

**MACROECONOMIC POLICIES, SHOCKS AND ECONOMIC GROWTH IN  
SOUTH AFRICA**

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## **Executive Summary**

Economic growth, in the world or in a particular region or country, depends to a large extent on the nature and quality of economic policy (Collier and Dollar, 2001). For example, if there is a good environment for households and firms to save and invest in the developing world, economic growth is generally observed. The International Monetary Fund (2000) also claims that where sound macroeconomic policies have been sustained, they have raised growth.

When South Africa emerged from the apartheid era in 1994 it had an urgent need to complement its political liberation and its openness to global trade and investment with economic growth that would benefit all members of the population. Realising this outcome will basically require increasing employment, since unemployment is concentrated to a large extent among the poor. This will require action on many fronts; including efforts to make labour markets function more efficiently while at the same time assuring more equity in the distribution of benefits. It will also demand reducing distortions in capital markets that require more capital-intensive activities. It will require improved education and training so as to make the workforce become more employable and productive. Lastly, it will require a macroeconomic-policy framework that influences economic growth.

In this study, we start with a review of the problems faced by South Africa since it emerged from the period of apartheid and tries to wrestle with the multiple objectives of reducing poverty, increasing employment, restructuring employment, increasing international trade and increasing the rate of economic growth. The study then briefly looks at the macroeconomic goals and policies introduced in Growth, Employment and Redistribution (GEAR) strategy and how these have been fulfilled. Macroeconomic policies were incorporated in 1996 by the new government into a strategy to promote GEAR.

To increase employment and lessen poverty, the new South African government in 1994 made it a priority to foster economic growth. The path to long-run economic growth was ensured by introducing macroeconomic policies in 1996 aimed at reducing fiscal deficits, lowering inflation, maintaining exchange rate stability, decreasing barriers to trade and liberalizing capital flows. These macroeconomic policies were steered by a strategy to promote Growth, Employment and redistribution (GEAR). The first objective of the GEAR programme was achieving macroeconomic balance in the South African economy – i.e., a reduced budget deficit and falling rate of inflation. The second objective was to make the South African economy get on a 6% growth path by the year 2000. Improved performances in fixed investment and non-gold exports were meant to propel this growth path. The third objective was redistribution through job creation realised from economic growth and labour market reforms.

The performance of GEAR has, to a great extent, also been dwarfed by the global economic crisis, which spread to South Africa in 1998. The decline in world demand for South African exports between 1995 and 2000, in general, brought about massive

shedding of labour by South African firms. This was done in order for the firms to become competitive. It is noted, in particular, that gold exports continued to decline absolute value and as proportion of exports of goods and services. Furthermore, the rate of growth of the manufacturing export sector fell from about 10% per year to about 0% in 1999.

This paper is an empirical study that sets out to investigate whether economic policy currently employed in South Africa is consistent with the theoretical views of how policy would affect economic growth. How strong is the case that macroeconomic policies have large effects on the growth of South African economy? The following variables represent macroeconomic policies: government expenditure, income tax rate, nominal interest rate, inflation target, foreign aid and domestic credit.

This study has three objectives with regard to the South African economy in the post-apartheid era:

- (i) Investigating the factors that influence economic growth by a simultaneous macro-econometric model;
- (ii) Investigating the types and channels of shocks that affect long-run economic growth;
- (iii) Investigating whether shocks hinder the usefulness of fiscal policy rules. How can a low-income country like South Africa retain fiscal policy flexibility without endangering medium-term fiscal-consolidation objectives?

Thus, in pursuing these objectives, the study will help to answer the following questions:

- (a) To what extent have monetary and fiscal policies affected economic growth in South Africa?
- (b) What are the most important shocks that have been affecting long-run economic growth in South Africa? Can the effect be mitigated by public policy interventions aimed at improving the investment climate?
- (c) How have the shocks been affecting monetary and fiscal policies in South Africa? Government expenditure and income tax rate are fiscal policy tools; and nominal interest rate and money stock represent monetary policy instrument.
- (d) What are the policy implications for the results of this study?

The study looks at a number of hypotheses that need to be tested. The following are the most important:

- Economic growth is determined mainly by movements in real effective exchange rate, domestic inflation rate, nominal money supply, government expenditure, tax rate, nominal interest rate, domestic savings and mining production.

- Imports growth hinders economic growth. Since exports changes contribute positively to real GDP growth (economic growth), the study attempts to test the other side of the coin – i.e., whether imports growth inhibit economic growth.
- Monetary policy shocks are more important in changing the course of long-run economic growth than are fiscal policy shocks. The “importance” of monetary shocks vis-à-vis fiscal shocks is reflected in the magnitude and length of period of persistence of the impacts on economic growth. The cointegrating vector autoregression system that contains appropriate variables is used to analyse these shocks.
- External shocks have a minimal effect on the long-run course of economic growth.
- External shocks have a very profound effect on domestic monetary and fiscal policies.

To address the first objective of the study, we estimate a *simultaneous-equation system* that includes the following behavioral equations: domestic inflation rate, real income growth, real effective exchange rate, government revenue and net capital inflows. Statistical methods for systems of simultaneous equations capture the mutual dependence among the variables in the model. We are particularly interested in the *full-information maximum likelihood method* as it allows for connections among variables from different equations within the system. Limited information methods do not take into account connections among variables from different equations within the system.

We then investigate the types and channels of shocks that affect long-run economic growth by employing the *Johansen technique*. The *Johansen’s method of cointegration* in investigating types and channels of shocks that affect long-run economic growth will augment the simultaneous equation method. The Johansen’s technique allows us to yield impulse responses and variance decompositions of the shocks that affect the equations of domestic inflation, foreign inflation, economic growth, exchange rate, money stock, nominal interest rate, income tax rate, government expenditure, government revenue, imports and investment. This technique attempts to address objectives 2 and 3, outlined above. This is done by examining the impulse responses (triggered by monetary and fiscal shocks or innovations).

The results of estimating of a simultaneous equation system show that real income growth is positively related to gross domestic savings, changes-in-the-money-stock variable, total mining production and its own past values. But the growth in real income is negatively related to imports, total government expenditure, tax, USA interest rate, changes in the USA CPI and changes in the South African nominal interest rate. We conclude that mainly movements in domestic nominal interest rate, corporate income tax, money stock, domestic savings and imports in South Africa determine economic growth.

On the other hand, from the same results of simultaneous-equation system, changes in the real effective exchange rate are negatively related to changes in the money stock and its

own past values, and positively related to changes in the foreign price and domestic nominal interest rate. We note that the negative effect of changes in the nominal money stock on the real effective exchange rate is in accordance with theoretical expectations. If there is an increase in the domestic nominal money stock, this should lead to an appreciation of the exchange rate through a transmission mechanism of the rising domestic prices. We also find that net investment is significantly positively influenced by imports expenditure, domestic interest rate and its own past values.

The hypothesis that imports growth hinders economic growth is confirmed by the simultaneous equation regression since the estimated coefficient of the natural logarithm of imports is negative. The estimated negative coefficient on the imports variable is significant at 10% significance level and can be interpreted as follows: a 1% increase in the Rand value of imports is followed by a decrease of about 0.02% of a unit change in real income growth. Thus, imports growth pushes down economic growth in South Africa.

However, the hypothesis that monetary policy shocks are more important in changing the course of long-run economic growth than are fiscal policy shocks is not confirmed as evidenced by the impulse response functions of the real economic growth variable due to shocks triggered in both the monetary and fiscal equations – nominal interest rate and money stock are monetary variables, and total government expenditure and corporate income tax rate are fiscal variables. Our results do not delineate clearly the impulse responses of the real economic growth due to monetary shocks from those due to fiscal shocks.

Foreign inflation shock (approximated by a one standard error shock to changes in the US CPI) and the foreign monetary shock (approximated by the US nominal interest rate shock) have literally no effect on the real GDP (real output) over the given horizon. This result confirms the hypothesis that external shocks have a minimal effect on the long-run course of economic growth in the South African economy.

The results also fail to confirm the hypothesis that external shocks have a very profound effect on South African monetary and fiscal policies. The impulse response functions show that there are no effects on South African tax rate and nominal interest rate due to the foreign shocks – represented by the US inflation and nominal interest rate shocks - over the entire horizon. And the South African money stock and total government expenditure begin to respond to the foreign shocks at the beginning of quarter 19. At that point, the effects on these monetary and fiscal variables begin to rise above zero in the case of the US inflation shock and to fall in the case of the US nominal interest rate.

In general, these results tell us that domestic nominal interest rate, corporate income tax, money stock, foreign nominal interest rate domestic savings and imports determine economic growth in South Africa. On the other hand, total mining production and total government expenditure do not influence economic growth. Both monetary and fiscal policy shocks are not important in determining the long-run course of economic growth. While net capital inflow shocks have a small positive effect on economic growth, imports

shocks have a negative one. External shocks do not affect the long-run path of economic growth, and fiscal and monetary policy variables.

What policy implications can we draw from the outcome of our analysis? By the look of things, the South African government is not doing enough to stimulate economic growth in the economy. Its current fiscal and monetary policies have not produced desirable robust results. A solution could emerge from the monetary side: the monetary authorities can afford to cut down the nominal interest rate during recession periods in order to stimulate capital inflow for domestic investment so as to boost economic growth. The optimal reduction in the nominal interest rate would still ensure that the ex-post real exchange rate does not rise above the ideal real exchange rate. One fiscal solution is offering foreign investors substantial tax holidays or tax cuts.

