

Full Length Research Paper

Nature and association of public and private investment: Public policy implications for South Africa

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South Africa has a low investment-to-GDP ratio compared to other developing countries. The share of government investment in the total investment has also been declining. In this context, the paper uses quarterly data from 1960 to 2005 to analyse the nature and relationship between public and private investment in South Africa. The findings of the study have strong policy implications and indicate that although public investment is not “crowding in/out” private investment, it exerts an indirect impact on private investment through the accelerator effect. Hence an increase in government spending on infrastructure and social sectors is likely to enhance private investment in the country. Therefore a more proactive fiscal policy is suggested to increase the investment-GDP ratio which can stimulate higher growth rates.

Key words: Crowding in/out, public investment, infrastructure.

INTRODUCTION

The association between public investment spending and private investment is a controversy in the macroeconomic realm that has strong implications for determining the government policy to promote economic growth. It is well-known that high levels of investment are the precondition for sustained economic growth, especially in developing countries (Blejer and Khan, 1984). It is thus vital to establish whether efforts being made by the state with regard to their investment contributions are thwarting or fostering the private sector's incentive to invest. Ascertaining such a relationship between these two elements is imperative for economic-growth oriented public policy. The nature of the relationship has been a long-contested issue both from a theoretical as well as an empirical perspective¹.

Under the Neo-classical framework “crowding out” of private investment by public investment occurs when the state decides to increase its contribution of investment within the economy. It may decide to finance this increase either through the issuance of debt or by raising taxes. New public investment financed by debt, draws liquidity out of the market and for a given level of money stock, drives interest rates up (Kuştepe, 2005). Under the assumption of full employment, this directly translates into a rise in the cost of borrowing that would be used to finance new private sector investment projects. Hence certain investment projects either become unprofitable or infeasible providing disincentive for the private sector to invest. Government investment financed by taxes may distort relative prices and thus lead to the misallocation of resources, for example away from investment projects taken up by the private sector and pumped into alternative uses that appear relatively cheaper (Atukeren, 2004). A tax increase will also diminish after tax-returns on private investments, providing economic agents with the incentive to revise their investment decisions downwards. Empirical studies in various country contexts (Bairam and Ward, 1993; Voss, 2002; Bende-Nabende and Slater, 2003; Mitra 2006) have shown that public investment spending crowds out, or less formally reduces the amount of private investment that would ordinarily be undertaken by the private sector of the economy. On the

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¹ Theoretically, the literature is primarily concerned with the effects of public spending on private investment, as the original concept of “crowding out” referred specifically to this issue. As public investment is one of the two major components of government spending, parallel conclusions are drawn without difficulty from the theory to take explicit consideration of the effects of public investment on private investment.

other end of the debate, the Keynesian opinion is one that argues for state intervention. In a state of less than full employment the interest rate sensitivity of investment is assumed to be low. In this case, an increase in interest rates from expansionary fiscal action is minimal and hence output and income expand.

The expectations of investors are altered by such behavior and it is assumed that this, in addition to the above, crowds in private investment rather than crowds it out. Empirical studies by Easterly and Rebelo (1993), Ramirez (1994) and Argimón et al. (1997) have argued that public investment may “crowd in” private investment when the state decides to invest specifically in the infrastructure of the economy; for example in the construction of new motorways, or decides to enhance the output of electricity generation through the construction of new power stations. The positive spillover effects created from such expenditure could induce private sector investment to proliferate from an increase in total factor productivity. Public investment, in certain cases, has the added benefit of boosting overall aggregate demand for the goods and services produced by the private sector. In the context of South Africa, Fielding (1997) and Fedderke (2000) found evidence of crowding in by public investment. Perkins et al. (2005) reported evidence of a feedback relationship between GDP growth and infrastructure investment. A subsequent study by Fedderke et al. (2006) reported much stronger evidence that infrastructure investment might lead output growth in South Africa, however the feedback from growth to infrastructure was reported to be weaker. They found not only a direct impact for infrastructure on growth, but also an indirect channel via higher private sector investment in productive capital.

While mooted a positive relationship between public and private investments, Aschauer (1989b) emphasized the need to recognize the heterogeneity of public spending and the differential economic impacts that the various components may have. He also emphasized the possibility of difference in the impact of public investment over the long and short run and found that an increase in public sector investment spending almost completely crowded out private investment in the short-run. In the long-run it was found that this public investment raised the profitability of private capital and thus induced further private investment. On balance, crowding in prevailed, implying an expansion of national investment. Mitra (2006) and Serven (1996) also present evidence of crowding in over the long run and crowding out in the short run.

