LONG-RUN EXOGENEITY BETWEEN SAVING AND INVESTMENT:
EVIDENCE FROM SOUTH AFRICA

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Abstract

This paper investigates South Africa's saving-investment behaviour between 1962 and 2001. The results show that due to the unlimited nature of net capital inflows (foreign debt) from 1962 to 1976, saving and investment were not bound by a long-run solvency constraint and thus unrelated in the long run. By contrast, the limit placed on foreign debt and the low level of net capital inflows from 1977-2001 forced saving and investment to move closely together. Further investigation within a structural cointegrating VAR approach reveals that private saving is strongly exogenous to private investment from 1977-2001. The main policy implication is that prior saving matters for investment. However, the interpretation of this result departs from a neo-classical view in which an economy is 'supply constrained'. Rather, the result shows that investment spending in South Africa is balance-of-payments constrained. Policy measures should focus on lifting the ceiling that the balance-of-payments places on the expansion of demand to which supply can adapt.

Introduction

The relationship between saving and investment remains one of the most debated and controversial issues in macroeconomics. Economists of a neo-classical persuasion as well as more recent endogenous growth theorists (Romer 1986) argue that it is prior saving that matters for investment and output growth. The policy prescriptions are clear-cut: fiscal policy can actively promote high levels of national saving through cuts in government spending and/or tax cuts, while monetary policy should maintain high and positive real interest rates to encourage saving through the financial sector, which can then be used to finance investment spending in an efficient way (Fry 1997). The neo-classical school is unequivocal in its view that saving is exogenous to investment.

Economists of a Keynesian or Post-Keynesian view present a fundamental departure from the neo-classical saving-investment paradigm (Davidson 1986). The argument is advanced that investment is exogenous to saving, not the other way around, and that cuts in government spending and high real interest rates suppress investment and growth. The policy prescriptions of Keynesians focus on the incentives to invest and how government policies can create a favourable environment for sustained increases in private investment expenditure. A recurrent policy prescription in Keynesian writings is the emphasis on the complementary relationship between public investment and private investment (the so called "crowding-in" effect), and how real interest rates impact positively on private investment by lowering the cost of capital.

Whether there is a long-run relation between saving and investment and whether it is saving that is exogenous to investment, or the other way around, have major implications for the conduct and efficiency of macroeconomic policy. The way in which macroeconomic policy is conducted ultimately depends on the belief of the policy maker about the direction of exogeneity between saving and investment.

In recent years, the saving-investment debate has intensified in South Africa. The switch from the Reconstruction and Development Programme (RDP) to the Growth, Employment and Redistribution (GEAR) policy document in 1996 seems to reflect changing views on the direction of exogeneity between saving and investment. In some quarters, the GEAR policy document has been described as reflecting an orthodox macroeconomic programme of tight monetary and fiscal policy (Gibson and van Seventer 2000; Weeks 1999). Based on this view, the conduct of macroeconomic policy stipulated in GEAR appears to embrace one of the fundamental views of the neo-classical school, which stresses that it is prior saving that matters for investment and not the other way around. The underlying assumption of the orthodox, neo-classical model used by the World Bank in policy discussions on South Africa, is that the economy operates at full capacity, which implies that saving determines investment (see Gibson and van Seventer 2000). In the end, little can be done on the demand side to improve the growth performance of the economy.

An important precondition for demand side policies to expand productive capacity on a sustainable basis is that there exists spare capacity (unemployed resources). This paper stresses a second important precondition. The success of expansionary demand side policies will not only depend on whether an economy has unemployed resources, but also on the

extent to which domestic spending is reflected on the current account of the balance-of-payments. Even with vast unemployed resources, the balance-of-payments may set a direct limit on the expansion of demand to which supply can adapt (Thirlwall 1979). In economies with high import propensities, plans to invest in excess of plans to save will place pressure on the current account. If the current account deficit cannot be financed through capital inflows and if the real exchange rate is not an efficient balance-of-payments adjustment mechanism, investment is forced to adjust to the level of domestic saving. The essence of the balance-of-payments constraint model is that an economy is demand-constrained, not supply constrained, and that policy measures should focus on lifting the ceiling that the balance-of-payments places on the expansion of domestic demand to which supply can adapt.

Against this background, the paper proposes the long-run solvency constraint model (Coakley *et al.* 1996) as a plausible explanation for South Africa's long-run saving-investment behaviour from 1962 to 2001. The essence of the long-run solvency constraint model is that current account deficits cannot be sustained through an indefinite inflow of capital, because international market lenders tend to penalise insolvent country borrowers by adding a larger risk premium to their interest. In the long run, countries are forced to maintain current account equilibrium, which implies that total saving equals total investment. Within the theoretical framework of the long-run solvency constraint model, the analysis draws on balance-of-payments theory of current account determination (Thirlwall 1974; Thirlwall 1999) to identify several theoretical conditions that may dictate the direction of exogeneity between saving and investment in an open economy like South Africa.

The empirical results show that South Africa's saving-investment behaviour from 1962 to 2001 is characterised by two different sub-periods. Further investigation shows that private saving is strongly exogenous to private investment between 1977 and 2001. The interpretation of this result departs from a neo-classical view in which an economy is 'supply constrained'. Rather, the result shows that investment spending in South Africa is balance-of-payments constrained: the balance-of-payments places a severe limit on the expansion of demand to which supply can adapt.

The rest of the paper is organised as follows. Section 2 outlines the long-run solvency constraint model and balance-of-payments theory. Section 3 discusses and explains the empirical methodology. Section 4 presents a descriptive analysis of the data and motivates why the long-run solvency constraint model is relevant in South Africa during 1962-2001. Section 5 reports the results of the cointegration and exogeneity tests. Section 6 derives the parsimonious vector error-correction model (VECM) and discusses its policy implications and usefulness for policy simulation experiments. The final section concludes with policy implications.

The Long-run Saving-Investment Relation in an Open Economy

This section consists of three parts. The first part presents the long-run solvency constraint model proposed by Coakley *et al.* (1996) as an explanation of why saving and investment are related in the long run, even when capital is perfectly mobile. The second part extends the model by decomposing the total saving-investment relation into its different sub-components. This decomposition may provide additional information when private investment responds to fiscal policy. Within the theoretical framework of the long-run solvency constraint model, the final part draws on balance-of-payments theory of current account determination to identify

several propositions that may help to predict the direction of exogeneity between saving and investment.

(a) The long-run solvency constraint model

In a controversial paper, Feldstein and Horioka (1980) estimated cross-section regressions of the following form:

$$(ti/y)_{jt} = a + b(ts/y)_{jt} + u_{jt}, \tag{1}$$

where $j = 1,\ldots, Z$ is a country index, ti is gross domestic investment, ts is gross domestic saving and y is national income (GDP). Feldstein and Horioka (hereafter FH) interpret the value of b as an indicator of international capital mobility. In other words, a value of $b = 0$ would indicate perfect capital mobility, based on the assumption that investment depends on world interest rates and technology and not on the domestic saving behaviour. In their cross-section study for 16 OECD countries over the period 1960-1974, FH report values for b that were not significantly different from unity, so the hypothesis of zero capital mobility could not be rejected.

Numerous authors have since challenged the FH interpretation as it contrasts with the widely held perception that capital is highly mobile across countries (Jansen and Schultz 1996). The subsequent empirical evidence conducted internationally, however, overwhelmingly confirms the FH finding of high saving-investment correlations across countries. This empirical regularity, according to Jansen (1996), belongs to the stylised facts that open economy macroeconomic theory needs to explain.[1] Several theoretical models have since been advanced to explain why high saving-investment correlations can co-exist with perfect capital mobility. Among these are the consumption smoothing literature on international capital mobility (Ghosh 1995; Hussein and de Mello 1999; Jansen and Schultz 1996) and the long-run solvency constraint model (Coakley *et al.* 1996 and Coakley *et al.* 1999).