## **1. Introduction**

Economic growth, in the world or in a particular region or country, depends to a large extent on the nature and quality of economic policy (Collier and Dollar, 2001). For example, if there is a good environment for households and firms to save and invest in the developing world, economic growth is generally observed. The International Monetary Fund (2000) also claims that where sound macroeconomic policies have been sustained, they have raised growth.

South Africa emerged from the apartheid era in 1994 with an urgent need to complement its political liberation and its openness to global trade and investment with economic growth that would benefit all members of the population. Realising this outcome will basically require increasing employment, since unemployment is concentrated to a large extent among the poor. This will require action on many fronts; including efforts to make labour markets function more efficiently while at the same time assuring more equity in the distribution of benefits. It will also demand reducing distortions in capital markets that require more capital-intensive activities. It will require improved education and training so as to make the workforce become more employable and productive. Lastly, it will require a macroeconomic-policy framework that influences economic growth.

The study starts with a review of the problems faced by South Africa since it emerged from the period of apartheid and tries to wrestle with the multiple objectives of reducing poverty, increasing employment, restructuring employment, increasing international trade and increasing the rate of economic growth. The study then briefly looks at the macroeconomic goals and policies introduced in Growth, Employment and Redistribution (GEAR) strategy and how these have been fulfilled. Macroeconomic policies were incorporated in 1996 by the new government into a strategy to promote GEAR. All this is presented in section 2. In section 3, we look at the objectives and hypotheses of the study. Section 4 contains our empirical methodology. Section 5 presents the data sources. We have our empirical results and analysis in section 6. Section 7 finds out whether our results confirm the hypotheses of the study or not. The final section, section 8, offers the summary of findings and conclusions of this study.

## **2. Macroeconomic Performance in South Africa: An Overview**

### **2.1 Growth, Employment and Redistribution (GEAR) Strategy**

To increase employment and lessen poverty, the new South African government in 1994 made it a priority to foster economic growth. The path to long-run economic growth was ensured by introducing macroeconomic policies in 1996 aimed at reducing fiscal deficits, lowering inflation, maintaining exchange rate stability, decreasing barriers to trade and liberalizing capital flows. These macroeconomic policies were steered by a strategy to promote Growth, Employment and redistribution (GEAR). The first objective of the GEAR programme was achieving macroeconomic balance in the South African economy – i.e., a reduced budget deficit and falling rate of inflation. The second objective was to

make the South African economy get on a 6% growth path by the year 2000. Improved performances in fixed investment and non-gold exports were meant to propel this growth path. The third objective was redistribution through job creation realised from economic growth and labour market reforms.

There were two scenarios that guided the GEAR strategy: the first one in relation to how the economy could be expected to perform over the medium term in the event that no policy changes were introduced; and the second one in relation to how the economy would perform if key policy changes were made. Among others, the following policy changes were deemed necessary for higher economic growth and job creation: significant reduction of the fiscal deficit and containment of debt service obligations; maintenance of consistent monetary so as to contain inflation; further liberalization of the capital account of the Balance of Payments; further reduction of import tariffs; introduction of tax incentives to stimulate new investments in labour absorbing projects so as to enhance job creation; and increase of the pace of restructuring of state assets.

Under GEAR, there were two scenarios that would assess the performance of the economy's high level of economic growth and reduced unemployment: the core scenario, which represented the results of unchanged policies, and the integrated scenario, which represented the results of changed macroeconomic policies. Under the medium-term integrated scenario, substantially higher growth was to be achieved mainly through macroeconomic strategy that hinged on the theoretical postulate that reduction in fiscal deficit would decrease real interest rates, which would ultimately bring about greater investment and job creation. However, the results from the integrated scenario indicate that a rather marginal reduction in unemployment to about 32% from 33% in 1995 would only start in 2000. The same trend of reduction in unemployment would continue beyond 2000.

One criticism leveled against the GEAR strategy is that it restricted economic growth to a level that was likely to have insignificant impact on prevailing levels of unemployment, inequality and poverty (Standing et al., 1996). The fact that the strategy introduced a cut in government expenditures without corresponding measures to promote the expansion of investment or exports, the strategy was seen as stifling growth in this regard.

The performance of GEAR has, to a great extent, also been dwarfed by the global economic crisis, which spread to South Africa in 1998. The decline in world demand for South African exports between 1995 and 2000, in general, brought about massive shedding of labour by South African firms. This was done in order for the firms to become competitive. It is noted, in particular, that gold exports continued to decline absolute value and as proportion of exports of goods and services. Furthermore, the rate of growth of the manufacturing export sector fell from about 10% per year to about 0% in 1999.



## **2.2 Alternative Macroeconomic Policies**

In view of the dismal performance of the GEAR strategy, a number of alternative macroeconomic policies have been suggested to stimulate economic growth, especially in sectors that are more labour-intensive. One possible route is to introduce discriminatory cost of borrowing investment funds. This would stress the importance of reducing the real rate of interest for sectors that rely heavily on bank borrowing.

### ***2.2.1 Monetary Policy***

Prior to 2000, the South African Reserve Bank was pursuing a monetary policy that stressed financial stability over economic growth. In particular, high interest rates have been maintained in order to avoid capital flight, excessive pressure on the exchange rate and high inflation. The success of this policy came about partly because dwindling fiscal deficits have avoided a situation in which there was pressure on South Africa's capital market to finance large government needs. But the drawback is that high interest rates have had a stifling effect on economic growth.

During the initial stage, policymakers tried to simultaneously pursue the following three objectives: an open capital market to enable access to external finance, a stable nominal exchange rate to underpin international trade and the freedom to adjust interest rates via monetary policy. However, Obstfeld (1998) cautions that these three goals constitute a 'trilemma': achieving all three simultaneously is not possible, at least not in the medium to long-term, and policymakers must decide which two to prioritise and abandon the third. Inevitably, by September 1998 the costs of trying to avoid the trilemma had become too high. In the second stage, from mid 1998, exchange rate stability was dropped in favour of monetary policy independence in the form of inflation targeting.

Between the early 1990s and 1999, the South African Reserve Bank set formal targets for money supply (M3) growth albeit in practice monetary policy was 'eclectic' with the nominal exchange rate sometimes implicitly targeted as well. Prior to 1994, exchange controls restricting capital outflows were in place on and off from 1961, only to be re-imposed in 1985 as a result of the debt standstill. This was done concomitantly with the dual exchange rate – commercial and financial rand rates – that attempted to encourage investments from abroad.

In spite of a closed capital account, there were still massive capital inflows due to a favourable political atmosphere that ensued in 1994, and this fulfilled the expectation that the democratic government would relieve the growth constraint. As a result of this promising environment, there was a substantial net capital inflow into the economy of around 4% of GDP between July 1994 and June 1995 (Stals, 1995). The South African Reserve bank was awakened to the size, speed and composition of capital inflows – mainly of short-term nature – notwithstanding the need for external capital to maintain long-term growth: its attempt to lower inflation and enhance international competitiveness could be marginalized by excessive money supply growth and pressure

for currency appreciation. As a strategy to reduce the size of net short-term capital inflows, the South African reserve Bank opted for capital account liberalization in March 1995, by offsetting large gross capital inflows with capital outflows. And, in order to remove restrictions on non-residents' transactions, the dual exchange rate was unified. This was followed by a series of steps towards the relaxation of restrictions on residents' foreign investments. The unified exchange rate carried the additional important advantage that capital inflows would now occur on the same basis as commercial transactions, adding to foreign exchange reserves and enabling the reduction of its 'forward book' and 'net open currency position', which were seen as posing a major risk to policymakers.

The South African Reserve Bank continued to pursue its existing policy goals of reducing inflation together with nominal exchange rate stability, alongside capital account liberalization that was introduced in March 1995, in order to maintain a competitive real exchange rate. This required a combination of high real interest rates and some 'sterilisation' of net capital inflows to limit the growth of money supply. Thus, this was an attempt by the Reserve bank to pursue both monetary and exchange rate targets despite having adopted an open capital market. However, the open capital market implied that net capital inflows could fall abruptly, as in February 1996 and may 1998. In both instances, the Reserve Bank tried to reduce capital outflow by absorbing exchange-rate risk from both importers and foreign investors, selling dollars into the market and increasing its net-capital-outflow position (Stals 1996; 1998). In contradistinction, real interest rates were raised substantially by 2.5% in 1996 and 7% in 1998 in a desperate effort to attract foreign portfolios back.

In February 2000, the South African monetary authorities introduced an inflation target range of 3 to 6 per cent. In that regard, the Reserve Bank of South Africa has formally adopted an inflation-targeting monetary policy framework. The implication of this framework is that the monetary authorities are now targeting the rate of inflation directly after switching from the previously applied "eclectic" monetary policy approach where intermediate objectives had an important role.

The primary concern of the new inflation-targeting monetary policy framework is price stability. The ultimate aim of this policy is, therefore, to reduce the inflation bias of discretionary policy since increased credibility leads inflation anticipations to moderate more rapidly. However, inflation targeting is an unprecedented step in the price stabilization policy of South Africa's monetary and foreign exchange system. This is expected to have significant effects on South Africa's monetary system and foreign exchange market performance.

Khamfula (2004) provides empirical evidence using ARCH and GARCH analysis to support the hypothesis that during the period of inflation Targeting, the interest and exchange rate volatility has significantly reduced, but this has been short of idealism, i.e. the achieved stable paths of these two series have been below their optimal or desirable ones. The study empirically examines how the introduction of inflation targeting has affected the performance of South African real interest and exchange rate in terms of

volatility. The most important finding in this study is that inflation targeting has helped to produce more stable and official exchange rate and interest rate in real terms, at least in the long term.

