valid, since the variances of these variables are changing and the relationship thus estimated will be 'spurious'. On the other hand, if the variables taken are turned 'stationary' by 'first-differencing', the long-term information contained in the trend element in each variable would have been, by definition, removed and the relationship estimated would only give only the short-run relationship between the variables. Thus, the regression analysis would only capture short-term, cyclical or seasonal effects, and would not be testing any long-term theoretical relationships (Masih et al, 2009).

In the second place, in traditional regression analysis, the endogenous and exogenous nature of variables is pre-determined by the researcher, usually on the basis of prevailing theories. Cointegration techniques have the advantage of not making any assumptions regarding the endogeneity and exogeneity of variables. Instead, in the final analysis, it is the data itself that will be allowed to determine which variables are in fact exogenous, and which are exogenous. Put differently, in traditional regression analysis, causality is assumed, whereas in Cointegration techniques, it is empirically proven by data. This is achieved through the 'Long-run Structural Modelling' or 'LRSM' technique which endeavors to estimate theoretically meaningful long-run (or cointegrating) relations by imposing restrictions on those long-run relations (and then testing) both identifying and over-identifying restrictions, based on theories and a priori information of the economies (Masih et al, 2009).

In this study, therefore, the following methodology, as outlined by Masih et al (2009) is employed:

(i) Conducting unit-root tests to test the stationarity of the variables,
(ii) determining the optimum order (or lags) of the vector autoregressive model or VAR.
(iii) Utilizing the lag order obtained in the previous step, to conduct Johansen Cointegration tests. The test of Cointegration is designed to examine the long-run theoretical or equilibrium relationship and to rule out any spurious relationship among the variables.
(iv) The cointegrating estimated vectors will then be subjected to exactly identifying and over-identifying restrictions based on theoretical and a priori information of the economy. This 'LRSM' technique as outlined above would confirm whether a variable is statistically significant, and also test the long-run coefficients of the variables against theoretically expected values.
(v) Since the evidence of Cointegration does not necessarily mean causality, establishment of causality is achieved through the Vector Error Correction Model (VECM), which is able to indicate the direction of Granger causality both in the short- and long-run.
(vi) While the VECM enables a researcher say which variable is leading and which is lagging, it does not tell which variable is relatively more exogenous or endogenous. To know this, the Variance Decomposition technique is used to indicate the relative

exogeneity or endogeneity of a variable, and achieves this by decomposing (or partitioning) the variance of the forecast error of a variable into proportions attributable to shocks (or innovations) in each variable in the system, including its own. The proportion of the variance explained by its own past shocks can help to determine the relative exogeneity or endogeneity of a variable. The variable that is explained mostly by its own shocks (and not by others) is deemed to be the most exogenous of all and vice versa. After determining relative exogeneity/endogeneity, the Impulse Response Function (IRF) is be applied to map out the dynamic response path of a variable due to a one-period variable-specific shock to another variable. In essence, IRF is a graphical way of expressing the relative exogeneity or endogeneity of a variable.

(vii) Lastly, the Persistence Profiles (PP) technique is applied. The results from the application of this technique are also in graphical form, and are designed to estimate the speed at which the variables would return to equilibrium in the event of a system-wide shock, as opposed to the Impulse Response Function (IRF) which maps out the effects of only a variable-specific shock on the long-run relationship (Masih et al, 2009).

c. Variables:

The variables used in the analysis are defined in the following table:

Variables:

GDP	GDP at current Local Currency values (LCU)	World Bank Data	As a proxy for growth
IPV	Gross Fixed Capital Formation (Private) at current local values (LCU)	World Bank Data	As a proxy for Private Investment
IPU	Gross fixed Capital Formation (public) at current local Values (LCU)	World Bank Data	As a proxy for public investment

Annual time series data was sourced for this study. The data is sourced from the World Development Indicators (WDI), which is available on the World Bank Databank (URL: http://databank.worldbank.org).