To derive the long-run solvency constraint model, first express the total saving-investment relation in terms of the national accounting identity, $ca = ts - ti$, where ca is the current account of the balance of payments. Next, consider the following saving and investment equations for economy j at time t:

$$ts_{jt} = a_{ts} + ts_{j,t-1} + b_{ts}R_t + e_{ts,jt} \tag{2}$$

$$\text{and} \quad ti_{jt} = a_{ti} + ti_{j,t-1} - b_{ti}R_t + f(ts_{j,t-1} - ti_{j,t-1}) + e_{ti,jt}, \tag{3}$$

where: $á_{ts}$ and $á_{ti}$ are intercept terms; R_t is the world interest rate; $(ts_{j,t-1} - ti_{j,t-1})$ is the error correction term; and $å_{s,jt}$ and $å_{i,jt}$ are unobserved error terms. The inclusion of the error correction term in equation (3) provides a long-run link between saving and investment; with the error correction coefficient f showing how fast investment adjusts towards its long-run equilibrium value in reaction to changes in saving. Equation (2) indicates that saving can be invested at the world interest rate R_t (which equates world saving and world investment), while investment in equation (3) is financed by borrowing at the world interest rate plus a

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[1] Jansen (1996) provides a survey of the empirical literature. More recent studies include Coakley and Kulasi (1997) and Schmidt (2001) .

market-determined risk premium that reflects default risk. The error correction term in equation (3) links the risk premium to the current account deficit, which imposes a long-run solvency constraint and forces countries to maintain current account equilibrium in the long run. The model emphasises the supply side insofar as international market lenders tend to penalise insolvent country borrowers by adding a larger risk premium to their interest rate (Coakley *et al*. 1999: 634). Without the risk premium (i.e. $f = 0$), saving and investment follow simple random walks, the current account of the balance-of-payments would be non-stationary and foreign debt would be unlimited.

Assume *Z* identical small open economies and sum over countries in equations (2) and (3). Equating world investment and world saving and noting that the risk premium drops out since world payments balance, solving for the world interest rate yields:

$$R_t = (\boldsymbol{b}_{ti} + \boldsymbol{b}_{ts})^{-1} \left[\boldsymbol{a}_{ti} - \boldsymbol{a}_{ts} + \sum_j (\boldsymbol{e}_{ti,jt} - \boldsymbol{e}_{ts,jt}) \Big/ Z \right] = R + u_t, \tag{4}$$

where u_t is a white noise process. The balance-of-payments for economy *j* at time *t* is given by subtracting equation (3) from (2) and substituting for R_t:

$$ts_{j,t} - ti_{j,t} = ca_{j,t} = (1 - f)ca_{j,t-1} + (\boldsymbol{b}_{ts} + \boldsymbol{b}_{ti})u_t + (\boldsymbol{e}_{ts,jt} - \boldsymbol{e}_{i,jt}). \tag{5}$$

Equation (5) is stationary as long as $-1 < 1 - f < 1$. The risk premium included in equation (3) ensures that national debt cannot explode, which shows up as a stationary current account in equation (5). A stationary current account implies that saving and investment cointegrate with a long-run unit coefficient ($ts_{j,t} = ti_{j,t}$). The long-run solvency constraint model provides a theoretical explanation as to why high saving-investment correlations may co-exist with a high degree of capital mobility.

In summary, the long-run solvency constraint model predicts that current account deficits cannot be sustained through an indefinite inflow of capital. A continually positive rate of growth of capital inflows implies an ever-growing debt burden, which is not sustainable in the long run, because market lenders penalise insolvent countries by adding a larger risk premium to their interest rate. In the long run the current account is zero, which implies that total saving equals total investment.

(b) An extension of the long-run solvency constraint model

The long-run solvency constraint model advanced by Coakley *et al*. (1996) only considers the saving-investment relation in totals. Such a specification may ignore valuable information when fiscal policy has an exogenous impact on private investment. By decomposing the total saving-investment relation into its different sub-components, it is possible to arrive at an improved specification, which remains consistent with the theoretical prediction that total saving equals total investment in the long run.

Consider the following decomposition of the total saving-investment relation:

$$(gs + ps) - (gi + pi) = ca = 0, \tag{6}$$

where *gs* is government saving, *ps* is private saving, *gi* is government investment and *pi* is private investment.

The crowding-out hypothesis can be tested by rewriting equation (6) in terms of private investment:

$$pi = \delta(gs - gi) + \boldsymbol{q} ps \qquad (7)$$

The specification of equation (7) is consistent with the crowding-out hypothesis, which states that dissaving by the government crowds out private investment. Equation (7) shows that dissaving by the government {a decrease in $(gs - gi)$} leads to a fall in *pi*.

As long as $\boldsymbol{d} = \boldsymbol{q} = 1$ in equation (7), the theoretical predictions of the long-run solvency constraint model in equation (6) remain intact: the current account of the balance-of-payments remains zero in the long run. Alternatively, in the spirit of the Ricardian equivalence theorem, if private investment remains invariant to fiscal policy in equation (7) so that $\boldsymbol{d} = 0$, then private saving and private investment must cointegrate with a long-run unit coefficient ($\boldsymbol{q} = 1$) to preserve the theoretical predictions of the long-run solvency constraint model. In other words, for a given level of $(gs - gi)$, the relation between private saving and private investment must be proportionate to ensure that total saving equals total investment in the long run.

(c) Exogeneity between saving and investment in an open economy

The saving-investment exogeneity issue is not explicitly developed in the Coakley *et al*. (1996) model. The main purpose of the long-run solvency constraint model is to provide a theoretical explanation why saving and investment cointegrate with a long-run unit coefficient. However, it is implicit in the model that saving is exogenous to investment. This is evident in equation (3), which shows that investment adjusts to saving through the error correction coefficient $\boldsymbol{f}$. The omission of an error correction mechanism in the saving equation (2) implies that saving does not adjust to changes in investment. The exogenous nature of saving, however, may not necessarily hold when foreign loans expand the productive capacity of an economy by permitting more investment. Within the theoretical framework of the long-run solvency constraint model, this section draws on balance-of-payments theory (Thirlwall 1974; Thirlwall 1979) to identify several conditions that may dictate the direction of exogeneity between saving and investment in an open economy.

The relation between saving and investment and the current account of the balance-of-payments can easily be seen by using the national income identity, which states that the investment-saving gap is equivalent to the import-export gap. In other words, a country can only investment more than it saves if it can import more than it exports. Whether a country can import more than it exports, in turn, depends on whether it can finance the current account deficit through net capital inflows.

In theory, the extent to which planned investment in excess of planned saving will show up as a deficit on the current account of the balance-of-payments depends on the trade structure of the economy under analysis. In the context of developing countries, which typically have very open economies, imports are often price inelastic and income elastic in demand, which reflect the crucial role of imported capital and intermediate goods in the production process (Van Wijnbergen 1983; Taylor 1983).

High levels of structural unemployment and supply bottlenecks caused by immobile factors of production are often prominent features in developing economies (Johnson 1984). An expansionary demand side policy (monetary or fiscal) may be just what is needed to bring some of the structurally unemployed into the labour force. However, given the high propensity to import capital and intermediate goods, the investment-saving gap caused by the demand stimulus will show up as a deficit on the current account of the balance-of-payments. The government has several ways to finance the resulting current account deficit (or import-export gap) brought about by the demand stimulus (Thirlwall 1974; Thirlwall 1999). It can: run down foreign exchange reserves; attract private capital from abroad; borrow from the international money market; or seek aid from international agencies. Provided that the government can finance the deficit through any of these means, the supply-side of the economy (saving or export) has enough time to respond to the demand stimulus. The role of external finance is of particular importance during the initial stages, because it is likely that a considerable time period may elapse before structural unemployment (supply bottlenecks) responds positively to the demand stimulus.

If the balance-of-payments deficit cannot be financed through capital inflows, then domestic expenditure (investment) will have to be realigned with domestic income (saving), or the government can switch expenditure to domestically produced goods. All these measures of correcting the deficit, however, will defeat the purpose of the demand stimulus. Alternatively, an exchange rate depreciation can improve the balance-of-payments position only if it increases domestic output more than it increases domestic expenditure, in other words, if domestic saving (export) is raised. This, in turn, will depend on the price elasticity of the demand for exports and imports. If exports and imports are price inelastic in demand, then the brunt of the balance-of-payments adjustment falls on domestic expenditure (investment).

The foregoing discussion provides useful theoretical guidelines to grasp a better understanding of the mechanisms that determine the direction of exogeneity between saving and investment in an open economy. Consider the following scenarios, where in each case it is assumed that there are unemployed resources, thus satisfying one of the preconditions necessary for expansionary demand side policies to increase productive capacity on a permanent basis:

i)   The long-run relation between saving and investment breaks down when capital inflows are indefinite. The main implication is that one variable cannot be exogenous to another with respect to the long run.

ii)   Provided that the economy has structural unemployment (spare capacity), investment is likely to exert an exogenous impact on saving if the initial investment-saving (import-export) gap brought about by the demand stimulus can be financed by capital inflows in a given period. The supply side of the economy (structurally unemployed) has enough time to respond to the demand stimulus.

iii)   On the other hand, saving is likely to be exogenous to investment if the balance-of-payments constraint is severe. Expansionary demand side policies in the face of a debt crisis or even during periods of mild capital inflows are likely to be self-defeating. The lack of external finance means that the investment-saving (import-export) gap cannot be sustained for a long enough period to induce a supply response from the economy. Without external finance, investment adjusts to the level of domestic saving, because the

balance-of-payments sets a limit on the expansion of demand to which supply can adapt.

iv)   Alternatively, without external finance, investment will be exogenous to saving if relative price changes (real exchange rate) act as an efficient balance-of-payments adjustment mechanism. The success of exchange rate depreciation in raising productive capacity depends on the price elasticities of the demand for imports and exports.