The final possibility that exists is explained by the Ricardian Equivalence Theorem. The premise for this theorem is that “an increase in the budget deficits is expected to be accompanied by an increase in taxes in the future, if not today” (Kuştepelı, 2005: 186). So public investment financed through the issuance of debt is expected to be repaid by revenue generated by taxes in the future. Therefore interest rates and private

investment are left unchanged as economic agents realize that their income will be taxed in the future and hence they do not alter their current level of savings and consumption. As a result private investment is neither crowded in nor crowded out and as such private and public investments are considered to behave independently of one another.

Whether public investment is financed by tax, debt or increased money creation may also contribute to its ultimate effect on private investment. The first two sources involve a transfer of resources from the private sector and thus could have a crowding-out effect. The monetarists argue that increase in money supply, whether or not accompanied by public expenditure, can have an expansionary effect on private sector. Spencer and Yohe (1970) provide a matrix of the possible outcomes of public expenditure financed by a mix of the above sources (Table 1). A, B and C are likely to have an expansionary effect promoting private investment while; G, H and I are likely to have a contractionary effect adversely affecting private investments. Outcomes of D, E and F are ambiguous. Detailed theoretical discussions of these are provided in Spencer and Yohe (1970). An empirical examination of these outcomes are difficult to validate given the practical difficulty in determining which investment, in general, is financed by means of taxes and which portion is financed by debt. Despite this Ahmed and Miller (1999) investigate this issue and conclude that tax-financed government expenditure tends to crowd out private investment more often than its debt-financed counterpart. Liquidity constraints are cited as the rationale behind such a finding.

The objective of the paper is to analyse the association between public and private investment in South Africa in the context of its low investment-to-GDP ratio compared to other developing countries. Understanding this relationship would enable the government to formulate policies most suited to improve the investment-GDP ratio of South Africa. The rest of the paper is organized as follows: Section II analyses the recent trends in fixed capital formation in the South African context. The composition of public investment in South Africa is analysed in Section III. The subsequent section discusses the various empirical approaches adopted in literature to investigate this issue and discusses the methodology adopted in this study. Section V undertakes econometric analysis to determine the relationship between public and private investment. Finally, a summary of the main findings and some possible implications that these pose for South Africa are offered in Section VI.

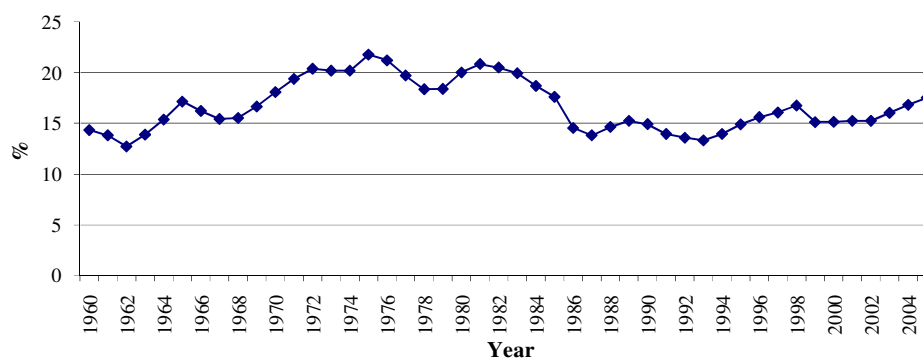
FIXED CAPITAL FORMATION IN SOUTH AFRICA

South Africa’s investment record has been less than impressive in recent times with its gross fixed capital formation to GDP ratio averaging around 14.9% for the

Table 1. Cataloging fiscal finance.

Change in supply of debt	Change in money supply		
	+	0	-
+	A) Deficit financed by mix of debt and money supply	D) Deficit financed by debt	G) Money retirement financed through borrowing
0	B) Deficit financed by new money	E) Equal change in tax yield and Expenditure	H) Money retirement financed through current surplus
-	C) Debt retirement financed by new money	F) Debt retirement through current surplus	I) Current surplus used to retire debt and money

Source. Spencer and Yohe (1970).

**Figure 1.** Trends in gross fixed capital formation to GDP ratio: South Africa 1960 to 2005.

period 2000 to 2003 (Figure 1). This is distinctly lower compared to the same period figures of other developing countries like India (22.2%) and China (39.6%) and developed countries like USA (18.9%) and Japan (24.9%). Public investment and private investment averaged 4.8 and 11.3 per cent of GDP in South Africa over the period 1990 to 2005.

Private investment has always exceeded public investment in South Africa except for a few years in the second-half of 1970s. But as observed in many other developing countries, the share of private investment in total investment in South Africa has been increasing since the late 80s and accounted for 72% of total investment in 2005. This growth in the share of private investment rates has not been because of its strong growth per se, but because of weaker investment by the government and public corporations. After peaking at 67499 million rand in 1976, public investment fell consistently in the 80s and early 90s (Figure 2). It reached a low of 31033 million rand in 1994 and recovered since then to 54760 million rand in 2005 (all

figures based on constant 2000 prices). The slump in public investment in the 80s and early 90s can be largely attributed to political uncertainty that the country underwent during the period. This was compounded by the restrictive monetary policy stance in the latter half of the 90s in order to bring inflation and the large budget deficit under control (Roberts, 2004).