Inflation targeting, as a new strategy for monetary policy, has gathered a lot of interest and debate among those at the helm of steering the economy from the monetary stance in recent times. Kydland and Prescott (1976) argue that monetary policy pursuing short-term goals in a discretionary, opportunistic manner is worse than a policy committed to and sticking to an a-priori well-chosen course of action. Inflation targeting is often advertised as a way for monetary policy to achieve an additional degree of this desirable commitment. The principal characteristic of this approach is the announcement of an official range of target for the inflation rate at a particular horizon and by public recognition that low and stable inflation is the main goal of monetary policy. To that end, communication with the public about the plans and objectives of the monetary policy makers is achieved. Hence, there is increased accountability of the central bank for achieving those objectives.

### ***2.2.2 Fiscal Policy***

Fiscal policy has, to a great extent, been regarded as one of the major successes in terms of meeting its objectives in the post-apartheid era. During this period, there has been a major transformation of the budgetary and expenditure processes. New systems of financial planning, expenditure management, reporting and accountability have been introduced. Budgeting has taken place within the Medium Term Expenditure framework (MTEF), which is a three-year rolling framework intended to provide greater certainty to line departments for planning and implementing policy programmes, which are budgeted and evaluated on the basis of output-linked performance indicators, rather than on inputs. For the treasury, the MTEF enables a combination of aggregate fiscal restraint with strategic reprioritisation for allocative efficiency. Since 1999, the Public Finance Management Act (PFMA) has been supporting the MTEF by imposing strong controls over financial management in all public sector institutions. The PFMA requires departments to set objectives for their expenditure. On the other hand, the treasury has imposed strict discipline on provincial governments that have overspent budgets.

The contribution of these fiscal reforms has been the steady decline in the fiscal deficit, which has been kept below 3% of GDP, as stated in GEAR. According to the Treasury (2004), since 2001 a more expansionary fiscal stance has been adopted and real growth in non-interest expenditure grew by about 8% per annum on average over the next three years. A large real increase of 5% in non-interest spending is budgeted for the 2004-2005 fiscal year, leading the deficit to rise to 3.2% level above the threshold of 3%. Public debt levels have also been substantially reduced from levels close to 50% of GDP to below 40%. The government has also reduced capital expenditure to allow for increased share of social spending within the budget. Between 1993 and 1997, overall per capita social spending increased by about 24% in real terms, with substantial redistribution across income and racial categories (Van der Berg, 2001). Expenditure on social security and

welfare increased dramatically. In contradistinction, capital expenditure fell to very low levels; and investment expenditure for the overall public sector dropped below 5% of GDP from 1992, in comparison with an average of 10% during the 1980s.

There has also been a significant improvement in revenue collection, contributing essentially to the success of fiscal policy. In 1997, the treasury granted organizational autonomy to the South African Revenue Service (SARS), and this has arguably resulted in increased efficiency in revenue collection, greater compliance by taxpayers and significant widening of the tax base. Efficiency improvements are reflected in the much smaller backlog of unassessed returns at the end of the tax year - in March 1998, the backlog was 49% of the 4.7 million returns, but in March 2003, this was only 5.5% SARS (1998; 2003). Risk profiling of taxpayers, more extensive and integrated taxpayer auditing, improved tax-payment enforcement and debt collection constitute measures of compliance. There has been a substantial increase in the number of taxpayers in tax base: over the four years from 1998/99 to 2002/3, the number of taxpayers grew an average of 12% per annum.

Government has been formally committed to promote growth and employment through private investment. The official view has been to cut tax on company profit (income) in as the most effective mechanism to increase investment. However, the impressive performance on the revenue side of the budget has been directed to tax cuts for the middle and formally-employed working classes, enabling these categories to increase their consumption expenditure, rather than to possible alternatives that might directly or indirectly have benefited the informally employed and unemployed via provision of public goods and services, or increased private investment to create jobs. To this end, about R73 billion in tax has been relieved since 1994/95 fiscal year, of which about R63 billion (86%) has gone to individuals and only R6 billion to companies (Treasury 2004).

### **3.1 Objectives of the Study**

This paper is an empirical study that sets out to investigate whether economic policy currently employed in South Africa is consistent with the theoretical views of how policy would affect economic growth. How strong is the case that macroeconomic policies have large effects on the growth of South African economy? The following variables represent macroeconomic policies: government expenditure, income tax rate, nominal interest rate, inflation target, foreign aid and domestic credit.

This study will likely provide an alternative and possibly new explanations of how economic growth in South Africa has been affected by a number of shocks by using econometric techniques. This will help uncover and explain the nature and duration of important shocks that have been affecting economic growth of South Africa. This is a new and very substantive contribution to the existing literature.

This study has three objectives with regard to the South African economy in the post-apartheid era:

- (i) Investigating the factors that influence economic growth by a simultaneous macro-econometric model;
- (ii) Investigating the types and channels of shocks that affect long-run economic growth;
- (iii) Investigating whether shocks hinder the usefulness of fiscal policy rules. How can a low-income country like South Africa retain fiscal policy flexibility without endangering medium-term fiscal-consolidation objectives?<sup>1</sup>

We need to assess the nature and duration of shocks to the South African economy that affect the long-run economic growth.<sup>2</sup> That is, whether the shocks are permanent or temporary is very important in determining the long-run course of economic growth. The South African economy is highly open, and this renders the country particularly susceptible to external shocks. For example, changes in the demand for minerals (especially gold and platinum) and manufactures are very important shocks in the South African economy since these commodities account for a very large proportion in South Africa's exports.

Thus, in pursuing these objectives, the study will help to answer the following questions:

- (e) To what extent have monetary and fiscal policies affected economic growth in South Africa?
- (f) What are the most important shocks that have been affecting long-run economic growth in South Africa? Can the effect be mitigated by public policy interventions aimed at improving the investment climate?
- (g) How have the shocks been affecting monetary and fiscal policies in South Africa? Government expenditure and income tax rate are fiscal policy tools; and nominal interest rate and money stock represent monetary policy instrument.
- (h) What are the policy implications for the results of this study?

### **3.2 Hypotheses and Hypothesis Tests**

The study looks at a number of hypotheses that need to be tested. The following are the most important:

- (i) Economic growth is determined mainly by movements in real effective exchange rate, domestic inflation rate, nominal money supply, government expenditure, tax rate, nominal interest rate, domestic savings and mining production. These are all determinants in equation 2 in their deemed appropriate forms.

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<sup>1</sup> Fiscal-consolidation objectives involve reduction in discretionary public expenditure, i.e., public employment, transfers, public consumption of goods and services, investment, and other capital spending).

<sup>2</sup> See the discussion on long-run and short-run economic growth that follows in section 3.

- (ii) Imports growth hinders economic growth. Since exports changes contribute positively to real GDP growth (economic growth), the study attempts to test the other side of the coin – i.e., whether imports growth inhibit economic growth. The variable  $\ln\_imports$ , in equation 2, which is the natural logarithm of South Africa’s Rand-value imports, captures imports growth.
- (iii) Monetary policy shocks are more important in changing the course of long-run economic growth than are fiscal policy shocks. The “importance” of monetary shocks vis-à-vis fiscal shocks is reflected in the magnitude and length of period of persistence of the impacts on economic growth. Presumably, if say a one standard error shock from monetary policy variables vis-à-vis fiscal policy variables, in general, triggers significantly huge changes to economic growth for at least 4 quarters into the future, then we can say that monetary shocks are more important than fiscal shocks in determining the course of economic growth. The cointegrating vector autoregression system that contains appropriate variables is used to analyse these shocks. The system includes the following variables (with appropriate VAR order): real income growth, growth of net capital inflows (i.e., natural logarithm of net capital inflows), imports growth, nominal interest rate, money supply, total government expenditure, corporate income tax rate, South African inflation rate, USA inflation rate, gross domestic savings growth (i.e., the natural logarithm of gross domestic savings), first difference of total mining production, first difference of the London Price of Gold, effective real exchange rate and total government revenue.

The monetary policy shocks will be triggered from the nominal interest rate and money supply (M1) variables; and the fiscal policy shocks will emanate from total government expenditure and corporate income tax rate variables.

- (iv) External shocks have a minimal effect on the long-run course of economic growth. External shocks come from the USA CPI.<sup>3</sup> “Minimal effect” would be reflected in the shortness of the period over which the impact of external shocks on economic growth persists. This is also treated in the appropriate VECM explained under (iii) above.
- (v) External shocks have a very profound effect on domestic monetary and fiscal policies. Here we would like to investigate whether external shocks – USA nominal interest and USA inflation rate - have reasonably big and persistent impacts on South African monetary and fiscal policy variables in terms of both magnitude and period. If this is true then we would conclude that such external shocks have “profound effect” on the South African monetary and fiscal policy variables. Again, this is taken care of by the appropriate VECM explained in (iii) above.

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<sup>3</sup> The USA is chosen here for it can generally represent the polar case of the developed world vis-à-vis that of the developing world, which South Africa can generally represent. This comparison is important especially in the case of investors comparing the South African real interest rate and that of the developed world interest rates. Since inflation is part of the real interest rate, it will suffice to consider the USA inflation alone.

## 4. Methodology

The empirical tests that employ econometric methods will be undertaken. To address the first objective of the study, we will estimate a *simultaneous-equation system* that includes the following behavioral equations: domestic inflation rate, real income growth, real effective exchange rate, government revenue and net capital inflows. Statistical methods for systems of simultaneous equations capture the mutual dependence among the variables in the model. We are particularly interested in the *full-information maximum likelihood method* as it allows for connections among variables from different equations within the system. Limited information methods do not take into account connections among variables from different equations within the system.