Empirical Methodology

The empirical methodology consists of three interrelated parts. In Section 4 we provide a thorough descriptive analysis of South Africa's saving-investment behaviour. Such an exercise provides valuable insights on the relevance of the long-run solvency constraint model in a South African context. The empirical analysis then proceeds with cointegration tests based on the unit root procedure and the structural cointegrating vector autoregressive (VAR) approach advanced by Pesaran *et al*. (2000). The remainder of this section provides a more detailed explanation of the empirical methodology that underlies the cointegration analysis.

(a) Cointegration analysis based on unit root tests

It is useful to recall that the long-run solvency constraint model predicts that total saving and total investment cointegrate with a long-run unit coefficient ($ts/y = ti/y$). The non-rejection of the long-run solvency constraint model has as its null hypothesis: $ts/y - ti/y = ca/y = 0$. The cointegration analysis based on unit root tests proceeds as follows. First, a necessary condition for ts/y and ti/y to cointegrate with a unit coefficient is that each individual series contains a unit root. Second, once this has been verified, the second step tests whether a linear combination of the two non-stationary series ($ts/y - ti/y$) is stationary. If the linear combination is stationary, we can conclude that total saving and total investment cointegrate with a long-run unit coefficient. Since $ts/y - ti/y = ca/y$ in a national accounting sense, we can arrive at exactly the same conclusion by skipping the first step and testing directly whether ca/y is stationary (see Coakley *et al.* 1999).

(b) The structural cointegrating VAR approach

The advantages of the structural cointegrating VAR approach have been well documented in Garrat *et al.* (2000) and Pesaran *et al.* (2000). In the context of this paper, the structural cointegrating VAR approach provides a flexible method of testing the underlying hypothesis in equations (8), which states that government policy is exogenous to private investment in the long run (see Pesaran *et al*. 2000). Furthermore, within the framework of the structural cointegrating VAR, it is possible to conduct exogeneity tests such as those proposed by Johansen and Juselius (1992), which exclusively focus on exogeneity with respect to the long-run parameters. For a more technical discussion of the structural cointegrating VAR approach and the associated exogeneity tests, readers can consult Appendix A. The discussion that follows provides a more 'reader friendly' explanation of the causality methods that will be adopted in the empirical section of the paper. The causality tests are analogous to those in Appendix A, but can be simplified by referring to Engle and Granger's (1987) two-step procedure.

Consistent with the theoretical framework of the long-run solvency constraint model, suppose that total saving and total investment cointegrate with a long-run unit coefficient in equation (1). From Engle and Granger's (1987) two-step analysis, we know that when two variables cointegrate the relation can be represented as an error correction model:

$$\Delta(ti/y)_{jt} = \sum_{i=1}^{m} \textbf{\textit{l}}_{1i}\Delta(ti/y)_{j,t-i} + \sum_{i=1}^{m} \textbf{\textit{l}}_{2i}\Delta(ts/y)_{j,t-i} - \textbf{\textit{l}}_{3}ecm_{j,t-1} + \textbf{\textit{x}}_{ti,jt}, \qquad (8)$$

where *ecm* is the error correction term obtained from equation (1) and defined as $ecm = (ti/y)_{jt} - \textbf{\textit{a}} - (ts/y)_{jt}$. The variables in differences (Ä) represent the short-run part of the model and the coefficient of the error correction term $\textbf{\textit{l}}_3$ shows how fast (*ti/y*) adjusts towards its long-run equilibrium value in reaction to changes in (*ts/y*). Equation (8) can also be written in terms of total saving:

$$\Delta(ts/y)_{jt} = \sum_{i=1}^{m} \textbf{\textit{l}}_{4i}\Delta(ts/y)_{j,t-i} + \sum_{i=1}^{m} \textbf{\textit{l}}_{5i}\Delta(ti/y)_{j,t-i} + \textbf{\textit{l}}_{6}ecm_{j,t-1} + \textbf{\textit{x}}_{ts,jt}. \qquad (9)$$

Standard Granger causality tests can be performed by using the error correction models in equations (8) and (9). A variable z_t is said to Granger cause another variable y_t if *present* values of y_t can be predicted with better accuracy by using *past* values of z_t (Charemza and Deadman, 1997). Total saving would Granger cause total investment in equation (8), for example, when the null hypothesis H_0: $\textbf{\textit{l}}_{2i} = 0$ can be rejected, based on a standard F-test.

The standard Granger causality procedure described above is a test for *short-run* or *temporal causality*. Furthermore, Granger causality does not imply a cause-effect (exogeneity), but rather 'predictability'. An important issue for policy makers is to distinguish between policy innovations that only have temporary effects, as opposed to those that have permanent effects. Hall and Milne (1994) show that weak exogeneity in a cointegrated system is analogous to long-run or permanent causality. A variable *y* is said to be weakly exogenous for a set of parameters (ë), if inference on ë conditional on *y* involves no loss of information (Engle *et al.*, 1983; Charemza and Deadman, 1997).

Following Johansen and Juselius (1992), tests for weak exogeneity in a cointegrated system exclusively focus on the error correction coefficients in equations (8) and (9). For example, total saving would be weakly exogenous to total investment, when the error correction coefficient is significantly different from zero in equation (8) {$\textbf{\textit{l}}_3 \neq 0$}, but insignificantly different from zero in equation (9) {$\textbf{\textit{l}}_3 = 0$}. In other words, total investment adjusts towards its long-run equilibrium value in reaction to changes in total saving, but not the other way around.

Based on the definitions developed by Engle *et al.* (1983), two additional concepts of exogeneity can be identified. Strong exogeneity is the relevant concept for forecasting. A variable z_t is said to be strongly exogenous to another one y_t, if it is weakly exogenous for the parameters of interest and if past values of y_t do not Granger-cause z_t. In the context of our present example, once it has been established that *ts/y* is weakly exogenous, it can also be regarded as *strongly exogenous* when the null hypothesis of H_0: $\textbf{\textit{l}}_{5i} = 0$ in equation (9) cannot be rejected, based on a standard F-test.

Super exogeneity is the relevant concept for policy simulation experiments and closely related to the Lucas critique (Charemza and Deadman 1997). Lucas (1976) questioned the usefulness of structural econometric models for policy simulation experiments by arguing that the structure of a model can be altered through the formation of different expectations, because expectations are sensitive to different policy measures or innovations. Thus, even if a model is stable and performs remarkably well within a specific sample, policy innovations induce changes in expectations often unanticipated by the policy maker, which subject the model to structural change and makes it inherently unstable. A variable can be regarded as super exogenous for the parameters of interest when it is weakly exogenous for the parameters of interest, and if the conditional model used for policy simulations is structurally invariant to changes in expectations (Charemza and Deadman 1997).

In summary, tests for exogeneity are conducted within a cointegrated system, which provides information on the permanent long-run effect of one variable on another. Furthermore, a distinction between the different degrees of exogeneity based on the definitions developed by Engle *et al*. (1983) will help to access the relative effectiveness of saving and/or investment policies.

Descriptive Analysis

The data are annual and cover the period 1960-2001. Due to the use of lagged and differenced variables, the sample period is reduced to 1962-2001. Appendix B provides a full description of all the variables and the data source.

Figure 1(a) plots total gross domestic investment as a ratio of GDP (*ti/y*) and total gross domestic saving as a ratio of GDP (*ts/y*) during 1962-2001.