After a period of declining GDP from 1989 to 1993, GDP made a recovery since 1994 and provided momentum for private investment through the standard accelerator effect. Although public investment also began showing an upward movement, private investment overtook its levels and began single-handedly determining the trend of South African investment. The 80s thus mark a departure from historic trends of near equal levels of public and private investment, with the latter substantially overtaking the former since mid-1980s. Despite this, the co-movement in public and private investment is apparent even in recent times as indicated by a positive correlation coefficient of 0.86 for the period 1994 to 2005. Though this indicates a complementary relationship

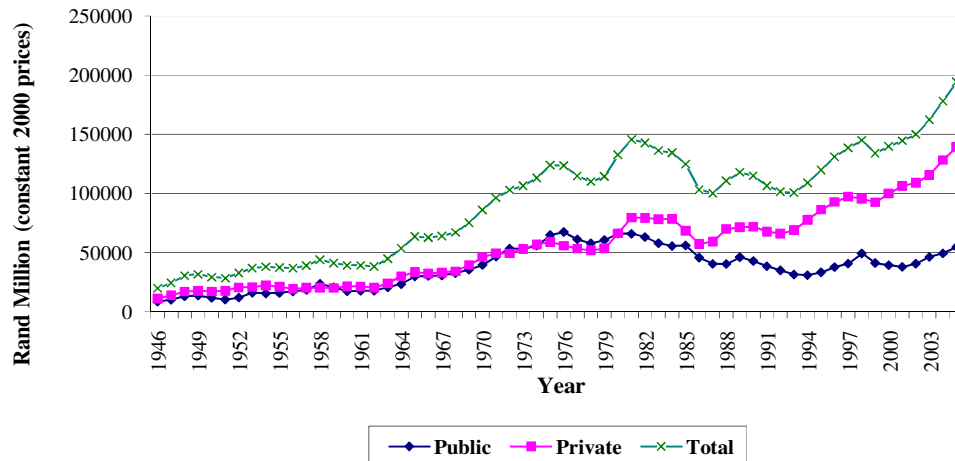


Figure 2. Gross fixed capital formation in South Africa: 1946 to 2005.

Table 2. Sector-wise average fixed capital formation (%)

Sector	1950s	1960s	1970s	1980s	1990s	2000 to 09
Agriculture, Forestry and Fishing	16.72	9.89	7.08	5.04	3.82	2.56
Mining and Quarrying	12.15	7.45	6.42	11.36	9.92	9.50
Manufacturing	10.83	15.02	16.47	17.02	21.62	19.65
Electricity, Gas and Water	7.12	7.46	8.65	12.41	7.22	7.47
Construction	0.43	0.97	1.54	1.33	1.09	1.76
Wholesale and Retail Trade	5.49	6.48	6.45	5.67	6.22	7.01
Transport, Storage and Communication	13.62	13.79	15.03	10.82	10.95	15.29
Financial Services	20.03	19.43	19.31	22.46	23.40	20.35
Community, Social and Personal Services	13.60	19.50	19.06	13.89	15.75	16.37

Source. Estimated from <http://www.reservebank.co.za>.

between public and private investment in South Africa, a more rigorous econometric analysis is necessary to draw conclusions.

The sector wise analysis of capital formation in South Africa indicates that since the 1980s financial services sector accounted for the highest capital formation in the economy, followed closely by the manufacturing sector (Table 2). Sectors that have been losing their shares since the 80s are electricity, agriculture and mining. Although the share of social services and transport has increased since the 1990s, its share continues to be lower than what it was in the 60s and 70s. The broad indication is that growth of investment has been higher in sectors where the private sector is expected to be active, compared to sectors where public investment is expected to be the driving source of capital formation.

COMPOSITION OF PUBLIC INVESTMENT IN SOUTH AFRICA

The heterogeneity of public investment needs to be

recognized because Public Investment in sectors, like public goods and services, which are not likely to be undertaken by the private sector has a positive impact on private investment (Cumbers and Birch, 2006). Whereas other types of investment spending made by the state, that are similar to those undertaken by the private sector tend to compete with each other and crowd out private investment (Serven, 1996). Aschauer (1989a) examines a comprehensive decomposition of public investment in the U.S.A. from 1949 to 1985. He finds that "core" infrastructure is one of the greatest determinants of total factor productivity and thus is significantly linked to growth.