Even though the full information maximum likelihood estimation of a seemingly unrelated regression equations (SURE) system takes into account inter-related error terms in the simultaneous system, the degrees of freedom are calculated as per individual equation. Since all available information is incorporated in a simultaneous-equation system, this produces more efficient estimation. Variables in the system are categorized as endogenous (those explained within the model) and exogenous (those determined outside the model). Simultaneity within the model exists because some endogenous variables appear as explanatory variables in other equations.

However, simultaneous equation methods have a number of limitations. The classification of variables as exogenous or endogenous is subjective. The restrictions used to identify the parameters can lead to the exclusion of relevant variables from some equations. The system parameters are assumed to be independent of changes that would make them subject to the Lucas critique.<sup>4</sup> Lastly, in order to be tractable, the systems have to be relatively simple.

### 4.1 The Simultaneous Equations

We carried out a number of pretests to arrive at the deemed appropriate forms of the variables in the five behavioral simultaneous equations, which are specified as follows.

#### 1. Domestic Inflation Rate

$$SA\% \Delta p_t = f_1(\Delta \text{real income}, \Delta \text{nominal money stock}, \Delta \text{reer}_t, USA\% \Delta p_t, SA\% \Delta p_{t-1})$$

Domestic inflation rate,  $SA\% \Delta p_t$ <sup>5</sup>, is measured by the percentage change over time in South African consumer price index (CPI),  $\Delta \text{real income}$  is the first difference of real

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<sup>4</sup> According to the Lucas critique, since economic policy, by its nature, seeks to change economic relationships (e.g., induce individuals and firms to produce more, save more, invest more, consume less), policy responses cannot be accurately predicted by a model when that policy has been designated to modify the structure of the economy.

<sup>5</sup> The  $\Delta$  is the first difference operator attached to the price variable.

GDP proxied by price-deflated GDP,  $\Delta$ nominal money stock is the first difference of the money supply (M1),  $\Delta$ ere<sub>t</sub> is the first difference of the effective real exchange rate in the current period t<sup>6</sup> and USA% $\Delta$ p<sub>t</sub> is the percentage change over time in the USA CPI that stands for foreign inflation rate. The variables in the domestic inflation equation are in line with the standard approach to the theory of demand for money.

## 2. Real Income Growth (Economic Growth)

$$\Delta \text{real income}_t = f_2(\Delta \text{reer}_t, \text{domestic inflation rate}, \ln\_ \text{imports}, \Delta \text{nominal interest rate}, \text{USA}\% \Delta p_t, \text{USA interest rate}, \text{tax}, \text{total government expenditure}, \Delta \text{money stock}, \ln\_ \text{domestic savings}, \Delta \text{mining production}, \Delta \text{real income}_{t-1})$$

In the real income growth equation,  $\Delta$ real income is the first difference of real GDP proxied by price-deflated GDP,  $\Delta$ ere<sub>t</sub> is the first difference of the effective real exchange rate (as defined in footnote 6), domestic inflation rate is measured by the percentage change over time in South African CPI,  $\ln\_ \text{imports}$  is the natural logarithm of South Africa's Rand-value imports,  $\Delta$ nominal interest rate is the South African nominal interest rates proxied by tender treasury bills - which are average tender rate on 3-month bills,  $\ln\_ \text{domestic savings}$  is the natural logarithm of South Africa's gross domestic savings and  $\Delta$ mining production is first difference of total the Rand-value of mining production in South Africa. Theoretically, real income growth should be related to real exchange rate, Government expenditure, inflation rate, domestic savings and money stock. We have decided to include money supply in the equation despite its perceived long-run neutrality on the influence of real variables such as real income. Mining in South Africa is the main source of income generation and this is why it is included in the equation. Imports are included in this equation so as to test the other side of influence of exports on economic growth.

In macroeconomic sense, if the domestic economy generates insufficient savings, to finance investment, foreign savings, equivalent to the current account deficit, must make up the difference. However, large current account deficits cannot be sustained for very long, unless capital inflows are large and stable, so investment is mainly dependent on domestic savings. The South African policy has been of the view that a key justification for the tight fiscal stance from 1993 was to raise government savings, which had become negative during the early 1990s over expenditure, but have been well above 2.5% since 1999.

## 3. Change in Real Effective Exchange rate

$$\Delta \text{reer}_t = f_3(\Delta \text{nominal money stock}, \Delta \text{nominal interest rate}, \text{USA}\% \Delta p_t, \Delta \text{reer}_{t-1})$$

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<sup>6</sup> The real effective exchange rate is South Africa's real exchange rate that takes a weighted average of its bilateral real exchange rates against its main trading partners. The real effective exchange rate helps to explain the contribution of exchange rates to changes in a country's competitiveness better than simply looking at its real rate against one currency, for example the US dollar, which may be distorted by variations peculiar to the particular foreign currency chosen.



In equation 3,  $\Delta\text{reer}_t$  is the change in the real effective exchange rate (as defined in footnote 4),  $\Delta\text{nominal money stock}$  is the first difference of the money supply (M1),  $\Delta\text{nominal interest rate}$  is the South African nominal interest rates proxied by tender treasury bills, which are average tender rate on 3-month bills and  $\text{USA}\%\Delta p_t$  is the percentage change over time in the USA CPI that stands for foreign inflation rate.

From the theory of exchange rate determination, we use Purchasing Power Parity, interest parity and the monetary theory of the balance of payments to come up with the exchange rate equation. An increase in money stock and inflation is expected to depreciate the exchange rate, and a rise in interest rate is expected to appreciate the exchange rate. Expected inflation rate is not included in this equation because of the currently introduced monetary policy of inflation targeting. With this policy expectations on inflation are of little help in changing the course of the exchange rate.

#### 4. Government Revenue

$$\%\Delta G_t = f_4(\Delta\text{real income}_t, \ln\_ \text{mining production}, \Delta\text{Gold price}, \%\Delta G_{t-1})$$

In equation 4,  $\%\Delta G_t$  is the percentage change in the Rand-value of South African Government revenue,  $\Delta\text{real income}_t$  is the first difference of real GDP proxied by price-deflated GDP,  $\ln\_ \text{mining production}$  is the natural logarithm of total Rand-value of mining production in South Africa and  $\Delta\text{Gold price}$  is the first difference of the London price of Gold. We relate government revenue to the main elements of the tax base: real GDP, mining production and gold sales. Gold price is included in this equation as an index of shifts in the export tax base.

#### 5. Net capital inflows (Net investment)

$$\ln\_ \text{Netcapflows}_t = f_5(\Delta\text{reer}_t, \ln\_ \text{imports}, \text{USA}\%\Delta p_t, \ln\_ \text{Netcapflows}_{t-1})$$

In equation 5,  $\ln\_ \text{Netcapflows}_t$  represents natural logarithm of net capital inflows, which is the actual net investment undertaken in South Africa,  $\Delta\text{reer}_t$  is the first difference of the real effective exchange rate (as defined in footnote 4),  $\ln\_ \text{imports}$  is the natural logarithm of South Africa's Rand-value imports,  $\text{USAnomInterest}$  is the 3-month USA treasury bills and  $\text{USA}\%\Delta p_t$  is the percentage change over time in the USA CPI that stands for foreign inflation rate. The real exchange rate, income tax rate and the real interest rate have a crucial role for capital flows into South Africa. With inflation targeting as a monetary rule in operation in South Africa, the exchange rate movements determine the size of capital flows. An attractive income tax rate is also very essential for inward-investment. Relatively high real interest rates have the benefit of attracting foreign investors. Changes in imports and foreign inflation are included on a priori grounds, i.e. we want to test the effect of these variables on a priori grounds.

We will then investigate the types and channels of shocks that affect long-run economic growth by employing the *Johansen technique*. The *Johansen's method of cointegration* in investigating types and channels of shocks that affect long-run economic growth will augment the simultaneous equation method. The Johansen's technique allows us to yield

impulse responses and variance decompositions of the shocks that affect the equations of domestic inflation, foreign inflation, economic growth, exchange rate, money stock, nominal interest rate, income tax rate, government expenditure, government revenue, imports and investment. This technique attempts to address objectives 2 and 3, outlined above. This will be done by examining the impulse responses (triggered by monetary and fiscal shocks or innovations).<sup>7</sup>

#### **4.2 Johansen's Cointegration Procedure and Long-run Equilibrium Relationships**

The existence of long-run equilibrium (stationary) relationships among economic variables is referred to in the literature as cointegration. The Johansen procedure examines the question of cointegration and provides not only an estimation methodology but also explicit procedures for testing for the number of cointegrating vectors as well as for restrictions suggested by economic theory in a multivariate setting. If the economic variables are found to be cointegrated, we can proceed to utilize the Vector Autoregression (VAR) representation in deriving the impulse response functions and the forecast-error decompositions. The basis of these impulse responses (triggered by monetary/fiscal innovations or shocks) and error decompositions here is the Johansen technique, which precisely looks at a Vector Error Correction Model (VECM).<sup>8</sup>

The most common application of cointegration is to test the existence of long-run relationships. One argument sometimes made is that cointegration is about long-run economic relationships, and one needs really long time series (not in the number of observations but in time span) to use cointegration technique. Maddala and Kim (1999) stress that this is not a meaningful argument for two reasons. (i) If the variables are nonstationary, then existence of a long-run equilibrium economic relationship implies cointegration. But not all cointegrating relationships need have meaning in the sense of long-run economic relationships. Cointegrating relationships need not have any economic interpretation. (ii) How long the long run is depends on the speed of adjustment of the particular markets considered. For financial markets with rapid speeds of adjustment, the long run is indeed short. For goods markets the speeds of adjustment are perhaps slow for some commodities and fast for others. For example, Johansen and Juselius (1990) estimate long-run demand for money functions for Denmark (55 observations) and Finland (67 observations) using quarterly data.