Figure 1(a)-(e)
Saving, Investment, Current Account and Foreign Debt: 1962-2001
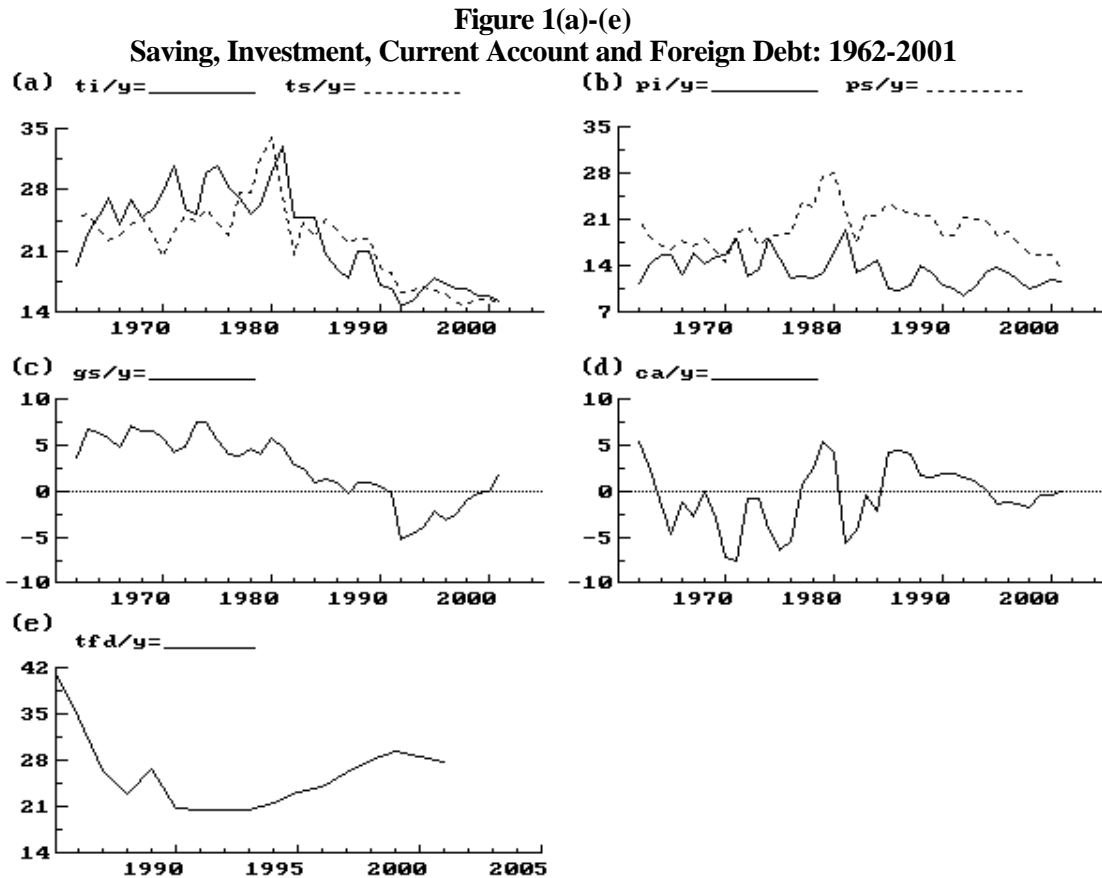
From the figure it is apparent that both ratios display structural breaks in the late 1970s. Figure 1(b) plots the gross domestic private investment ratio (pi/y) and gross domestic private saving ratio (ps/y). Although both series show evidence of structural breaks, their downward trends since the late 1970s are less precipitous compared to the total ratios in Figure 1(a). The gross government saving ratio (gs/y) in Figure 1(c) exhibits a sharp decreasing trend since the late 1970s and remains negative during most of the 1990s.

Figure 1(d) shows that South Africa sustained a deficit on the current account of the balance-of-payments (ca/y) during the 1960s and 1970s. From the theoretical framework of the long-run solvency constraint model, we know that current account deficits financed through an indefinite inflow of capital implies an ever-growing debt burden. Unofficial data published by Fallon and De Silva (1994) show that South Africa's total foreign debt to GDP ratio (fd/y) increased rapidly from around 16% in 1965 to about 40% in 1976/1977. Since then the total foreign debt ratio declined to around 20% in 1980 but thereafter reached another peak in 1985. South Africa's balance-of-payments and foreign debt position changed dramatically in 1985 when Western nations imposed a debt moratorium that forced the immediate repayment of foreign debt. From the official data that are available since 1985 in Figure 1(e), it can be seen that the total foreign debt to GDP ratio decreased from almost 42% in 1985 to a steadier rate that varies between 20% and 30% during 1986-2001.

The data analysis in Figures 1(a)-(e) provides ample evidence that all the series exhibit different features between the sub-periods 1962-1976 and 1977-2001. Table 1 reports the

correlation coefficients between saving and investment and the average current account ratios during the two sub-periods.

Table 1
Correlation Coefficients Between Investment and Saving and Average Current Account

Correlations	1962-1976	1977-2001
ti/y - ts/y	-0.17	0.87
pi/y - ps/y	-0.44	0.35
pi/y - ps/y$_{t-1}$	-0.55	0.60
Average	1962-1976	1977-2001
ca/y	-2.56	0.57

The correlation coefficient is negative and very low for the *ti/y -ts/y* relation in 1962-1976. Structural change is reflected in the positive and high correlation coefficient in 1977-2001. Although the *ps/y -pi/y* relation contains the correct theoretical sign in 1977-2001, the contemporaneous correlation coefficient is fairly low. However, the correlation coefficient between *pi/y* and $(ps/y)_{t-1}$ is much higher at 0.60. Finally, the average current account ratio changed from a large deficit of 2.56% in 1962-1976 to almost zero in 1977-2001.

To summarise, the descriptive evidence suggest that South Africa's saving-investment (or current account) behaviour is characterised by two different sub-periods during 1962-2001. This finding is important for two reasons. First, structural breaks inadvertently affect the power of cointegration and unit root tests (Maddala and Kim 1998). To generate unbiased results, the cointegration analysis in this paper will be based on a split-sample methodology. Second, the theoretical framework of the long-run solvency constraint model provides plausible reasons why South Africa's saving-investment behaviour displays different features during 1962-1976 and 1977-2001. It would appear that the unlimited nature of foreign debt during 1962-1976 allowed large and persistent current account deficits, which explain the low correlation coefficient between saving and investment during this period. In contrast, the limit placed on foreign debt in 1977-2001 forced South Africa to maintain current account equilibrium (or a close saving-investment relation).

Empirical Results

(a) Cointegration analysis based on unit root tests

Recall from equation (5) and the methodology discussed in Section 3 that empirical support for the long-run solvency constraint model implies that the current account of the balance-of-payments (*ca/y*) is a stationary variable. The Augmented Dickey-Fuller (ADF) unit root test provides a simple method of testing this proposition (Coakley *et al.* 1999).

Table 2 reports ADF unit root tests for the sub-periods 1962-1976 and 1977-2001 identified in the previous section.

Table 2
ADF Unit Root Tests: 1962-1976 and 1977-2001

	1962-1976
ti/y	-1.81
ts/y	-3.85**
pi/y	-3.53**
ps/y	-3.73**
gs/y	-4.57**
ca/y	-2.52

	1977-2001
ti/y	-1.37
*D*ti/y	-4.71**
ts/y	-0.98
*D*ts/y	-4.23**
pi/y	-2.91
*D*pi/y	-5.28**
ps/y	-1.33
*D*ps/y	-3.89**
gs/y	-1.44
*D*gs/y	-3.40**
ca/y	-4.09**

<u>Notes</u>:

1. The 95% critical value for the ADF test is –3.08 during 1962-1976 and –2.98 during 1977-2001 (Dickey and Fuller, 1979). ** denotes significance at the 5% level.
2. The ADF tests are of order one and contain intercepts and no trends.
3. In most cases the Akaike Information, Schwartz Bayesian and Hannan-Quinn model selection criteria chose the ADF test instead of the Dickey-Fuller (DF) test. The final results of the unit root tests, however, do not depend on whether we use the ADF- or DF-tests.

With the exception of *ti/y*, the null hypothesis of a unit root in the levels of all the variables can be rejected at the 5% significance level during 1962-1976. The unit root test shows that *ca/y* is non-stationary, so saving and investment appear to be unrelated in the long run during 1962-1976.

Consider the unit root tests for the sub-period 1977-2001 in Table 2. The results indicate that all the saving and investment variables are stationary in levels but non-stationary in first differences. The unit root hypothesis is rejected for *ca/y*, so saving and investment cointegrate with a long-run unit coefficient.

The main conclusion that can be drawn from the unit root analysis is that South Africa's saving-investment behaviour is characterised by two sub-periods during 1962-2001. During the first sub-period (1962-1976), saving and investment are unrelated in the long-run (a non-stationary current account). By contrast, during the second sub-period (1977-2001), saving and investment cointegrate with a long-run unit coefficient (a stationary current account).

(b) The structural cointegrating VAR approach: total saving and total investment

Before we proceed with the cointegration analysis for the total saving-investment relation, it is important to identify the correct lag length and to determine whether the unrestricted VAR is correctly specified (see Appendix A). Misspecification errors that result from an incorrect lag length and/or omitted variables, can lead to erroneous cointegration tests and in the process falsify inferences on exogeneity. The unrestricted VAR for the total saving-investment relation is estimated over the period 1977-2001, based on the descriptive evidence in Section 4 and the unit root (cointegration) analysis, which suggest that saving and investment are closely related during this period.

Table 3 records statistics on the lag length and corresponding diagnostic tests of the unrestricted VAR, where F_j (. , .) denotes an F-test for the hypothesis of an k-period lag ($F_s = k$). F_{det} denotes and F-test for the deterministic components of the unrestricted VAR.