Looney and Frederiken (1997) disaggregated public investment into: "total, energy, post-office (including telephone and telegraph), railway, local authority and rural works" and found state investment into energy to be the greatest stimulus for private capital accumulation. In a cross country study, Ahmed and Miller (1999) find that public investment in the transport and communication sectors crowd in private investment for the developing countries sub-sample though not in the case of developed countries. The most plausible explanation for

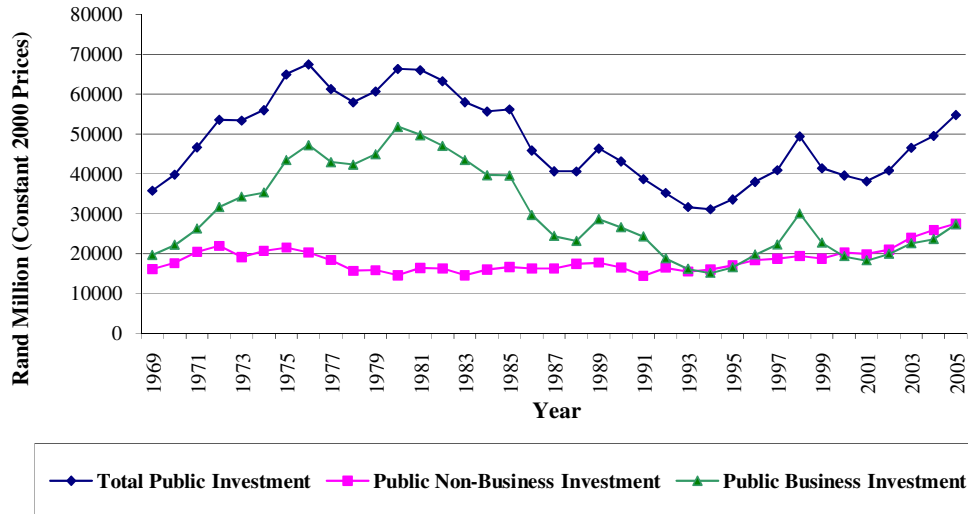


Figure 3. Public investment in South Africa. Note: Business Investment is defined as investments by public corporations and investments in economic services by the government.

this is that "...transportation and communication expenditure may stimulate private investment during the initial build-up of transport and communication infrastructure. Once the basic structure exists, however, further effects may diminish or disappear." (Ahmed and Miller 1999: 10). This is a valuable explanation that may rationalize discrepancies observed between developed and developing countries concerning the impact public investment has on private investment.

The trends in the composition of South African public investment since the 80s indicates distinctly the withdrawal of government from business investment and since the mid-90s non-business investments have exceeded business investment (Figure 3). Table 3 disaggregates public investment into its various components. The first salient observation is that construction works has consistently been the largest portion of public investment with an average share of approximately 48%. Although in the years immediately after the transition from the apartheid government the share of investment machinery in total public investment went up and overtook construction works, this pattern was soon reversed.

Even though the share of public investment in total investment has been falling since the 80s, its share in total investment in construction has been rising since the 90s (Figure 4). The same is true for investment in non-residential buildings. Public Investment in residential buildings showed a little upturn in the late 90s and early years of the new millennium inline with the new government's efforts to provide adequate housing to those living in informal settlements. The share of public investments in commercial sector investments like transport equipment and machinery and other equipment shows distinct downward trends.

The disaggregated analysis of public investment in

South Africa indicates that it is becoming increasingly of a non-competitive nature to private investment. Therefore public investment is not expected to have a crowding out effect on private investment. However the falling shares of electricity, transport etc in total capital formation in South Africa indicates a need for higher levels of public investment in these infrastructure sectors in order to promote private investment. We test this hypothesis next.

EMPIRICAL APPROACHES

The approaches taken in the empirical literature to econometrically analyse the relationship have been using production functions², cross country panel data analysis³ or time series analysis. A detailed review of these studies is found in Agénor et al. (2005). Two distinct approaches undertaken using time-series data are the structural economic model approach (Martinez-López, 2005; Erenburg, 1993) and Causality modeling. The former method is grounded in theory and relies on deducing economic implications from theory in a rational way. In comparison, the latter method is considered atheoretical and is grounded purely on its strong mathematical roots. Given the limitations of using the theoretical approach without incorporating the source of funding of government investments, we concentrate on causality modeling approach. Other advantages of this methodology are discussed at the end of this section.

Granger causality tests have been used in literature to

² Ramirez (1994) uses the modification of a neoclassical production function, which takes account of private and public capital as separate inputs. Other relevant factors are accounted for through the inclusion of the output gap, changes in real bank credit, the real exchange rate and dummy variables.

³ Ghura and Goodwin (2000), studied the determinants of private investment in a group of 31 countries in Asia, Latin America, and sub-Saharan Africa using panel regression techniques.