4. EMPIRICAL RESULTS AND DISCUSSIONS

(i) Unit root tests

The empirical analysis is started by determining the stationarity of the variables utilized in the study. To recap, a variable is stationary when its mean, variance and covariance are all constant over time. In time series studies, it is critical to determine the stationarity of the variables before proceeding to tests for Cointegration. Ideally, all variables should be I (1), meaning that in their original 'level' form, they should be non-stationary, and in their 'first differenced' form, they should be stationary. The 'differenced' form of each variable is created by taking the difference of their logarithmic forms. For example, DGDP= LGDP - $LGDP_{t-1}$.

Both the Augmented Dickey-Fuller (ADF) test and PhilipsPerron (PP) test were conducted on each variable (in both level and differenced form). Table 1 and 2 below summarize the results of the ADF test, while Table 3 and 4 reflect the results of the PP test. See Annexure "A" for the full results on the ADF test results, and Annexure B" for full results of the PP test results.

Table 1: ADF TEST: VARIABES IN LEVEL FORM

VARIABLE	ADF	VALUE	T-STAT.	C.V.	RESULT
LGDP	ADF (1) =SBC	61.3306	- 0.499	- 3.580	NON-STATIONARY
	ADF (1) =AIC	63.9950	- 0.499	- 3.580	NON-STATIONARY
LIPU	ADF (1) =AIC	12.4817	- 3.314	- 3.580	NON-STATIONARY
	ADF (1) =SBC	9.8173	- 3.314	- 3.580	NON-STATIONARY
LIPV	ADF (1) =SBC	37.9498	- 4.918	- 3.580	STATIONARY
	ADF (1) =AIC	40.6142	- 4.918	- 3.580	STATIONARY

Table 2: ADF TEST: VARIABLES IN DIFFERENCED FORM

VARIABLE	ADF	VALUE	T-STAT.	C.V.	RESULT
DGDP	ADF (1) =SBC	59.1043	- 2.087	- 2.975	NON STATIONARY
	ADF (1) =AIC	61.0481	- 2.087	- 2.975	NON STATIONARY
DIPU	ADF (1) =SBC	5.5928	- 3.931	- 2.975	STATIONARY
	ADF (1) =AIC	7.5366	- 3.931	- 2.975	STATIONARY
DIPV	ADF (2) =SBC	31.7974	- 4.291	- 2.975	STATIONARY
	ADF (3) =AIC	34.4151	- 4.119	- 2.975	STATIONARY

When using the ADF test, the null hypothesis is that the variable is non-stationary. The null hypothesis is tested by comparing the test-statistic corresponding to the highest AIC and/or SBC values to the critical value. If the test statistic is lower than the critical value, then then the null hypothesis cannot be rejected, and it can be concluded that the variable is non-stationary. In determining which test statistic to compare with the 95% critical

value for the ADF statistic, the ADF regression order based on the highest computed value for AIC and SBC is used.

By applying this principle, as can be seen in table 1 above, the test-statistic for variables LGDP and LIPU was lower than the critical value, and these variables were therefore being found to be non-stationary, while the test statistic for variable LIPU was found to be higher than the crucial value, making this variable stationary in the level form.
In the differenced form, the test statistic for variables DIPV and DIPU were found to be higher than the critical value, meaning that these variables were stationary in the differenced form, while the test-statistic for variable DGDP was found to be lower than the critical value making the variable non-stationary in the differenced form.

Since the results based on the ADF test would not allow for proceeding with Cointegration testing, the Philips Perron (PP) test results were also analysed to test for stationarity. It is noted that the difference between the two tests is that while the ADF test is only able to resolve the autocorrelation problem, the PP test takes care of both the autocorrelation and heteroskedasticity issues.

The null hypothesis for the PP test once again is that the variable is non-stationary, and the null hypothesis is tested based on the p-value of the test statistic, which informs us of the percentage error we are making in rejecting the null.

As can be seen from table 3 and 4 below, in all cases of the variables in level form, the null hypothesis cannot be rejected suggesting that all the variables are non-stationary. Also, in all cases of the variable in differenced form, the null hypothesis was rejected and it could be concluded that all the variables are stationary.