Table 3
Misspecification Tests Based on UVAR: Total Investment and Total Saving

	Lag length		
	ti/y	*ts/y*	Deterministic
F_s=1 (2,17)	5.38**	3.94**	
F_{det}=(2,17)			6.04***

	Diagnostic tests	
	ti/y	*ts/y*
F_{ar} (2,16)	0.03	2.76
c^2_{nor} (2)	5.49	0.67
F_{arch} (2,16)	0.55	4.47**
F_{het} (1,23)	4.14	11.19***

Notes:

1. F_{ar} is an F-test for serial correlation up to order two; c^2_{nor} is a chi-square statistic for normality; F_{arch} is an F-test for autoregressive conditional heteroscedasticity of order two; and F_{het} is an F-test for heteroscedasticity.
2. The diagnostic tests for the single equation VAR's are obtained from Microfit 4.0 (Pesaran and Pesaran, 1997).
3. *** denotes significance at the 1% level and ** at the 5% level.

The deterministic components include an *intercept*, *time trend* and three dummy variables to capture the impact of specific events and outliers. The first dummy variable *dum70s* takes the value of unity in 1978-1980 and zero otherwise to capture the increase in saving relative to investment following the sharp increase in the dollar price of gold; the second dummy variable *dum80s* variable takes the value of unity in 1985-1987 and zero otherwise to capture the decrease in investment in reaction to the uncertainty that followed after Western nations imposed a debt moratorium in 1985; and the third dummy variable *dum90s* takes the value of unity in 1992 and zero otherwise to capture the sharp increase in dissaving by the government. Initially, the unrestricted VAR was estimated with $k = 2$. However, the F-tests showed that the two-period lags were insignificantly different from zero (not reported), so Table 3 reports the statistics for the one-period lags.

The results in Table 3 can be interpreted as follows. The first part of the table reports F-tests for the significance of the one-period lags and the deterministic components. The F-tests show that the one-period lags for *ti/y* and *ts/y* are significant at the 5% level. The F-test also shows that the deterministic components are highly significant at the 1% level. The diagnostic tests in the bottom half of the table are useful to detect any misspecification errors, either as a result of an incorrect lag length and/or omitted variables. The *ti/y* equation of the unrestricted VAR appears to be well specified; none of the diagnostic tests are significant at the 5% level. However, the *ts/y* equation of the unrestricted VAR may have specification problems based on the significance of *arch* (autoregressive conditional heteroscedasticity) and *heteroscedasticity* effects.

With these caveats in mind, Table 4 reports the results of the cointegration analysis based on an order one VAR with the unrestricted intercept and no trend option given in Pesaran *et d.* (2000). The maximal eigenvalue and trace test statistics in Panel A reject the null hypothesis of no long-run relation between total saving and total investment at the 5% significance level. The results support the existence of a unique long-run relationship between total saving and total investment during 1977-2001.

Johansen's (1991) exact identifying restriction is used to obtain the normalised cointegrating vector in panel B. The long-run relation between total investment and total saving equation can be written as (t-statistic in parentheses):

$$ti / y_t = 1.16 ts / y_t \qquad (10)$$
$$(11.60)$$

At this stage it is important to stress that equation (10) provides no information about the endogenous/exogenous nature of the variables. The primary objective at this point is to determine whether total saving and total investment cointegrate with a long-run unit coefficient.[2] This proposition is tested in Panel C.

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[2] For example, if we normalise on the *ts/y* equation, the total saving-investment relation can be written as:
$$ts/y = 0.84 ti/y. \qquad (a)$$

Table 4
Cointegration Analysis: Total Investment and Total Saving

Panel A: Cointegration statistics	
Hypotheses	r = 0
$l_{max\ eigen}$	35.47**
95% critical value	**14.88**
l_{trace}	41.39**
95% critical value	**17.86**

Panel B: Normalised cointegrating vector		
Variable	*ti/y*	*ts/y*
	1	-1.16***
		(0.10)

Panel C: LR test for a unitary long-run relation between *ti/y* and *ts/y*		
Variable	*ti/y*	*ts/y*
LR:χ^2 (1)	—	3.06
p-value		[0.08]

Panel D: LR test statistics for zero restrictions on adjustment coefficients ($\blacksquare$)		
Variable	**D***ti/y*	**D***ts/y*
$\acute{a}_{(ti/y)}$	-0.59	0.26
LR:χ^2(2)	19.40***	5.15
p-value	[0.00]	[0.07]

Notes:
1. *** denotes significance at the 1% level and ** at the 5% level.
2. The 95% critical values are given in Pesaran *et al.* (2000) and correspond to the option of an unrestricted intercept and no trend.
3. Standard errors are in parentheses ( ) and *p*-values in brackets [ ].
4. Weak exogeneity in panel D is tested by using PcFIML 9.21 (Doornik and Hendry, 1997).

The likelihood ratio (LR) statistic of 3.06 in panel C falls below the 5% critical value of 3.84; so null hypothesis that the long-run coefficient in equation (10) is *insignificantly* different from unity cannot be rejected. The empirical evidence support the theoretical proposition that total saving and total investment cointegrate with a long-run unit coefficient.

Weak exogeneity of the variables is examined in Panel D. The LR statistic shows that the error correction coefficient enters significantly in the *ti/y* equation of the vector error correction model (VECM). However, when its significance is tested in the *ts/y* equation of the VECM, the null hypothesis that the error correction coefficient is insignificantly different from zero cannot be rejected at the 5% significance level. On the basis of these results we can conclude that *ts/y* is weakly exogenous with respect *ti/y*. Or, put in another way, total investment adjusts towards its long-run equilibrium value in reaction to changes in total saving, but not the other way around:

$$ti/y \Leftarrow ts/y.$$

Before the results are interpreted there must be a note of caution. The diagnostic tests in Table 3 suggest that the *ts/y* equation of the unrestricted VAR presents specification problems. In the next section, we consider the decomposition of the total saving-investment relation suggested in equation (7). Such a specification may be superior to the one in totals, but at the same time, remains consistent with the theoretical prediction that total saving equals total investment in the long run.

(c) The structural cointegrating VAR approach: private saving and private investment

Based on the decomposition in equation (7), the unrestricted VAR includes private saving (*ps/y*), private investment (*pi/y*) and government saving (*gs/y*). Following Schmidt (2001), the effect of fiscal policy is captured by the government saving rate. The deterministic components of the unrestricted VAR remain unchanged to those defined for the total investment-saving relation.

To test the underlying hypothesis in equation (7) that dissaving by the government crowds out private investment, the analysis draws on the methodology advanced in Pesaran *et al.* (2000) by restricting government saving as the long-run exogenous variable. This specification allows no feedback effects between government saving and the private saving-investment relation in the long run, but allows for feedback effects in the short run. Based on this specification, we obtained one unique cointegrating vector (not reported here). The long-run relation, conditional on government saving as the long-run exogenous variable, is given by (t-statistics in parentheses):

$$pi/y_t = 0.17\, gs/y_t + 0.50\, ps/y_t \qquad (11)$$
$$\quad\quad (1.70) \quad\quad\quad (3.57)$$

Equation (11) shows that the government saving coefficient is quantitatively small and not statistically significant at the 10% level. The results do not support the crowding-out hypothesis in the long run.

Based on the information in equation (11), we specify an alternative unrestricted VAR in which the government saving rate is restricted to the short run. In this specification private saving and private investment enter the system unrestrictedly. The deterministic components include {*intercept*, *time trend*, *dum70s*, *dum80s*, $\Delta gs/y$, $\Delta gs/y_{t-1}$}. Note in particular that the government saving variables in differences (Δ) are included to capture the crowding-out hypothesis in the short run. Furthermore, since government saving is restricted as the short-run exogenous variable, the dummy variable *dum90s* is no longer relevant and therefore excluded from the deterministic components. Table 5 reports statistics on the lag length and diagnostics of the underlying VAR.

Table 5
Misspecification Tests Based on UVAR: Private Investment and Private Saving

Lag length			
F-test	*pi/y*	*ps/y*	Deterministic
F_s=1 (2,16)	3.77**	5.80**	
F_{det}=(4,32)			4.76***

Diagnostic tests		
Diagnostics	*pi/y*	*ps/y*
F_{ar} (2,15)	1.65	1.22
c^2_{nor} (2)	0.49	0.51
F_{arch} (2,15)	0.11	0.07
F_{het} (1,23)	2.45	2.61

Notes:

1. F_{ar} is an F-test for serial correlation up to order two; c^2_{nor} is a chi-square statistic for normality; F_{arch} is an F-test for autoregressive conditional heteroscedasticity of order two; and F_{het} is an F-test for heteroscedasticity.
2. The diagnostic tests for the single equation VAR's are obtained from Microfit 4.0 (Pesaran and Pesaran 1997).
3. *** denotes significance at the 1% level and ** at the 5% level.