Table 3. Composition of South African public investment (Percentages)

Year	Residential buildings	Non-residential buildings	Construction works	Transport equipment	Machinery and Other equipment
1950	5.57	12.74	45.35	14.52	10.69
1960	7.69	16.56	55.59	12.64	13.70
1970	7.90	18.55	55.00	8.58	16.91
1980	7.87	14.44	55.69	8.20	22.57
1985	7.68	16.81	34.66	7.12	35.70
1990	3.89	14.26	56.17	4.05	27.19
1995	3.37	14.09	34.25	3.78	43.50
2000	5.91	11.99	40.89	2.13	39.08
2005	5.19	15.44	44.36	5.34	29.67
2009	5.10	16.05	64.02	0.14	10.29

Source. Estimated from <http://www.reservebank.co.za>.

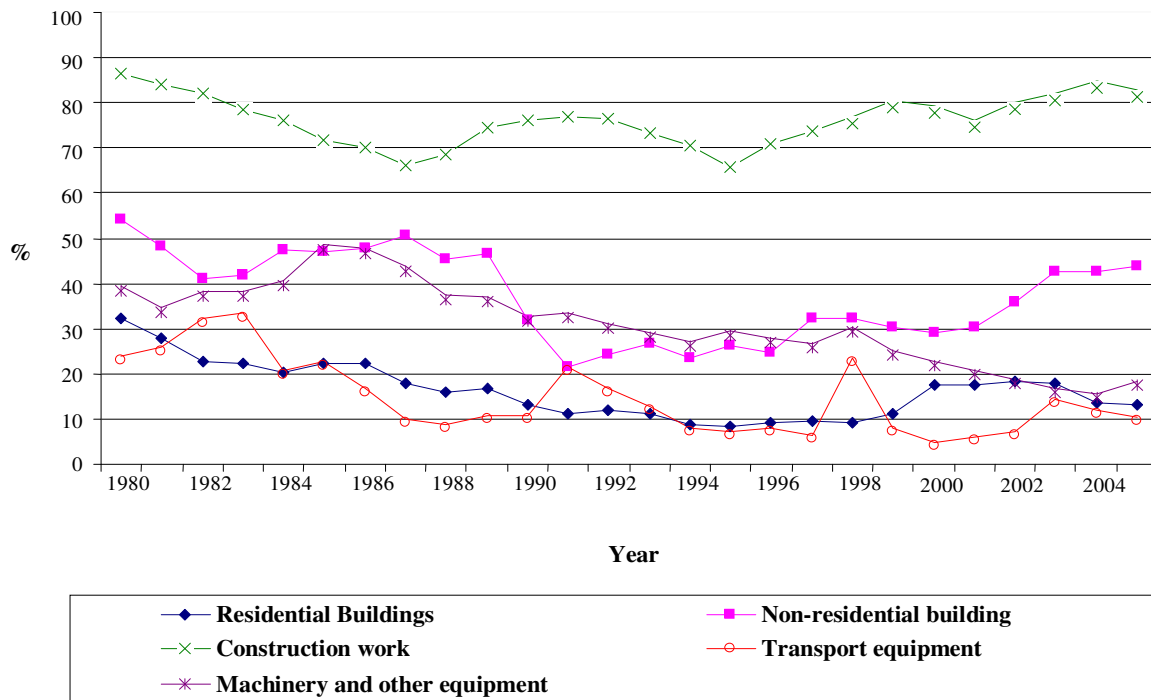


Figure 4. Share of public investment in total sector wise investment: South Africa 1980 to 2005.

test the relationship between public and private investment. Erenburg and Wohar (1995) implement Granger-causality tests, with annual U.S. data from 1954 to 1989, to determine which way the causality runs. Their results seem to suggest “feedback” effects between public and private investment, implying that these two variables share a symbiotic relationship. Atukeren (2004) used Granger-causality methodology extensively on a sample of twenty five developing countries spanning Africa, Asia and Latin America, over the period 1970 to 2000 to unearth the relationship between public and private investment. His results for South Africa indicate that

public investment crowds in private investment. By implementing a probit analysis, the author explores the characteristics of these countries that increase the probability of crowding out. He finds that “the higher the share of government involvement in an economy, the lower the trade openness, the more restrictions there are on the use of foreign currencies, and the more stable the macro and monetary environment is, the higher the likelihood that public investments may crowd out private investments” (Atukeren, 2004: 318). The vector autoregressive (VAR) approach is an extension of Granger causality methodology and allows

one to go beyond the bivariate framework⁴. The VAR approach involves performing a regression for a system of equations. The individual VAR equations contain lagged values of all variables in the system where all the variables are predetermined (that is, no exogenous variables). This method of estimation was made popular by Christopher Sims (1980) and will be considered in greater depth in the empirical section of the paper. The advantages of the VAR framework are highlighted in Voss (2002)⁵. Firstly, in the author's opinion, there has been no structural model which has been successful in fitting the data on public and private investment very well. Implementing the VAR framework, one can examine the dynamic aspects of public and private capital accumulation without having a fully-specified structural model. A cross-country comparison of the results obtained utilizing this approach becomes feasible and valid. Finally, the author notes that the endogeneity of public investment is acknowledged; as it rightfully should be in the study at hand. Given the advantages of VAR methodology, we adopt this methodology for our study.