The Johansen (1988, 1991) and Johansen and Juselius (1990) estimation techniques have distinct advantages over Engle and Granger (1987) single equation method because of their estimating values of cointegrating vectors and their optimal statistical inference properties. Johansen's techniques use the full information maximum likelihood (FIML) to estimate the cointegrating vectors, and to test for the order of cointegrating vectors and linear relationships in a multivariate model.

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<sup>7</sup>For a comprehensive literature on cointegration and VECM, see Banerjee et al.(1993) and Enders (1995).

<sup>8</sup>Appendix A2 provides an explanation on cointegration and VECM.

#### **4.2.1 Impulse Response Functions from VECM**

Cochrane (1998) notes that the interpretation of the impulse response functions from a vector autoregression is complicated. An impulse response function for real GDP (economic growth), for example, to a monetary or fiscal policy shock reflects both the effect of the initial innovation and the effect of the predictable subsequent moves in the policy instrument. In the case where only unanticipated changes in a policy variable affect economic growth or investment, the impulse response function simply shows the impact of the innovation. However, anticipated movements in interest rates almost affect economic growth and investment. For example, the response of economic growth to a surprise change in our measure of money supply would be different if a surprise change were typically followed quickly by additional shifts in policy in the same direction than if it were typically followed by large offsetting policy moves. Thus, the impulse response functions from VECM actually capture the combined effects of the initial shock and the later policy moves that are predictable based on the shock.

### **5. Data Sources**

The data set spans over the period 1994.I-2004.II. The variables for which data are sourced include: nominal GDP, nominal money stock, nominal interest rate, home inflation rate, domestic savings, foreign inflation rate (US price index), South African mining production, Gold price, income tax rate, imports, government revenues and net capital flows. The sources of these data will be *IMF* International Finance Statistics, the World Bank and the South African Reserve Bank.

The measure of the nominal stock of money, M1, is defined as the currency outside banks plus demand deposits. The measure of the nominal interest rate is the 90-day Treasury Bill rate. The measure of the price level is the consumer price index. The level of real income is measured by real GDP.

### **6. Empirical Results and Analysis**

#### **6.1 The Simultaneous-Equation system Results**

We used the method of seemingly unrelated regression equations (SURE) to estimate the parameters of the simultaneous-equation system. The results are given in the tables that follow.

**Table 1a**  
**Dependent Variable: Inflation Rate (CPISA)**

Regressor	Coefficient	Standard Error	T-Ratio [Prob]
Constant	9.43	3.69	2.56 [0.02]
$\Delta$ RGDP	-1.62	0.27	-6.00 [0.00]
$\Delta$ M1	0.21	0.08	2.63 [0.01]
$\Delta$ CPUSA(-2)	-3.13	0.84	-3.70 [0.00]
CPISA(-1)	0.97	0.03	32.33 [0.00]

Note: F-stat.  $F(4, 34) = 259.7104$  [0.000]

**Table 1b**  
**Dependent Variable: Real Income Growth (RGDP)**

Regressor	Coefficient	Standard Error	T-Ratio [Prob]
Constant	56.99	26.81	2.13 [0.04]
logIMPTS	-2.08	1.26	-1.65 [0.10]
$\Delta$ IRATE	-0.36	0.13	-2.77 [0.01]
$\Delta$ CPUSA(-1)	-0.16	0.30	-0.53 [0.60]
$\Delta$ M1	0.07	0.03	2.33 [0.02]
USAINT(-2)	-0.17	0.06	-2.83 [0.01]
TGEXP	-0.11	0.03	-3.67 [0.00]
TAX	-0.15	0.05	-3.00 [0.00]
logGDS	1.19	1.59	0.75 [0.46]
logTMPROD(-1)	7.35	5.47	1.34 [0.19]
RGDP(-1)	0.80	0.09	8.89 [0.00]

Note: F-stat.  $F(10, 28) = 2.0446$  [0.066]

**Table 1c**  
**Dependent Variable: Change in Real Effective Exchange Rate ( $\Delta$ REER)**

Regressor	Coefficient	Standard Error	T-Ratio [Prob]
Constant	-3.27	2.15	-1.52 [0.14]
$\Delta$ M1(-1)	-0.30	0.16	-1.88 [0.08]
$\Delta$ IRATE	0.57	0.89	0.64 [0.53]
$\Delta$ CPUSA	3.55	1.93	1.84 [0.08]
$\Delta$ REER(-1)	-0.56	1.13	4.31 [0.00]

Note: F-stat.  $F(4, 34) = 2.5301$  [0.058]

**Table 1d**  
**Dependent Variable: Total Government Revenue (TGREV)**

Regressor	Coefficient	Standard Error	T-Ratio [Prob]
Constant	105.03	139.26	0.75 [0.46]
$\Delta$ RGDP	1.02	0.56	1.82 [0.08]
logTMPROD	-7.98	30.11	-0.27 [0.79]
$\Delta$ GLOPRC	0.01	0.01	1.00 [0.29]
logIMPTS	-5.03	2.68	1.88 [0.07]
TGREV(-1)	-0.15	0.16	-0.94 [0.34]

Note: F-stat.  $F(5, 33) = 0.628$  [0.862]

**Table 1e**  
**Dependent Variable: Natural Logarithm of Net Capital Flows (logNCPF)**

Regressor	Coefficient	Standard Error	T-Ratio [Prob]
Constant	-3.75	2.81	-1.33 [0.19]
logIMPTS	0.73	0.30	2.43 [0.02]
$\Delta$ IRATE	0.11	0.07	1.57 [0.10]
logNCPF(-1)	0.58	0.10	5.80 [0.00]

Note: F-stat.  $F(3, 35) = 27.1680$  [0.000]

Table 1a contains results of estimation of our simultaneous equation system for the inflation equation and it shows that the changes-in-money-stock variable,  $\Delta M1$ , has a significantly positive effect on the South African inflation rate at 5% level of significance. Changes in real GDP and two-period lagged US CPI (approximating foreign inflation) have significant negative effects on the South African inflation rate. There is also a positive and significant dynamic feedback on the South African inflation rate.

In Table 1b we can see that current real income growth is positively related to gross domestic savings (logGDS), changes-in-the-money-stock variable ( $\Delta M1$ ), one-period lagged growth of total mining production and one-period lagged values of real income growth. On the other hand, the growth in real income is negatively related to imports (logIMPTS), total government expenditure (TGEXP), tax, two-period lagged USA interest rate, one-period lagged changes in the USA CPI and changes in the South African nominal interest rate ( $\Delta$ IRATE). Most of these effects, positive or negative, are quite significant at the 5% level of significance.

In Table 1c, current changes in the real effective exchange rate are negatively related to changes in the money stock and one-period lagged changes in the real effective exchange rate, and positively related to changes in the foreign inflation (approximated by changes in the US CPI) and South African nominal interest rate. All these effects, but that of changes in nominal interest rate, are significant at the 10% level of significance. However, only the one-period lagged changes in the real effective exchange rate is

significant at the 5% level of significance. We also note that the negative effect of changes in the nominal money stock on the real effective exchange rate is in line with a priori expectations. Increasing the nominal money stock should lead to a depreciation of the real effective exchange rate through a transmission mechanism of the increasing domestic prices.

Total government revenue in table 1d is insignificantly positively related to changes in the real GDP and changes in the London price of gold, and insignificantly negatively related to imports, changes in the growth of total mining and one-period lagged values of total government revenue at the 5% level of significance.

The last table, Table 1e, shows that the net capital flows variable (net investment) is significantly positively influenced by imports expenditure and one-period lagged values of the growth of net capital flows at the 5% level of significance. The South African nominal interest rate does not quite significantly affect net capital flows in South Africa.

## **6.2 Unit Root and Co-integration tests**

Augmented Dickey-Fuller tests for stationarity indicate that the following series are integrated of order 1: real GDP, money stock, natural logarithm of imports, natural logarithm of net capital flows, nominal interest rate, total government expenditure and gross domestic expenditure. The univariate analysis of the nonstationary series indicates that these variables can be characterised as I(1) processes. On the other hand, the following series are integrated of order zero (or stationary): changes in the South African CPI, changes in the US CPI, natural logarithm of gross domestic savings, changes in total mining production, changes in the London price gold, real effective exchange rate and total government revenue. These results are displayed in Table 2 below.

**Table 2: Unit Root Test Results**

Variable	ADF statistic	Order of Integration
RGDP	-2.75	I(1)
M1	-2.55	I(1)
$\Delta$ CPISA	-3.93	I(0)
$\Delta$ CPIUSA	-4.78	I(0)
logIMPTS	-1.28	I(1)
logGDS	-5.11	I(0)
logTMPROD	-6.38	I(0)
$\Delta$ GLOPRC	-3.74	I(0)
logNCPF	-2.70	I(1)
IRATE	-2.02	I(1)
REER	-5.17	I(0)
TGREV	-6.06	I(0)
TGEXP	-3.32	I(1)
GDEXP	-1.92	I(1)
TAX	-2.10	I(1)

Note: ADF critical value at 5% is  $-3.54$ ; and the DF regressions include an intercept and a linear trend.