The F-tests show that the first period lags and the deterministic components are significant at the 5% and 1% significance levels, respectively. The most important information is contained in the bottom half of the table. None of the diagnostic tests is significant at any conventional level so the unrestricted VAR for the private saving-investment relation seems to be well specified. This is in contrast to the unrestricted VAR for the total saving-investment relation, which showed signs of misspecification in Table 3.

Table 6 reports the cointegration analysis for the private saving-investment relation.

Table 6
Cointegration Analysis: Private Investment and Private Saving

Panel A: Cointegration statistics	
Hypotheses	r = 0
$l_{\text{max eigen}}$	32.09**
95% critical value	**14.88**
l_{trace}	42.97**
95% critical value	**17.86**

Panel B: Normalised cointegrating vector		
Variable	*pi/y*	*ps/y*
	1	-0.90***
		(0.20)

Panel C: LR test for a unitary long-run relation between *pi/y* and *ps/y*		
Variable	*pi/y*	*ps/y*
LR:χ^2 (1)	—	0.18
p-value		[0.66]

Panel D: LR test statistics for zero restrictions on adjustment coefficients (**a**)		
Variable	**D**pi/y	**D**ps/y
$á_{(pi/y)}$	-0.63***	0.20
LR:χ^2(2)	15.69	0.97
p-value	[0.00]	[0.32]

Notes:
1. *** denotes significance at the 1% level and ** at the 5% level.
2. The 95% critical values are given in Pesaran *et al.* (2000) and correspond to the option of an unrestricted intercept and no trend.
3. Standard errors are in parentheses ( ) and *p*-values in brackets [ ].
4. Weak exogeneity in panel D is tested by using PcFIML 9.21 (Doornik and Hendry 1997).

The maximal eigenvalue and trace test statistic in Panel A support the presence of a unique long-run relation between private saving and private investment. Based on the normalised cointegrating vector in Panel B, the long-run relation between private saving and private investment can be written as (t-statistic in parentheses):

$$pi / y_t = 0.90 \, ps / y_t \qquad (12)$$
$$(4.50)$$

Equation (12) shows that the long-run relation between private investment and private saving is significant and close to unity. The LR test in Panel C cannot reject the null hypothesis of a unitary long-run relation between private investment and private saving; the LR statistic of 0.18 falls well below the 5% critical value of 3.84.

Evidence of a unitary long-run relation between private saving and private investment remains consistent with the theoretical prediction of the long-run solvency constraint model, but differs slightly in interpretation. For a given level of government saving, private investment and private saving cointegrate with a long-run unit coefficient to ensure that total saving equals total investment in the long run. The main advantage of the decomposed saving-investment relation is that it provides additional information, which is not detectable when the saving-investment relation is specified in total. In this case, it shows that government saving (fiscal policy) has a negligible long-run impact on private investment.

Weak exogeneity tests with respect to the long-run parameters are reported in Panel D of Table 6. The LR test shows that the error correction coefficient ($\acute{a}_{(pi/y)}$ = -0.63) enters significantly in *pi/y* equation of the VECM, but insignificantly in the *ps/y* equation of the VECM. The results show that private saving is weakly exogenous with respect to private investment.

Recall from the exogeneity concepts discussed earlier that weak exogeneity is a necessary condition for a variable to be strongly exogenous. In other words, once it has been established that private saving is weakly exogenous, it can also be regarded as strongly exogenous when the lags of *pi/y* do not Granger-cause *ps/y*. In this application, evidence of weak exogeneity automatically implies strong exogeneity. From Appendix A equation (ii), it can be seen that for a lag length of one ($k = 1$) the *pi/y* terms automatically fall away. In other words, private saving is strongly exogenous to private investment:

$$pi/y \Leftarrow ps/y.$$

The Parsimonious VECM

Since private saving is strongly exogenous to private investment, a more parsimonious VECM can be obtained by conditioning on the level of *ps/y*. Such a specification is economically easier to interpret and provides the final model for policy analysis. Consider the following parsimonious VECM, where the error-correction term is defined as *ecm = pi/y − ps/y* (t-statistics in parentheses):

$$\Delta(pi/y)_t = -4.43 + 0.35\Delta(ps/y)_t + 0.49\Delta(gs/y)_t + 0.43\Delta(gs/y)_{t-1} - 0.66\,ecm_{t-1}$$
$$\quad\quad (-5.67) \quad\quad (3.08) \quad\quad\quad (2.76) \quad\quad\quad (2.29) \quad\quad (-6.48)$$

$$-3.39\,dum70s - 3.25\,dum80s,$$
$$\quad (-4.04) \quad\quad (-3.23)$$

$$(13)$$

$R^2 = 0.75 \quad\quad F_{arch}\,(2,16) = 0.25 \quad F_{het}\,(1,23) = 0.25 \quad$ standard error $= 1.22\%$

$F_{ar}(2,16) = 1.80 \quad\quad F_{reset}\,(1,18) = 1.35 \quad \mathbf{c}^2_{nor}\,(2) = 0.45$

The diagnostic tests are defined as before (see endnotes to Tables 3 and 5) and F_{reset} is an F-test for functional form misspecification. The insignificance of all the diagnostic tests suggests that the model is well specified. Furthermore, the conditional VECM is well determined with all the variable coefficients significant at least at the 5% level.

To assess the forecasting performance of the parsimonious VECM, we estimate the model over 1977-1993 and forecast for the period 1994-2001. Figure 2 reports the one-step ahead forecasts of the VECM. Overall, the forecasts (dotted line) trace the actual values (solid line) fairly well over the period 1994-2001. The accuracy of the forecasts deteriorates somewhat over the last two to three years, which may reflect the improvement in government saving from large negative rates during most of the 1990s to zero rates in 1999-2000 and a positive rate in 2001. Importantly, the VECM does not suffer from forecasting failure in any single year. This is evident in Figure 2 where all the actual values fall within the 95% confidence bars of the individual forecasts.

Figure 2
One-step Ahead Forecasts of VECM
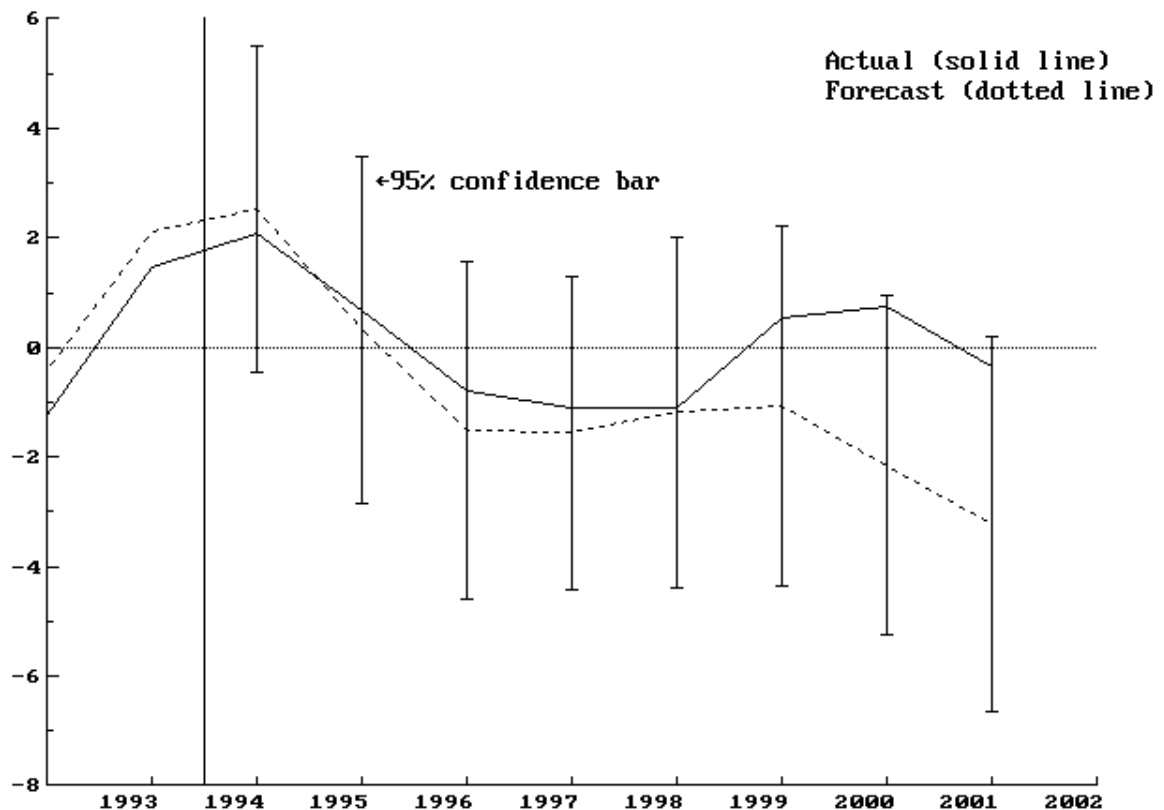
The VECM in equation (13) display several interesting features. First, the cumulative sum of the government saving coefficient is almost unity at 0.92. The result shows that the government exerts a strong crowding-out effect on private investment in the short run. Second, the magnitude of the error correction coefficient (-0.66) implies a relatively fast speed of adjustment towards long-run equilibrium. More specifically, the result shows that 66% of the disequilibria between actual and equilibrium private investment is made up during the course of a year. The magnitude of the error correction coefficient is a useful indicator to access the relative effectiveness of policy innovations. For example, saving-promoting policies are likely to be more effective in a model where the error coefficient is 66% as opposed to another model where the speed of adjustment is slow at 20%.