MODEL AND METHODOLOGY

In order to understand the impact of public investment on private investment we need to incorporate the other control variables that also determine private investment. We adopt the VAR model used in Agénor et al. (2005), and discuss the economic rationale of these control variables below.

Log of real GDP provides a proxy for aggregate demand and captures effects of growth-driven private investment. The public capital variable is included to take account of the "stock" effects specifically in order to observe the effects that the current level of public capital may have on private investment. Crowding-out effects can occur through the removal of liquidity from the markets by excessive government borrowing. These effects are captured by the credit variable which provides an indication of the amount of credit the private sector has had access to in order to fund investment projects. Finally, the rate of change of the real effective exchange rate is a measure of the relative price of imported and domestic capital goods as well as a means to encapsulate indirect output effects that public investment present for private investment. The data source for all the variables is the South African Reserve Bank website. The variable definitions are presented in Appendix 1.

Prior to estimation, the stationarity of the variables were investigated. Plotting correlograms of the variables in their level form suggested the existence of unit roots. Augmented Dickey-Fuller unit root tests (see Dickey and Fuller, 1981) were run using three random walk models (RWM), namely pure RWM, RWM with drift and RWM with drift and trend, which confirmed that the series in their level form were nonstationary. All series except the real effective exchange rates turned out to be first-difference stationary. Thus exchange rates could not be included with the rest of the variables in the cointegration model. Cointegration of variables is a necessary condition before performing VAR estimation to avoid the

possibility of spurious results⁶. Various models, based on data availability, were tested for cointegration (in Appendix 2).

Although cointegration was established between all the first-difference stationary variables, strong correlation between some of them indicates the presence of multicollinearity and hence the following reduced-form VAR model was estimated for the current study:

$$\begin{pmatrix} \Delta \text{PublGDP}_t \\ \Delta \text{PvtlGDP}_t \\ \Delta \text{LNRealGDP}_t \end{pmatrix} = \begin{pmatrix} \alpha \\ \beta \\ \gamma \end{pmatrix} + \sum_{i=1}^n \begin{pmatrix} \delta_i & \eta_i & \theta_i \\ \lambda_i & \mu_i & \pi_i \\ \rho_i & \sigma_i & \omega_i \end{pmatrix} \begin{pmatrix} \Delta \text{PublGDP}_{t-i} \\ \Delta \text{PvtlGDP}_{t-i} \\ \Delta \text{LNRealGDP}_{t-i} \end{pmatrix} + \begin{pmatrix} u_{1t} \\ u_{2t} \\ u_{3t} \end{pmatrix}$$

where α, β, γ are constants

and u_{it} for $i=1,2,3$ are innovations (or stochastic error terms)

The individual error terms are assumed to be serially uncorrelated with the regressors.

MODEL ESTIMATION AND RESULTS

Stata 9.1 was used to estimate the models for quarterly data over the period 1960:Q1 to 2006:Q1. Summary statistics are presented in Table 3 in Appendix. Based on the autocorrelation and partial autocorrelation functions VAR models with two lags (half a year), four lags (one year), six lags (one and a half years) and eight lags (two years) were estimated. The Akaike's Information Criterion was used to select the model with eight lags. The longer lags are better suited to capture the dynamic effects of public investment and private investment on each other. The results of VAR are summarized in Table 4. The findings of the three models bring out interesting points. Model 1 indicates the direct impact of public investment and aggregate demand on private investment. A striking feature of this model is that none of the lagged coefficients of public investment are statistically different from zero. This implies that examining a timeframe of two years, public investment does not significantly affect private investment. Therefore neither crowding out nor crowding in was present in the South African economy over the period 1960 to 2006, according to the model estimated.

The natural logarithm difference of real GDP impacts significantly on the level of private investment. After a one year lag, real GDP has a highly significant and substantial effect on private investment. Thus aggregate demand is a potentially vital stimulant for private investment. Firms and other private sector agents respond positively to buoyant economic conditions, with firms' management engaging in expansionary activity to take advantage of perceived future increases in aggregate demand. After two years this no longer remains the case. The coefficient becomes negative and is significant at the

⁴ Refer to Lütkepohl (1993) and Hamilton (1994) for a lucid introduction to the methodology. For a less mathematically-demanding paper, Stock and Watson (2001) is a practical implementation of this approach to a macroeconomic issue.

⁵ Voss (2002) uses VAR methodology on quarterly data for the U.S.A. over 1947 to 1988 and Canada for the period 1947 to 1996.