Two or more variables are cointegrated if they have a long-term, or equilibrium, relationship between them. While the method of Engle and Granger (1987) only applies to the single equation estimation to test for cointegration between variables, the estimation techniques by Johansen (1988, 1991) estimate the cointegrating vectors, and test for the order of cointegrating vectors and linear relationships in a multivariate model. In a vector autoregression, cointegration between variables gives an indication that a shock to any one of the equations will trigger responses from the rest of the equations in the system. Table 3 is a summary of results of co-integration analysis using the Johansen maximum likelihood approach, i.e., the co-integration likelihood ratio tests based on maximal eigenvalues and trace of the stochastic matrix. Both tests confirm that there are only two co-integrating vectors in the given set of variables.

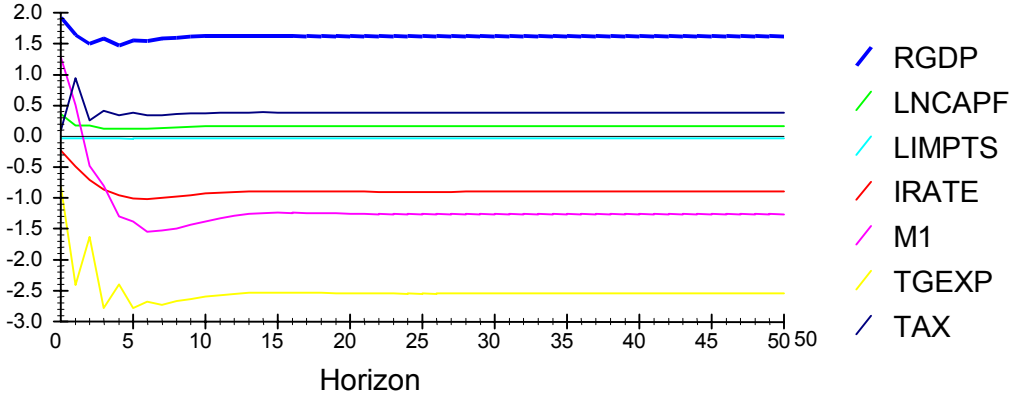
**Table 3: Johansen Cointegration Results based on the Trace and Maximal Eigen Value Test Statistics**

Max. eigenvalue stat.	(5% crit. value)	Trace stat.	(5% crit. value)
32.14	(33.64)	69.81	(70.49)

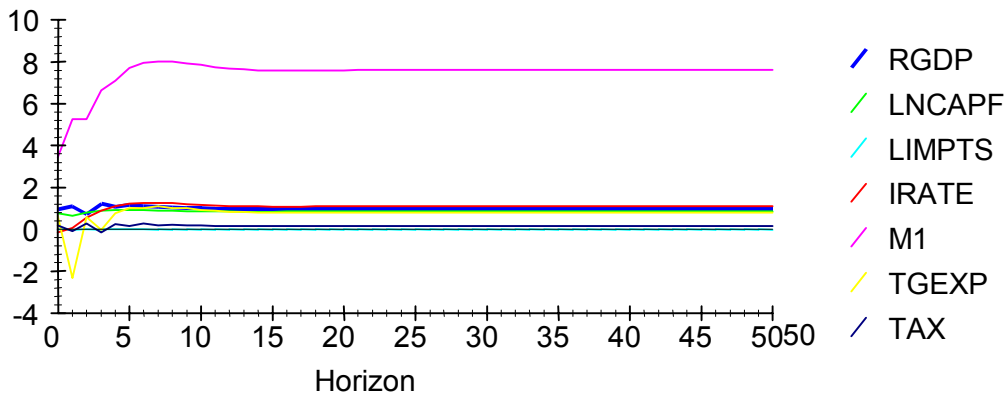
Note: The null hypothesis of  $r \leq 2$  is set against the alternative hypothesis of  $r = 3$  for the maximum eigen value test and the null hypothesis of  $r \leq 2$  is set against the alternative hypothesis of  $r \geq 3$  for the trace test.

### 6.3 Shocks and Impulse Responses

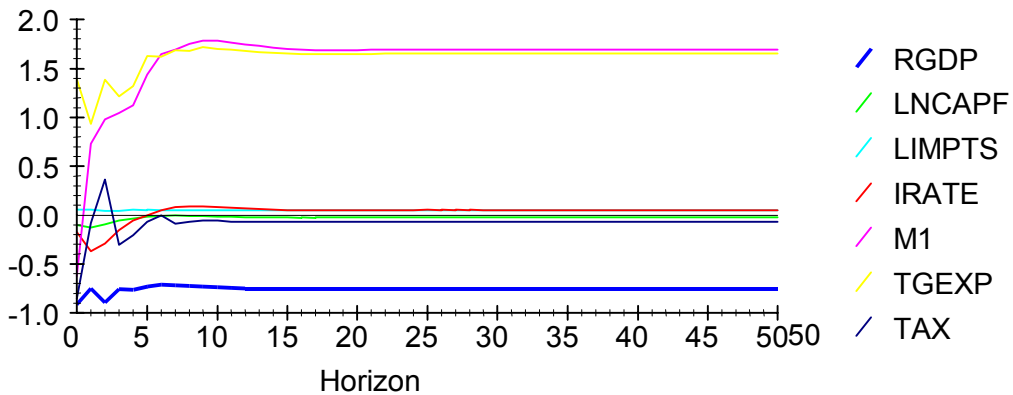
**Figure 1a: Impulse Responses to one S.E. shock in the equation for RGDP**



**Figure 1b: Impulse Responses to one S.E. shock in the equation for LNCAPF**

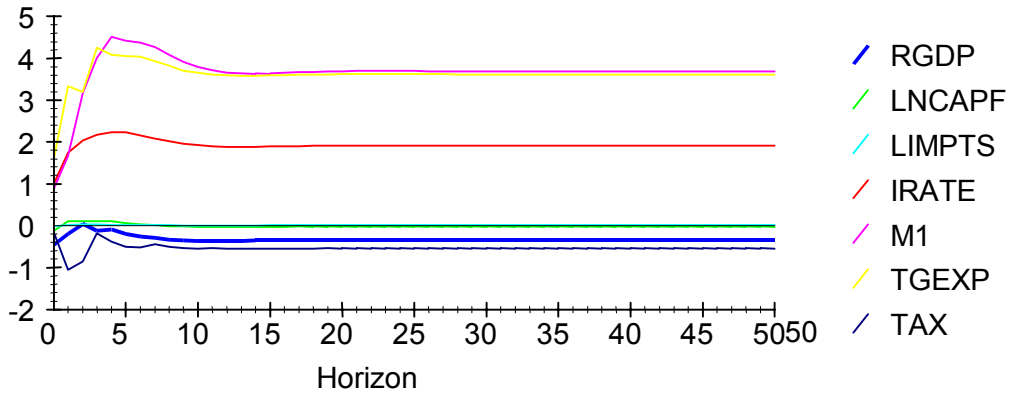


**Figure 1c: Impulse Responses to one S.E. shock in the equation for LIMPTS**

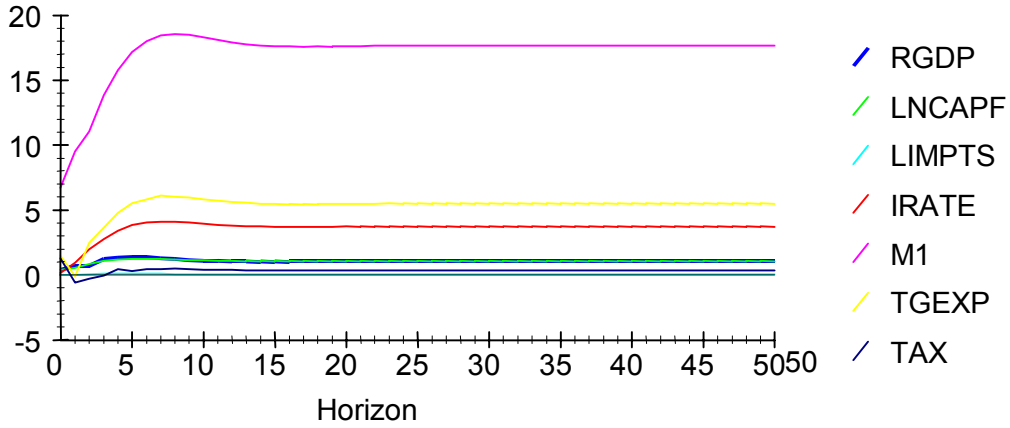




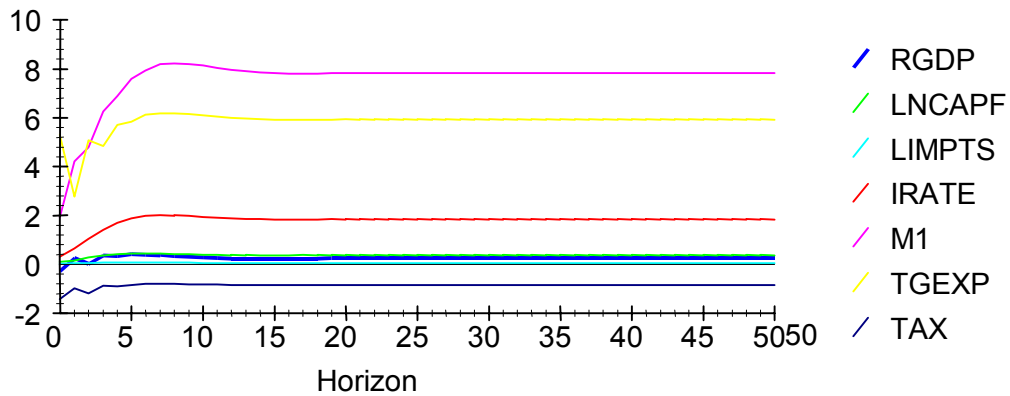
**Figure 1d: Impulse Responses to one S.E. shock in the equation for IRATE**