The foregoing analysis has shown that the VECM in equation (13) provides a theory-consistent and statistically robust empirical model. The important question, however, is whether the conditional VECM is useful for policy simulation experiments; in other words, based on the definition of super exogeneity, whether the conditional VECM in equation (13) is structurally invariant to changes in the expectations of domestic and foreign savers. Based on the theory in Section 2 and the stylised facts of the South African economy outlined in Section 4, it should be apparent that the conditional VECM is not invariant to changes in the expectations of the international community (foreign savers). The long-run relation between saving and investment breaks down when foreign capital inflows are indefinite, while exogeneity depends on whether a country has experienced substantial capital inflows/outflows from one period to another or whether capital inflows have been modest. The VECM in equation (13), conditional on private saving as the strongly exogenous variable, is dependent on the sample period under analysis (1977-2001) during which South Africa experienced modest capital inflows, even on a year-to-year basis. Domestic policy measures that change the expectations of foreign savers are likely to induce structural change in the conditional VECM, which rejects the notion of super exogeneity. The rejection of super exogeneity has important policy implications of its own.

Let us consider some of the policy implications by using a practical example. Since private saving is strongly exogenous to private investment in equation (13), the relevant policy issue is to identify appropriate policy instruments that will stimulate private saving to achieve a desired level of private investment. An overview of the empirical literature suggests that the real interest rate, tax incentives, government saving, financial deepening, the inflation rate and macroeconomic stability are all important determinants of domestic saving (Edwards 1996; Hussein and Thirlwal 1999). Now suppose that the monetary authorities base their policy strategy on the conditional VECM in equation (13) and decide to implement restrictive monetary policy by raising the official interest rate. A rise in the real interest rate may stimulate private saving directly by making saving deposits more attractive, or indirectly through lower inflation and a more stable macroeconomic environment.

The policy strategy of achieving a higher level of private investment will work as long as the expectations of the international community (foreign savers) remain unchanged. However, there is no *a priori* reason to believe that this condition will hold, because many of the determinants that stimulate private saving also feature in studies that have modelled the determinants of foreign capital. Fedderke and Liu (2002) show that foreign capital flows to South Africa during 1960-1995 are sensitive to interest rate differentials, political risk (uncertainty), growth and macroeconomic stability. Therefore, policy measures that stimulate domestic saving may simultaneously change the expectations of foreign savers/investors and attract foreign capital. In turn, many of the factors that determine foreign capital flows are also significant determinants of domestic investment (Fielding 1997). Large inflows of capital triggered by saving-promoting policies invalidate the usefulness of the conditional VECM for policy simulations, because the model (conditional on private saving as the strongly exogenous variable) only works when capital inflows are relatively mild. The stability and good forecasting properties of the VECM during 1977-2001 reflect the inability of South Africa to attract capital inflows of the same magnitude than those experienced during 1962-1976.

In summary, policies that promote domestic saving are likely to work when the expectations of foreign savers/investors remain unchanged. However, if saving-promoting policies

simultaneously attract foreign capital, policy measures need to be more flexible to reflect the changing macroeconomic environment. If plans to invest exceed plans to save in reaction to a cut in the official interest rate, the balance-of-payments would be unaffected if the investment-saving gap is financed by capital inflows. Foreign capital allows an expansion in the productive capacity (supply-side) of an economy by permitting more investment. Or, put in another way, foreign capital allows enough time for the supply side of the economy to respond to the demand stimulus.

Conclusions and Policy Implications

The empirical results in this paper have shown that South Africa's long-run saving-investment behaviour over 1962-2001 is characterised by two different sub-periods. During 1962-1976, saving and investment were not bound by a long-run solvency constraint. The unlimited nature of net capital inflows (including foreign debt) allowed large and persistent current account deficits on the balance-of-payments. The period 1977-2001 witnessed a significant change in South Africa's balance-of-payments position. The limit placed on foreign debt and the low level of net capital inflows forced saving and investment to move closely together.

Further investigation of the saving-investment relation during 1977-2001 was conducted within a structural cointegrating VAR approach. Overall, the vector error correction model (VECM) during 1977-2001 seems to be well specified, theory-consistent and statistically robust. The empirical results suggest several implications for the conduct and efficiency of macroeconomic policy in promoting high and sustainable investment levels in South Africa.

i)   First, the long-run exogeneity tests show that private saving is strongly exogenous to private investment during 1977-2001. The main policy implication is that prior saving matters for investment. An important area for future research is to identify appropriate policy instruments that stimulate private saving. The impact of the real interest rate, the government's tax effort, government saving, financial deepening, the inflation rate and macroeconomic stability all seem to be relevant determinants of domestic saving in studies conducted internationally (see Edwards 1996; Hussein and Thirlwall 1999).

ii)   The result of an exogenous private saving variable is consistent with South Africa's balance-of-payments position at the time. Thus, the interpretation of the result departs from a neo-classical view in which an economy is 'supply constrained'. The limit placed on foreign debt and the low level of capital inflows during 1977-2001 (even on a year-to-year basis) imposed a severe constraint on the expansion of demand to which supply could adapt. Without external finance, investment was forced to adjust to the level of domestic saving. In addition, the exogeneity of private saving suggest that relative price changes (real exchange rate) did not act as an efficient balance-of-payments adjustment mechanism during the sample period. The main policy implication is that expansionary demand-side policies are unlikely to be sustainable without external finance to support the initial investment-saving gap. Without higher levels of capital inflows than those experienced during 1977-2001, South Africa will increasingly have to

rely on domestic saving to finance private investment expenditure in a non-inflationary way.

iii)   How do the results in this paper compare to saving-investment studies that have been conducted in an international context? Schmidt (2001) examines the saving-investment exogeneity issue for a group of five advanced economies (United States, United Kingdom, Canada, France and Japan). The results show that for all the countries there are significant feedback effects between saving and investment: saving determines investment, but investment also determines saving. In contrast to the South African case, the results suggest that investment-promoting policies may be effective in raising the level of domestic saving. One possible explanation for the contrasting results can be found in the different balance-of-payments experiences of advanced economies compared to those of developing economies. Many developing countries like South Africa experienced a debt crisis during the 1980s that placed a direct limit on the expansion of demand to which supply could adapt. A second explanation is that expansionary demand-side policies in advanced economies are likely to place less pressure on the balance-of-payments compared to a typical developing economy that imports most of its capital and intermediate goods.

iv)   Since the foregoing analysis suggests that the expansion in domestic demand is inhibited by a foreign exchange constraint in South Africa, domestic resources generated from saving-promoting policies need to serve as a substitute for foreign exchange. A more direct and effective way of generating sufficient foreign exchange is to promote exports. Rapid growth in exports directly lifts the ceiling that the balance-of-payments places on the growth of demand to which supply can adapt.

v)   The notion of super exogeneity is rejected in the context of the conditional VECM. Policy measures geared towards increasing the level of domestic saving may simultaneously change the expectations of foreign savers and attract foreign capital, which subject the VECM to structural change. The stability and good forecasting properties of the VECM during 1977-2001 reflect the inability of South Africa to attract capital inflows of the same magnitude than those experienced during 1962-1976. The rejection of super exogeneity has an important policy implication of its own. Policy measures need to be flexible enough to adapt to a changing macroeconomic environment. If saving-promoting policies attract foreign capital, policy makers have some scope to implement more expansionary measures. Foreign capital expands the productive capacity of the economy (supply) by allowing investment to exceed saving during the initial stages of the investment programme.