⁶ Cointegration requires the variables to be stationary after some number of differences as well as a linear combination of these variables to produce stationary residuals.

Table 4. Results of VAR estimation.

Variable	Model 1 (Dependent variable: $\Delta\text{PrvtIGDP}$)	Model 2 (Dependent variable: $\Delta\text{LNRealGDP}$)	Model 3 (Dependent variable: $\Delta\text{PubIGDP}$)
$\Delta\text{PubIGDP}$			
Lag 1	0.0243174 (0.0641541)	-0.0015193 (0.0017463)	-0.4041122*** (0.0763283)
Lag 2	0.0377448 (0.069358)	0.0008372 (0.0018879)	-0.2916289*** (0.0825197)
Lag 3	0.0113676 (0.0709332)	0.0028466 (0.0019308)	-0.0412533 (0.0843937)
Lag 4	-0.0182183 (0.0689858)	0.001109 (0.0018778)	0.1739891** (0.0820769)
Lag 5	-0.0607554 (0.0671542)	0.0036416** (0.0018279)	-0.0791229 (0.0798977)
Lag 6	-0.0977741 (0.0656089)	0.0003522 (0.0017859)	-0.1174188 (0.0780592)
Lag 7	-0.0269045 (0.0636627)	0.0013563 (0.0017329)	-0.0446855 (0.0757436)
Lag 8	-0.0009242 (0.0584279)	0.0023526 (0.0015904)	-0.0034105 (0.0695155)
$\Delta\text{PrvtIGDP}$			
Lag 1	-0.2905495*** (0.0754476)	0.0028801 (0.0020537)	-0.062923 (0.0897648)
Lag 2	-0.1078926 (0.0779623)	0.005851*** (0.0021221)	0.0509051 (0.0927568)
Lag 3	0.0217082 (0.0774062)	0.0006525 (0.002107)	0.0938196 (0.0920952)
Lag 4	0.0650552 (0.0764255)	-0.0002343 (0.0020803)	0.0167571 (0.0909284)
Lag 5	0.1055168 (0.0752263)	-0.0048173** (0.0020476)	0.3184952*** (0.0895015)
Lag 6	-0.0670946 (0.0789896)	-0.0057296*** (0.0021501)	0.104261 (0.093979)
Lag 7	-0.0348626 (0.0797073)	-0.0071383*** (0.0021696)	-0.0073316 (0.0948329)
Lag 8	0.0396772 (0.0779171)	-0.0001477 (0.0021209)	0.0410586 (0.092703)
$\Delta\text{LNRealGDP}$			
Lag 1	1.553025 (2.741403)	-0.3493205*** (0.0746202)	4.630134 (3.261623)
Lag 2	4.12547 (2.81796)	-0.134906* (0.076704)	6.034419* (3.352708)
Lag 3	3.031924 (2.784159)	0.0320146 (0.075784)	3.644734 (3.312493)
Lag 4	13.82394*** (2.766752)	0.522604*** (0.0753102)	4.659488 (3.291783)
Lag 5	2.599544 (3.015422)	0.1131227 (0.0820789)	5.500839 (3.587642)
Lag 6	1.548654 (3.009958)	-0.1005593 (0.0819301)	6.107043* (3.58114)
Lag 7	-0.1550169 (2.968756)	-0.1504803* (0.0808087)	4.44254 (3.53212)
Lag 8	-5.968548** (2.775225)	0.1841271** (0.0755408)	-3.128753 (3.301864)
Parameters	25	25	25
RMSE	0.599248	0.016311	0.712964
R2	0.2756	0.7961	0.5409
P > Chi2	0.0000	0.0000	0.0000

five per cent level. The model is capturing the cyclicity of aggregate demand on private investment. With an initial overall increase in private investment driven by aggregate demand, the interest rate mechanism comes into play. Interest rates increase in response to the increased demand for funds and consequently quell the exuberant investment decisions of the private sector. Model 2 however provides indications that although public investment may not have a direct impact on private investment, the former is seen to contribute to increased aggregate demand which in turn provides stimulus to private investment. Therefore public investment is seen

to indirectly affect private investment positively through the accelerator affect.

Turning the attention to Model 3, lag five of the private investment variable is positive and highly significant. This finding suggests that the movements of public investment follow the movements of private investment after just over a year. The private sector appears to be the lead agency in terms of its investment contribution in South Africa. It is in keeping with the economic policy followed by the country over the years. Unlike other developing countries such as India, Argentina, Brazil and others, that implemented socialist policies with the public sector

taking the role of lead agency in the economy.