TABLE 3: PP TEST- VARIABLES IN LEVEL FORM

PP	VARIABLE	T-STAT.	C.V.	RESULT
	LGDP	- 1.071	- 3.649	non-stationary
	LIPU	- 2.006	- 3.649	non-stationary
	LIPV	- 1.889	- 3.649	non-stationary

TABLE 4: PP TEST- VARIABLES IN DIFFERENCED FORM

PP	VARIABLE	T-STAT.	C.V.	RESULT
	DGDP	- 3.126	- 2.927	stationary
	DIPU	- 8.916	- 2.927	stationary
	DIPV	- 3.584	- 2.927	stationary

Since the PP tests confirm that all the variables are non-stationary in the level form, and all the variables are stationary in the differenced form, it is possible to proceed to the next step of the

study, namely testing of Cointegration.

(ii) Determination of the order of the VAR model

Before moving to Cointegration tests, it is first necessary to determine the order of the Vector Auto Regression or VAR, namely, the optimum number of lags to be used. The lag length is usually determined by evaluating the amount of lags recommended by the AIC and SBC. As can be seen in table 5 below, the results show that AIC recommends an order of 1. On this basis, an order of 1 VAR is used to test for Cointegration,

TABLE 5: ORDER OF THE VAR

Order	AIC	SBC
1	98.8008	91.0258

(iii) Testing Cointegration

Having established that the variables are I (1) and also having determined the optimal VAR order as 1, the tests for Cointegration were proceeded with. Two tests to identify co-integration between the variables were conducted, namely the Johansen method and Engle-Granger method. In this regard, it is noted that the Johansen method uses the maximum likelihood approach (i.e. Eigenvalue and Trace) and is able to identify more than one cointegrating vector. It gives hypothetical values to the coefficients of all the variables to see which combination makes the error term stationary. On the other hand, the Engle-Granger method utilizes a residual-based approach and can identify only one co-integrating vector. It simply tests for the stationarity of the error term.

The null hypothesis for the Johansen test is that there is no Cointegration among the variables. This is once again tested by comparing the test-statistic against the 95% critical value. If the test-statistic is lower than the critical value, then the null hypothesis cannot be rejected, and it is concluded that there is no Cointegration. If the test-statistic is higher than the critical value, then it can be concluded that the null hypothesis is to be rejected, and that there is at least one Cointegration. The results, as shown in table 6 below, reflect that, since the Eigenvalue and Trace Statistics are both higher than their respective critical values at the 95% significance level, the null hypothesis is to be rejected, and that there is at least one Cointegration. Furthermore, in Table 6 below, r<=1 indicates the null hypothesis that the number of cointegrating vectors are less than or equal to one. Since the test statistics are unable to reject this null, it is accepted that there is only one cointegrating vector among the variables.

TABLE 6: JOHANSEN TEST RESULTS

Cointegration LR Test Based on Maximal Eigenvalue of the Stochastic Matrix					
Null	**Alternative**	**Statistic**	**95% Critical Value**	**90% Critical Value**	**Result**
r = 0	r = 1	37.532	25.420	23.100	
r<= 1	r = 2	9.623	19.220	17.180	
r<=2	r=3	5.169	12.39	10.55	
Cointegration LR Test Based on Trace of the Stochastic Matrix					
Null	**Alternative**	**Statistic**	**95% Critical Value**	**90% Critical Value**	**Result**
r = 0	r>= 1	52.324	42.340	39.340	
r<= 1	r>= 2	14.792	25.770	23.080	
r<=2	r=3	5.169	12.39	10.55	

Thus, on the basis of the standard Johansen Cointegration test (see Table 6 below); it is concluded that the variables have one cointegrating vector at the 95% significance level, as per the maximal Eigenvalue and Trace Statistics

(iv) <u>Long-run structural modelling (LRSM)</u>

Having found evidence of Cointegration, it is assumed that the relationship among the variables is not spurious. Simply put, it is accepted that, there is a theoretical relationship among the variables and they tend towards equilibrium in the long-run.