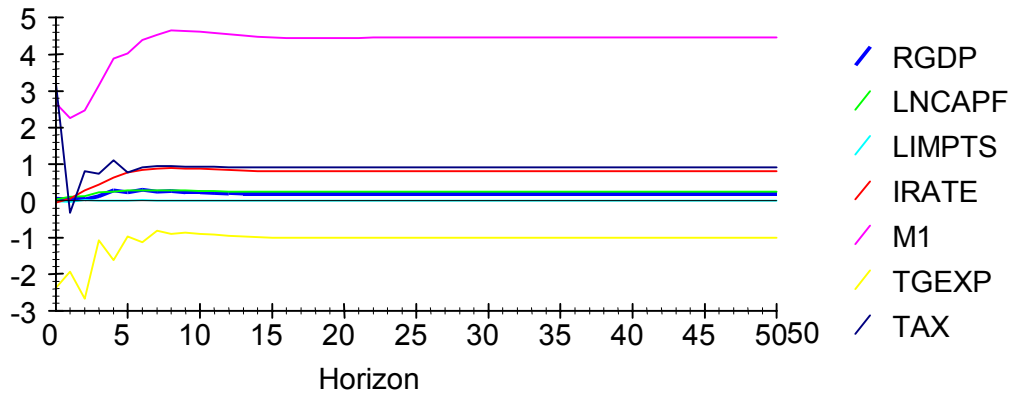
**Figure 1e: Impulse Responses to one S.E. shock in the equation for M1**



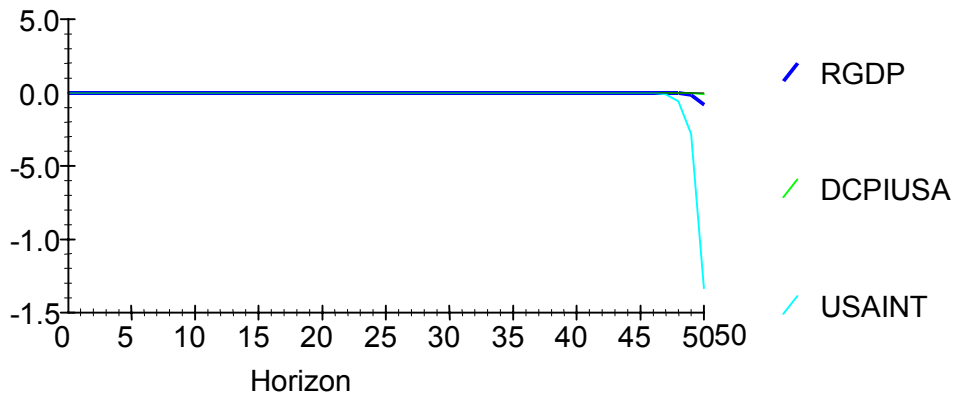
**Figure 1f: Impulse Responses to one S.E. shock in the equation for TGEXP**



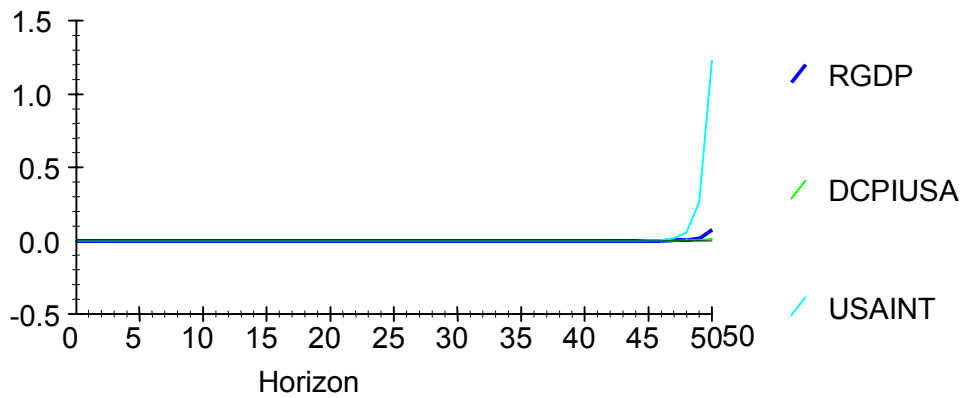
**Figure 1g: Impulse Responses to one S.E. shock in the equation for TAX**



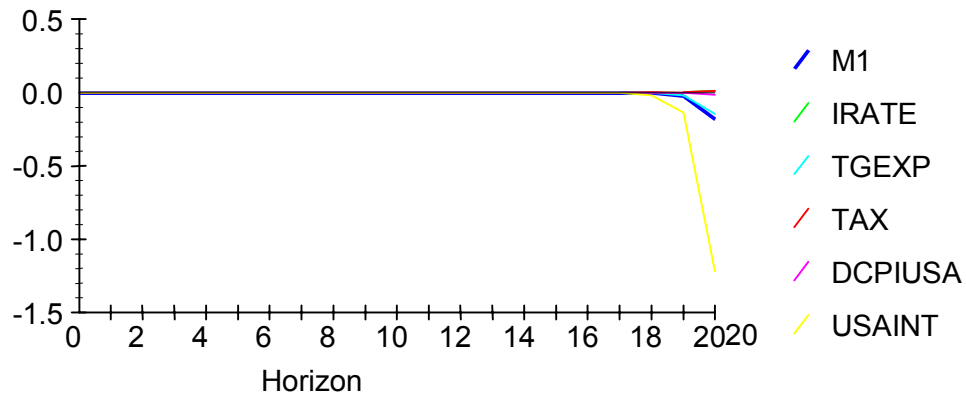
**Figure 1h: Impulse Responses to one S.E. shock in the equation for  $\Delta$ CPIUSA**



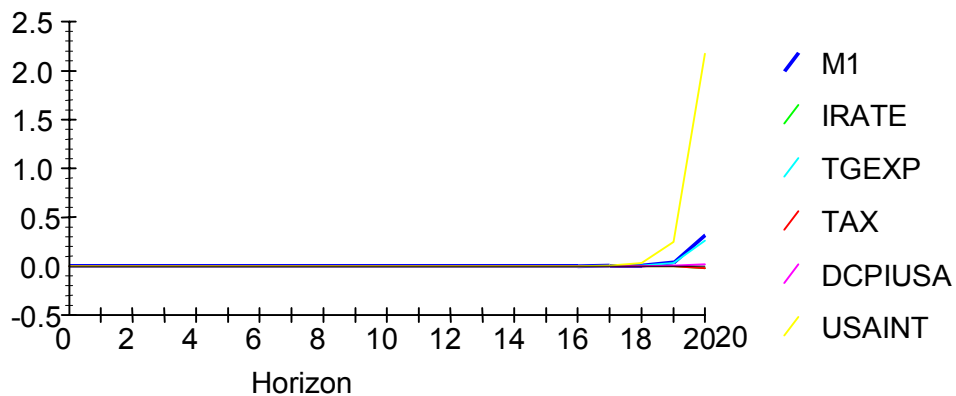
**Figure 1i: Impulse Responses to one S.E. shock in the equation for USAINT**



**Figure 1j: Impulse Responses to one S.E. shock in the equation for DCPIUSA**



**Figure 1k: Impulse Responses to one S.E. shock in the equation for USAINT**



In each one of the graphs in Figure 1, we have a plot of the impulse response function of a shock (equal to one estimated standard error) to a given equation in the cointegrating VAR model. In Figure 1a, the impact effect of a unit shock in real GDP – real output - (measured as one standard error) on the money stock is positive. This impact effect contrasts with that of the nominal interest rate, which is negative. But the subsequent effect of the real output on the two monetary policy variables decline steadily for the first quarters and then remains constant over the rest of the horizon.

Again, the impact effect of the real output on total government expenditure is negative, then, subsequently, the response function declines during the first five quarters and finally it remains constant over the rest of the horizon. On the other hand, the impact

effect of the real output shock on tax is positive but relatively small. The effect of the real output on tax increases to 1% of a unit of tax rate during the first quarter, then decline in the second quarter and finally remains constant at 0.25% of a unit of tax rate over the remainder of the horizon.

There is a positive impact effect of the real output shock on the net capital flows and this remains constant generally over the whole horizon. We can also see that there is a zero effect on the imports over the given horizon as a result of the real output shock. We also note that the largest positive impact of the real output shock is exerted on the real output itself.

In Figure 1b, we can see that the impact effect of the one standard error shock in the equation for net capital flows (net investment) on money stock is relatively large (4%). The subsequent effect rises to 8% by the fifth quarter and remains at this level over the rest of the horizon. Most of the effect of the net capital inflows shock on nominal interest rate, total government expenditure, real output and net capital flows itself is at a constant level of 1% over the given horizon. But there is almost zero effect of the net capital flows shock on tax and imports over the given horizon.