The joint significance of estimated coefficients in Model 3 is significantly different from zero (p-value approximately zero). The same is true for Models 1 and 2. All sample regression lines fit the data reasonably well except for Model 1, where only 27.56 per cent of the total variation in the first differences of private investment to GDP is explained by the regression model. Understandably this would be the case as there are numerous determinants of private investment beyond those tested in this study. Implementing a Lagrange-Multiplier test for autocorrelation in the residuals, one was not able to reject the null hypothesis of no autocorrelation at lags four, five, six and eight. Therefore the assumption made concerning the error terms of the estimated models is valid. According to the Jarque-Bera normality statistic, one cannot reject the null hypothesis of normally distributed disturbance terms.

The results of analysis indicate that although public investment does not directly granger-cause private investment, the former does have an indirect impact on private investment through the GDP accelerator effect.

Conclusion

This study set out to determine the association between public and private capital accumulation in the context of South Africa given the low and declining levels of its investment-GDP ratio. The falling investment-GDP ratio has coincided with the falling share of public investment in total investment in the country. Public investment as a percentage of total investment has been declining from 1980 touching a low of 28% in 2005. An analysis of the composition of public investments revealed that the business investment of the government has declined substantially in recent years. The reduction in the share of public investment has been mainly in sectors like machinery and transport equipment. Its share in construction, residential and non-residential buildings have either increased or remained stable since the mid 90s. Therefore it is indicative that public investment is becoming of non-competing nature to the private sector and the emerging hypothesis is that public investment has a crowding-in effect on private investment. The paper tested this using reduced-form vector autoregressive (VAR) approach with quarterly data from 1960 to 2006. Private investment was found to be positively determined by its past levels as well as the real GDP levels. Although public investment was not seen to have a significant direct impact on private investment, it has a positive and significant impact on real GDP. This indicates that although public investment has been too low to make a direct impact on private investment, it has benefited private investment by boosting overall aggregate demand for the goods and services produced by the private sector.

Thus the accelerator effect seems to feature quite

prominently in the South African economy with aggregate demand providing important stimulus to private capital accumulation. A concerted effort is required to raise the levels of public investment in non-business sectors, which is expected to have an accelerator effect on raising private investment and raising the investment-GDP ratio of the country. Public policy should thus be aimed at stimulating private investment through the provision of necessary infrastructure as well as ensuring a stable and healthy socio-economic environment. A proactive fiscal policy agenda is therefore necessary to stimulate investment in the country.

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Appendix 1. Variable definitions.

Name	Description
<i>PubIGDP</i>	Public investment, comprising investment by the general government and public corporations, as a percentage of GDP.
<i>PrvtIGDP</i>	Private investment made by private business enterprises as a percentage of GDP.
<i>LNRealGDP</i>	The (natural) logarithm of real GDP.
<i>PubKGDP</i>	Public capital stock of both the general government and public corporations, as a percentage of GDP.
<i>CreditGDP</i>	Total credit made available by all monetary institutions as a percentage of GDP.
<i>RCRealEER</i>	The rate of change of the real effective exchange rate. Essentially a measure of the exchange rate of the rand, taking account of the various countries' inflation rates.

Appendix 2. Stationarity and cointegration results.

Variable	ADF value	Critical value
Stationarity		
Level form		
PubIGDP	-2.652	-4.012
PrvtIGDP	-3.331	-4.012
LNRealGDP	-3.149	-4.012
PubKGDP	1.301	-4.130
CreditGDP	2.952	-4.242
RCRealEER	-7.737*	-4.124
First-Differences		
PubIGDP	-16.629*	-4.012
PrvtIGDP	-17.246*	-4.012
LNRealGDP	-18.054*	-4.012
PubKGDP	-4.722*	-4.132
CreditGDP	-5.224*	-4.251
Cointegration #		
Model 1 (Annual 1965 - 2005) (PubIGDP; PrvtIGDP; PubKGDP; CreditGDP; LNRealGDP)		
Residuals	-5.404*	-4.251
Model 2 (Quarterly 1960Q1 - 2006Q1) (PubIGDP; PrvtIGDP; LNRealGDP)		
Residuals	-16.602*	-4.012
Model 3 (Annual 1946 - 2005) (PubIGDP; PrvtIGDP; PubKGDP; LNRealGDP)		
Residuals	-7.196*	-4.132

Augmented Dickey-Fuller critical values are for a Random Walk Model with both drift and trend. * indicates that the ADF value is greater than the respective critical value at the 1% level, in absolute terms. # All the three models were found to be cointegrated, however models 1 and 3 faced the problem of multicollinearity and hence Model 2 was selected for estimation.

Appendix 3. Summary statistics: Regression variables of presented VAR models.

Variable	Mean	Std. Dev.	Min.	Max.
<i>PubIGDP</i>	8.706272	3.506835	3.66986	16.82501
<i>PrvtIGDP</i>	12.21815	1.4301	9.596691	15.94641
<i>LNRealGDP</i>	11.95508	0.3646956	11.09808	12.56176