However, in order to test the coefficients of the cointegrating vector against the theoretical and a priori information of the economy, the 'Long-run Structural Modelling' or LRSM procedure is applied. Really speaking, this is an attempt to quantify this apparent theoretical relationship among the variables, so as to be able to compare the statistical findings of the Johansen test

with theoretical (or intuitive) expectations. Using the LRSM component of MicroFit, and normalising the variable of interest, namely GDP, the results in Table 7 were obtained. By calculating the t-ratios manually, it is found that LIPV is significant, while LIPU is insignificant.

TABLE 7: LRSM RESULTS

Variable	Coefficient	Standard Errors	Implication
LGDP	1.0000	(*NONE*)	-
LIPV	-.28164	(1.2026)	significant
LIPU	-.26789	(0.17909)	insignificant
Over-Identifying			

Variable	Chi-Sq. p-value	Implication
LGDP	-	-
LIPV	6.7037[0.010]	insignificanc
LIPU	0.053767[0.817]	Significance

From the above analysis, we arrive at the following cointegrating relation (numbers in parentheses are standard deviations):

$$\text{LGDP} + \underset{(1.2026)}{-2.8164}\ \text{LIPV} + \underset{(0.17909)}{-.26789}\ \text{LIPU} \rightarrow I(0)$$

(v) <u>Vector error correction model (VECM)</u>

From the analysis thus far, it has been established that at least one of the variables used in this study is cointegrated to a significant degree – namely LIPV. But the cointegrating equation reveals nothing about the direction of Granger causality between the variables, and does not indicate which variable is leading and which variable is lagging (i.e. which variable is exogenous and which variable is endogenous). The Information on direction of Granger-causality is particularly useful for the South African policy makers, since, by knowing which variable is exogenous and endogenous, the policymakers can better construct their policies and interventions, and better forecast or predict their expected results. Typically, a policymaker would be interested to know which variable is exogenous, as he would then direct his intervention at that variable, thus causing a significant effect on the expected movement of the remaining variables. Therefore, in order, to establish the endogeneity or exogeneity of the variables, the 'Vector Error Correction Modelling' or VECM technique is applied.

By decomposing the change in each variable to short-term and long-term components by virtue of VECM, it is possible to ascertain which variables are in fact exogenous and which are endogenous. The principle in action here is that of Granger-causality, a form of temporal causality where the extent to which the change in one variable is caused by another variable in a previous period, is determined. As can be seen in table 8 below, by examining the error correction term,

e_{t-1}, for each variable, and checking whether it is significant, it is found that there are two exogenous variables, namely LIPU and LIPV, while variable LGDP is found to be endogenous. See Annexure "E" for full results on VECM.

TABLE 8: VECM RESULTS

Variable	ECM (-1): t-statistic [p-value]	Implication
LGDP	-5.9168[.000]	Variable is endogenous
LIPV	-.071757 [.478]	Variable is exogenous
LIPU	.24234 [.810]	Variable is exogenous

The implication of this result is that, as far as the variables included in this study are concerned, the variables of interest to the South African authorities and policymakers should be LIPV and LIPU. The reason for this is that since these variables are exogenous, they would receive shocks and transmit the effects of those shocks to the other variables.

However, the limitation of VECM is the fact that it does not indicate which variable between LIPV and LIPU is more exogenous. Thus, purely on the basis of these results, it would be difficult for policymakers to make any serious commitments either way. To know this information, Variance Decomposition (VDC) technique is employed in the next stage of the analysis in order to determine relative exogeneity and endogeneity, so as to further guide the authorities in their decision-making process. It should be noted that, while the VECM does not provide info on relative exogeneity/endogeneity, it does provide another useful piece of information in the form of the coefficient.
Moreover, the fact that there is at least one variable that is shown to be endogenous in the VECM, implies that the error term of at least one variable is significant. This is actually a further proof that Cointegration does exist among the variables. This approach of proving Cointegration is known as the ARDL approach.

(vi) Variance Decomposition (VDC)

Despite having established that LIPU and LIPV are the exogenous variables in our study, it is not possible to draw any conclusions regarding the relative exogeneity of these two variables. In other words, of the remaining variables, which is the most lagged variable compared to others, or, indeed the least exogenous. Since VECM is not able to assist in this regard, Variance Decomposition (VDC) is used.