vi)   Although saving-promoting policies may improve South Africa's investment performance, it is important to highlighting the following caveats. First, if monetary policy is overly cautious by keeping the interest rate excessively high, then the growth rate may fall below the rate permitted by the balance-of-payments. In this case, the limit of demand to which supply can adapt is not balance-of-payments constrained, but policy constrained. Second, cuts in government spending may attract foreign capital by reducing macroeconomic uncertainty. However, as Gibson and van Seventer (2000) argue, if an

improvement in government saving is achieved through cuts in investment spending, then the costs in terms of growth and employment may not be equally compensated for by foreign capital inflows.

vii) The results do not support the crowding-out hypothesis in the long run. Government saving has a negligible impact on private investment in the long run, but a strong crowding-out effect in the short run. This result, however, is not independent of the period under analysis during which government saving remained low and negative for prolonged periods. Gibson and van Seventer (2000) present a more detailed and comprehensive analysis of the government sector in South Africa. Simulations based on a structuralist computable general equilibrium model show that redirecting government spending towards productive investment raises growth by a full percentage point. The main disadvantage of this policy strategy is the deterioration in the current account. Their results are consistent with the underlying hypothesis in this paper. What our econometric analysis emphasises, however, is that the best way to guarantee the success of investment programmes in raising productive capacity on a sustainable basis is to support them with foreign capital inflows during the initial stages.

viii) How did the South African economy perform since the introduction of the GEAR policy document in 1996? During 1997-2001 the growth rate and current account deficit to GDP ratio averaged 2.22% and 0.86%, respectively. In the same period, inflation was fairly mild at 6.35%. Despite a relatively low inflation rate, the figures show that South Africa has thus far not managed to attract sufficient amounts of foreign capital to sustain the target growth rate of 4.2% set out in the GEAR policy document. If there is pessimism about the ability of South Africa to attract sufficient foreign capital and/or to promote faster export growth on a sustainable basis, what is the alternative?

The less able South Africa is to finance its plans to invest in excess of plans to save with foreign capital, the more inflation it must be prepared to tolerate for a given level of investment. Expansionary demand-side policies in the face of a balance-of-payments (foreign exchange) constraint inevitably lead to nominal exchange rate depreciations and a resulting rise in the price of imported goods. The inflationary process becomes self-perpetuating when the initial rise in the price of imported goods triggers a wage-price spiral. The relevance of 'imported inflation' as a main determinant of South Africa's inflation rate has been shown elsewhere (Nell 2000).[3]

Without foreign exchange, the relevant question then becomes: How much inflation are we prepared to tolerate in exchange for faster growth and lower unemployment? This, in turn, depends on the South African Reserve Bank's (SARB) inflation target and whether the current inflation rate is in line with the predetermined target. With an inflation target of 3%-6% at the time of writing and an actual inflation rate of around 6.5% in 2001, there appears to be little scope to implement more expansionary monetary policy measures. The close proximity between the upper limit of the inflation target and the actual inflation rate seems to reflect the SARB's relatively conservative monetary policy stance in recent years.

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[3] An updated version of this paper is available on request from the author.

The success of expansionary demand side policies in the face of a foreign exchange constraint depends on what the true 'optimum' inflation rate really is in South Africa. Suppose, for example, that the upper limit of the inflation target is not 6% but 8%. With an actual inflation rate of 6.5%, the SARB can afford to be less conservative by allowing plans to invest to exceed plans to save (or plans to import to exceed plans to export). Although expansionary policy measures may create inflationary pressure in the short run, this need not necessarily be so in the long run if the productive capacity of the economy increases.

An important area for future research is to determine whether the SARB's inflation target of 3%-6% is in fact the true 'optimum' inflation rate. Empirical studies conducted in an international context provide some guidance. Sarel (1996) identifies an optimum inflation rate of 8%. Below 8%, the relation between inflation and growth tend to be slightly positive, but above 8%, the relation is strongly negative. The panel study by Ghosh and Phillips (1998) also finds a structural break, but the positive impact of inflation on growth only occurs at inflation rates between 2%-3%, otherwise inflation and growth are negatively related.

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Appendix A: Econometric Methodology: The Structural Cointegrating VAR Approach

The econometric method adopted in this paper is the structural cointegrating VAR approach of Johansen (1991) and developed in Pesaran *et al.* (2000). Consider an unrestricted VAR (UVAR) for k lags on a vector of n variables $\mathbf{x}_t$ with n_0 deterministic/exogenous I(0) variables $\mathbf{q}_t$ (such as intercept, trend, event-specific dummies, and I(0) variables):

$$\mathbf{x}_t = \sum_{j=1}^{k} \mathbf{A}_j \mathbf{X}_{t-j} + \mathbf{K}\mathbf{q}_t + \mathring{a}_t \text{ with } \mathring{a}_t \sim \text{IN}\,(\mathbf{0},\,\mathbf{Ó}), \qquad (i)$$

where $\mathbf{A}j$ is an $n \times n$ matrix of autoregressive coefficients, $\mathbf{K}$ is an $n \times n_0$ matrix of coefficients of the n_0 deterministic variables, and $\mathring{a}_t$ is a vector of n unobserved errors which have a zero mean and constant covariance matrix Σ. When the variables being modelled $\mathbf{x}_t$ are I(1) but there are $r < N$ cointegrating vectors $\hat{a}\,\mathbf{\clubsuit}_t$ which are I(0), the UVAR in equation (i) can be written as a vector error-correction model (VECM):

$$\ddot{A}\mathbf{x}_t = \sum_{j=1}^{k-1} \tilde{A}\mathbf{1}_j \ddot{A}\mathbf{ti/y}_{t-j} + \sum_{j=1}^{k-1} \tilde{A}\mathbf{2}_j \ddot{A}\mathbf{ts/y}_{t-j} + \acute{a}(\hat{a}'\mathbf{x}_{t-1}) + \mathbf{K}\mathbf{q}_t + \mathring{a}_t, \qquad (ii)$$

where   is the first difference operator, $\mathbf{x}_t = [(ti/y),(ts/y)]'$, and $\acute{a}$ and $\hat{a}$ are $2 \times r$ matrices of rank r. Since the value of r is not known *a priori*, the cointegration analysis is based on Johansen's (1988, 1991) fully modified maximum likelihood systems procedure outlined in Microfit 4.0 (Pesaran and Pesaran 1997). The adjustment coefficients in equation (7) is given by $\acute{a} = [\acute{a}_{(ti/y)}, \acute{a}_{(ts/y)}]$ and the matrix of long-run coefficients by $\hat{a} = [\hat{a}_{(ti/y)}, \hat{a}_{(ts/y)}]'$.

The causality tests conducted in this paper are equivalent to exogeneity tests. Following the seminal work of Engle *et al.* (1983), exogeneity tests are distinctly different from the standard Granger causality procedure, which only tests whether one variable precedes another.

The procedure in Johansen and Juselius (1992) is followed to test for weak exogeneity with respect to the long-run parameters. For example, for *ts/y* to be regarded as weakly exogenous with respect to *ti/y*, requires that the adjustment coefficient $\acute{a}_{(ti/y)}$ is significantly different from zero ($\acute{a}_{(ti/y)}$ 0) when it enters the   *ti/y* equation of the VECM in equation (ii), but insignificantly different from zero ($\acute{a}_{(ti/y)} = 0$) when it enters the   *ts/y* equation of the VECM. In other words, investment adjusts towards it long-run equilibrium value in reaction to changes in saving (*ti/y   ts/y*), but not the other way around.

Based on the definitions provided by Engle *et al.* (1983), strong exogeneity is the relevant concept for forecasting. A variable z_t is said to be strongly exogenous to another one y_t, if it is weakly exogenous for the parameters of interest and if past values of y_t do not Granger-cause z_t. In the context of our present example, once it has been established that *ts/y* is weakly exogenous, it can also be regarded as strongly exogenous when the null hypothesis of $\mathbf{Ç}\mathbf{1} = 0$ in equation (ii) cannot be rejected, based on a standard F-test.

Appendix B: Definition of Variables and Data Source

The data are taken from the South African Reserve Bank's historical data set (1960-2001) published on the internet (http://www.resbank.co.za/Economics/econ.html). The variable definitions are as follows:

ca/y   = current account of the balance-of-payments as a ratio of nominal GDP (*y*)

gs/y   = gross government saving as a ratio of nominal GDP (*y*)

pi/y   = gross investment of private business enterprises as a ratio of nominal GDP (*y*)

ps/y   = gross private domestic saving as a ratio of nominal GDP (*y*):

    private saving = (personal saving of households + corporate saving)

ti/y   = total gross domestic investment as a ratio of nominal GDP (*y*)

ts/y   = total gross domestic saving as a ratio of GDP (*y*)

tfd/y   = total foreign debt as a ratio of GDP (*y*)