Briefly, VDC decomposes the variance of the forecast error of each variable into proportions attributable to shocks from each variable in the system, including its own. The variables which are explained most by their own past are regarded as the most exogenous variables, while

variables which least explain their own past are classified as the most endogenous.

In this study, both the Orthogonalized VDC and the Generalised VDC approach have been utilized. By applying the Generalized VDC approach, and the results depicted in Table 9 and Table 10 below are obtained.

TABLE 9: VDC: HORIZON: 15 YEARS (GENERALIZED)

	LGDP	LIPV	LIPU	RANKING
LGDP	.36030%	0.85%	0.54%	3
LIPV	0.12404%	0.99987%	0.016258%	1
LIPU	0.20680%	0.27648%	0.99845%	2

TABLE 10: VDC: HORIZON: 30 YEARS (GENERALIZED)

	LGDP	LIPV	LIPU	RANKING
LGDP	0.91475%	0.74694%	0.20927%	3
LIPV	0.11877%	0.99955%	0.015399%	1
LIPU	0.21512%	0.037326%	0.99539%	2

TABLE 11: VDC: HORIZON 15 YEARS: ORTHOGONALIZED

	LGDP	LIPV	LIPU	RANKING
LGDP	.36030%	0.63970%	0.00%	3
LIPV	0.12404%	0.87596%	0.00%	1
LIPU	0.20680%	0.3246e-3%	0.79288%	2

TABLE 12: VDC: HORIZON 30 YEARS: ORTHOGONALIZED

	LGDP	LIPV	LIPU	RANKING
LGDP	.091475%	0.90852%	0.00%	1
LIPV	0.11877%	0.88123%	0.00%	2
LIPU	0.21512%	0.0014517%	0.78343%	3

For the above two tables, rows read as the percentage of the variance of forecast error of each variable into proportions attributable to shocks from other variables (in columns), including its own. The columns read as the percentage in which that variable contributes to other variables in explaining observed changes. The diagonal line of the matrix (highlighted) represents the relative exogeneity.

According to these results, the ranking of the variables by degree of exogeneity (extent to which variation is explained by its own past variations) is as follows:

(1) LIPV~ (2) LIPU ~ (3) LGDP

The implications of the information provided by the VDC analysis provide valuable information to the policymakers in South Africa.

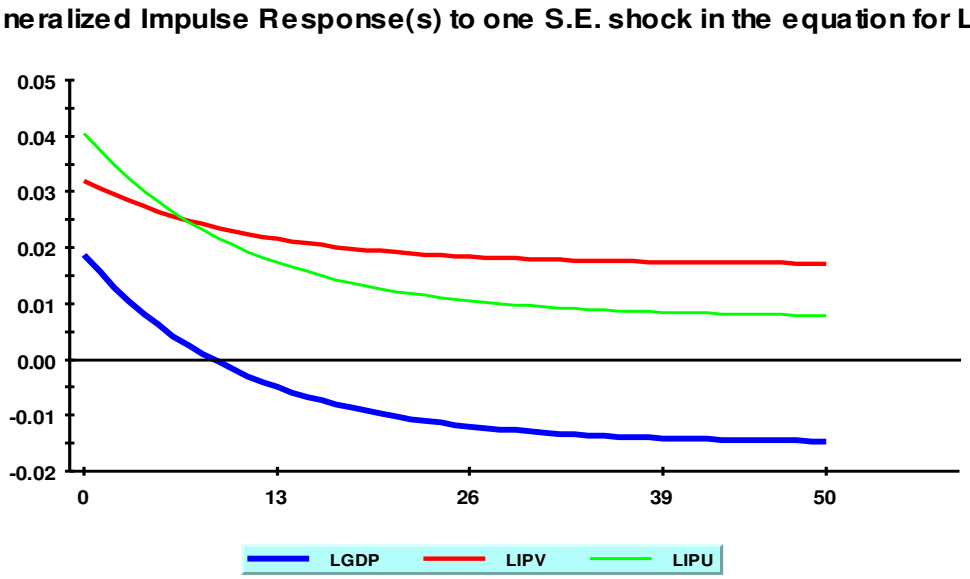
By knowing which variable is exogenous and endogenous, the policymakers can better construct their policies and interventions, and better forecast or predict their expected results. Typically, a policymaker would be interested to know which variable is exogenous, as he would then direct his intervention at that variable, thus causing a significant effect on the expected movement of the remaining variables. The implication of this result is that, as far as the variables included in this study are concerned, the primary variable of interest to the South African authorities and policymakers should be LIPV or Private Investment. The reason for this is that since this is the most exogenous variable, it would receive a shock and transmit the effects of that shock to the other variables included in our study. Furthermore, as LIPU or Public Investment displayed some relative exogeneity too, it should also feature in the policy decision-making process of the authorities in South Africa.

(vii) Impulse Response Functions (IRF)

Essentially, the impulse response functions (IRFs) map out the dynamic response path of a variable owing to a one-period standard deviation shock to another variable. Thus, they produce similar information to VDCs, except that they can be presented in graphical form. In this study, both Orthogonalized and generalized IRFs for the all variables have been conducted. For the sake of brevity, only the generalized IRFs are discussed here. It is found that the results are consistent with those obtained in the VDC analysis. From figure 1, it is observed that LGDP is the most responsive to the individual shocks given to the other variables. This suggests that LGDP is the endogenous variable among all the variables

included in this study. On the other hand, it is observed that LIPV is the least responsive to the individual shocks given to the other variables. This suggests that LIPV is the most exogenous variable among all the variables included in this study, which is also consistent with the VDC analysis in the previous section of this paper.

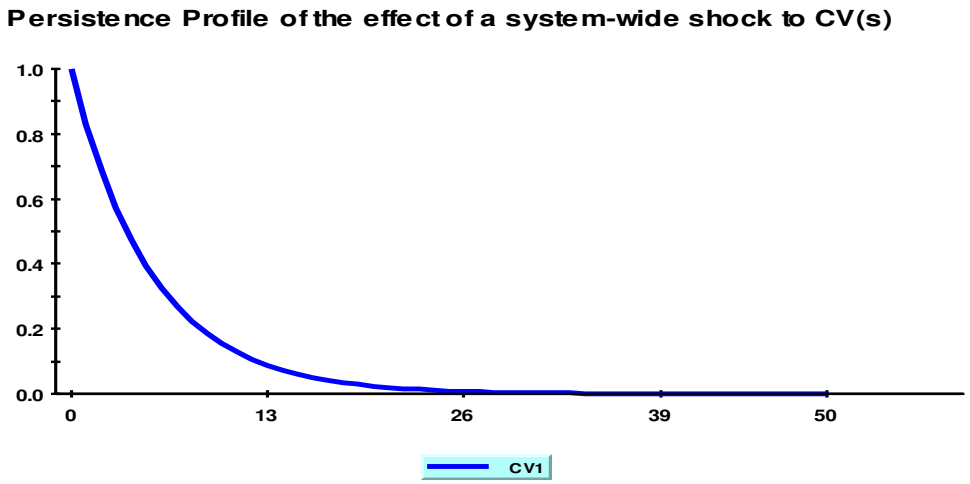
FIGURE 1: IMPULSE RESPONSE FUNCTION



(viii) Persistence Profile (PP)

The Persistence Profile (PP) illustrates the situation when the entire cointegrating relationship of the variables is shocked, by a factor that is external to our cointegrating relationship. More specifically, it indicates the time horizon that is required for the relationship to return to equilibrium. The focus here is on the effect of a system-wide shock on the long-run relations, instead of a variable-specific shock as in the case of IRFs. Figure 2 below shows the persistence profile for the cointegrating relationship of this study. It indicates that when the external shock is initially imposed on the variables; they temporarily deviate away from their state of equilibrium. However, it would take approximately twenty-six (26) years for the cointegrating relationship to return to equilibrium following the system-wide shock.

FIGURE 2: PERSISTENCE PROFILE



5. CONCLUSION

This paper attempts to add to the existing research and literature in this regard by determining whether a long-run theoretical relationship does indeed exist between Public and Private Investment in South Africa and the level of economic growth eventually achieved by the country.

Utilizing annual data ranging from 1980 to 2014, time series techniques of Cointegration, long-run structural modelling (LRSM) and variance decompositions (VDCs) were employed to answer the stated research objectives. The results of our LRSM analysis indicate that there is a long-run theoretical relationship that does exist between the level of economic growth in South Africa and the amount of Investment (both Private and Public) made in the country.

With regard to our second research objective, the paper successfully demonstrates that a degree of causality does exist between GDP and Public and Private Investment. Based on our VECM and VDC results, GDP proves to be an endogenous variable. By contrast, IPV or Private Investment is shown to be the most exogenous variable in the cointegrating relationship, thus suggesting that it would the variable most suited to receiving an external shock, and transmitting the shock to GDP and other related variables.

6. POLICY IMPLICATIONS

Based on the findings of the study both from the descriptive and econometric results, the following conclusions are derived.

A strong private sector is an important engine for stimulating economic growth. The greater the share of private investment in the gross domestic product of a country, the higher the average growth rate of the economy. This is reflected by the creation of more employment opportunities, higher output and good standard of living of people. Attainment of higher growth through private investment depends among other factors on the past policy of the country towards the sector.

Given the relative significance and importance of the private sector investment in stimulating economic growth, policies designed to attract private investment should be deep enough to stimulate sustainable growth.

Considering the long run positive effect of real private investment the government of should take supplementary reforms that promotes private sector development, in supportive of entrepreneurial endeavor and with a bias towards expansion of business activities. In particular, the government has roles to play at different levels of the economy to encourage the private sector and to attain sustainable development. These include supply of efficient infrastructure facilities such as electricity, telephone, water and road; improving the tax administration system for example minimizing the random imposition of taxes and increasing access to information and advisory services. In the absence of some or all of these prerequisites, private investment expansion which is a means for accumulation of physical capital and increment of national output may not result at the projected level.

Second, the long run positive effect of real public investment on growth calls the responsible authority, first to identify which sectors of public investment are crowding in and which sectors are crowding out private investment, before expansion of state participation. The guiding principle for public investment should be complimentary rather than compete with private investment.

The evidence suggests a clear need to improve the productivity of public sector investment by identifying much more rigorously the types of investment that have positive net returns and are likely to be complementary to the private sector. At the same time, policymakers should be undertaking measures to stimulate private investment. This can be done in part by structural reforms in the financial sector, which facilitate the mobilization of savings and help allocate funds to productive private sector investment, and in part by ensuring a stable macroeconomic environment.

7. LIMITATIONS AND SUGGESTIONS FOR FUTURE RESEARCH

It is noted that a relatively small dataset was employed in this study. Another major limitation of this practice is that not too many variables can be included in such a model, due to its small sample size. The reason for this is that the inclusion of too many variables in such a scenario would lead to loss of degrees of freedom, and consequently, the resultant sample may not be regarded as sufficient enough to make exceedingly accurate inferences. Thus, in future, the usage quarterly data would be more appropriate and perhaps, provide the basis for more precise estimations and inferences.

Furthermore, the number of variables utilized in the study are relatively few in number.

Consequently, the model has the ability to explain the variation in Economic Growth in light of only a few variables, resulting in there being limited implications of the study in the area of practice. This caveat can be taken care of in future, by increasing the number of variables employed in the model, thereby enabling the model to explain the variation in GDP more adequately. While this research focuses on only a few parameters with regards to Public and

Private Investment, there is a wide array of other factors, such as Interest rate and availability if credit to the private sector, that have major influence on the rate of private investment. A better understanding of most of these factors would enable policymakers to more effectively market South Africa as an investment destination.

Finally, we have adopted basic time series techniques as the basis for our empirical estimations. Even though these robust and advanced estimation techniques surpass ordinary OLS regression analysis, they are still based on an assumption, namely the existence of a linear relationship among the variables. To overcome this caveat, we recommend the application of cutting-edge econometric techniques and dynamic modelling to a more extensive data set in related future research.

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