Figure 1c shows that the impact effect of the imports shock is negative. By the fifth quarter the effect rises to 1.75% and remains at this level, together with the effect on total government expenditure, over the remainder of the given horizon. There is also a significant effect of the imports shock on the real output: the impact effect is negative (roughly -0.9%) and the subsequent effect roughly remains constant at this level over the given horizon. Most of the effect of the imports shock on the imports and nominal interest rate is, in each case, slightly above 0% level over the horizon. On the other hand, most of the effect of the imports shock on tax is slightly below 0% over the given horizon. Net capital flows generally responds at 0% level to the imports shock.

We can see in figure 1d that while the impact effect of the nominal interest rate shock (a monetary policy shock) on the nominal interest rate and the money stock is the same (positive and given by 1%), by the fifth quarter, the subsequent effect on the money stock rises to 4.5% and roughly remains constant at this level over the rest of the given horizon. By the fifth quarter, the subsequent effect of the nominal interest rate on itself rises to 2% and remains constant at this level over the remainder of the given horizon.

The impact effect of the money supply shock on the total government expenditure is positive (2%). But by the third quarter, the subsequent effect of the money supply shock rises to 4.5% and this remains constant over the rest of the given horizon. We also note that the nominal interest rate has roughly no effect on the net investment over the given horizon. Most of the nominal interest rate shock on the real output, tax and imports is at a constant level of about, respectively, -0.3%, -0.5% and -0.5% over the given horizon.

We can see in Figure 1e that, overall, the money stock shock (a monetary policy shock) exerts the largest and positive (18%) effect on the money stock variable over the given horizon. Most of the effect of the money stock shock on the total government expenditure

(a fiscal policy variable) remains at a constant level of 5% over the horizon. The effect on the nominal interest rate (a monetary policy variable) due to the money stock shock is at a constant level of 3%. It is also interesting to note that this type of monetary policy shock exerts a positive effect on the real output and net capital flows at a constant level of 1% over the given horizon. Lastly, the effect of the money stock shock on the imports and tax variables is relatively insignificant.

In Figure 1f, for most part of the given horizon, the impulse response functions for money stock, total government expenditure and nominal interest rate, as a result of the total government expenditure shock (a fiscal policy shock), are positive and remain constant at 8%, 6% and 2%, respectively. On the other hand, the impulse responses for imports, net capital flows and real output are relatively close to zero. And the effect of this type of fiscal policy variable on tax is negative and remains at a constant level of 1% over the given horizon.

In Figure 1g, the effect of the tax shock (a fiscal policy shock) on the money stock, over the given horizon, is mostly at a constant level of 4.5%. The impulse response functions for tax and nominal interest rate roughly remains at a constant level of 1%, while those of net capital flows, real output and imports are relatively close to zero. Finally, the impulse response for the total government expenditure due to this fiscal policy shock is negative and the function lies at a constant level of -1% over most of the given horizon.

Figures 1h and 1i show, respectively, that a one standard error shock from changes in the US CPI (which is our foreign inflation shock) and from the US nominal interest rate (which is our foreign monetary shock) have a zero effect on the real output (real GDP) over the entire given horizon.

In Figures 1j and 1k, we see how South African monetary and fiscal variables respond to the foreign shocks (shocks from the US nominal interest rate and changes in CPI). In both figures, there are no effects on South African tax rate and nominal interest rate due to the foreign shocks – those from the US inflation and nominal interest rate - over the given horizon. The other South African monetary and fiscal variables – money stock and total government expenditure – start to respond to the foreign shocks only after 18 quarters. At the beginning of quarter 19, the effects on these variables start to become positive in the case of the foreign inflation shock and negative in the case of the foreign nominal interest rate.

#### **6.4 Tests on Granger Causality**

Granger (1969) starts from the premise that the future cannot cause the present or the past. Strictly speaking, the term “Granger causality” means “precedence”. For instance, do movements in prices precede movements in interest rates, or is it the opposite, or are the movements contemporaneous? This is the purpose of Granger causality. It is not causality, as it is usually understood.

Granger devised some tests for causality that proceed as follows. Consider two time series,  $\{RGDP_t\}$  and  $\{TGEXP_t\}$ ; where  $RGDP$  is the real income growth series and  $TGEXP$  is the total government expenditure series. The series  $TGEXP_t$  fails to Granger cause  $RGDP_t$  if in a regression of  $RGDP_t$  on lagged  $RGDP$ 's and lagged  $TGEXP$ 's, the coefficients of the latter are zero. Similarly, in a regression of  $TGEXP_t$  on lagged  $RGDP$ 's and lagged  $TGEXP$ 's, if the coefficients of the former are zero, then  $RGDP_t$  fails to Granger cause  $TGEXP_t$ . That is, consider

$$RGDP_t = \sum_{i=1}^k \alpha_i RGDP_{t-i} + \sum_{j=1}^k \beta_j TGEXP_{t-j} + u_{1t} \quad \text{and}$$

$$TGEXP_t = \sum_{i=1}^k \lambda_i RGDP_{t-i} + \sum_{j=1}^k \delta_j TGEXP_{t-j} + u_{2t}$$

where the disturbances  $u_{1t}$  and  $u_{2t}$  are assumed to be uncorrelated. Then if  $\beta_j = 0$  and  $\lambda_i = 0$  ( $i, j = 1, 2, \dots, k$ ),  $TGEXP_t$  fails to cause  $RGDP_t$  and  $RGDP_t$  fails to cause  $TGEXP_t$ , respectively. Thus, Granger causality or noncausality is concerned with whether lagged values of  $TGEXP$  do or do not improve on the explanation of  $RGDP$  (in the first equation above) obtainable from only lagged values of  $RGDP$  itself.

Note that the direction of causality may depend critically on the number of lagged terms included in the regression. The Granger causality test is very sensitive to the number of lags used in the analysis. Thus, the lag length is very important in determining whether there is unidirectional causality or bilateral causality (feedback) in a given regression equation.

Table 4 gives results on Granger Causality tests. In carrying out the test of causality between real GDP growth and total government expenditure, for example, the null hypothesis is set thus  $H_0: \beta_j = 0$ , i.e., the  $TGEXP_{t-j}$  do not belong in the regression. The results in Table 4 indicate that there is a unidirectional causality between the real GDP growth and the natural logarithm of net capital flows. This causality runs from the net capital flows to the real GDP growth. We also see that no causality exists between (i) the real GDP growth and the nominal interest rate, and the real GDP growth and the nominal money stock. This result confirms that the concept of neutrality of money on output is at play here. Another outcome of interest is the bilateral causality that exists between (i) the real GDP growth and total government expenditure, and (ii) the nominal interest rate and the nominal money stock.

**Table 4: Results on Granger Causality Tests**

Direction of causality	Computed $F$ value	Crit. $F$ value at 5%	Decision
logNCPF $\rightarrow$ RGDP	4.2548	3.2750	Reject the null hypothesis
RGDP $\rightarrow$ logNCPF	0.0910	3.2750	Do not reject the null hypothesis
logIMPTS $\rightarrow$ RGDP	4.2586	3.2750	Reject the null hypothesis
RGDP $\rightarrow$ logIMPTS	3.1428	3.2750	Do not reject the null hypothesis
IRATE $\rightarrow$ RGDP	3.1230	3.2750	Do not reject the null hypothesis
RGDP $\rightarrow$ IRATE	0.9724	3.2750	Do not reject the null hypothesis
M1 $\rightarrow$ RGDP	1.1491	3.2750	Do not reject the null hypothesis
RGDP $\rightarrow$ M1	0.3158	3.2750	Do not reject the null hypothesis
TGEXP $\rightarrow$ RGDP	4.6383	3.2750	Reject the null hypothesis
RGDP $\rightarrow$ TGEXP	3.3402	3.2750	Reject the null hypothesis
TAX $\rightarrow$ RGDP	3.9339	3.2750	Reject the null hypothesis
RGDP $\rightarrow$ TAX	0.2392	3.2750	Do not reject the null hypothesis
M1 $\rightarrow$ IRATE	5.8128	3.2750	Reject the null hypothesis
IRATE $\rightarrow$ M1	6.7738	3.2750	Reject the null hypothesis
TAX $\rightarrow$ TGEXP	3.5832	3.2750	Reject the null hypothesis
TGEXP $\rightarrow$ TAX	0.1973	3.2750	Do not reject the null hypothesis

## 7. Hypotheses versus Results

Our first hypothesis is confirmed by the results given in Table 1b. Most of the available estimated coefficients are individually significant in this table of results. The overall significance of the regressors is also impressive at 10% level as the given estimated  $F$ -statistic has a low probability value of 0.06, which is much smaller than 0.10.

The second hypothesis has been confirmed by the result in Table 2 in the sense that the estimated coefficient of the natural logarithm of imports is negative. The estimated negative coefficient on the imports variable, is significant at 10% significance level, can be interpreted as follows: a 1% increase in the Rand value of imports is followed by a very small decrease of about 0.02% of a unit change in real income growth. Thus, imports growth inhibits economic growth in South Africa.

We, however, note that the third hypothesis fails to hold as evidenced by the ensuing impulse response functions of the real economic growth variable due to shocks triggered in both the monetary and fiscal equations – nominal interest rate and money stock are monetary variables, and total government expenditure and corporate income tax rate are fiscal variables. In fact, the dynamic response paths of the real economic growth due to the money stock shock, total government expenditure and tax rate lie slightly above zero

and are roughly similar over the given horizon. The response path of the real economic growth due to the nominal interest rate lies slightly below zero. All these responses are not significantly different from zero (see Figures 1d, 1e, 1f and 1g). Thus, our results do not delineate clearly the impulse responses of the real economic growth due to monetary shocks from those due to fiscal shocks.

Our fourth hypothesis is confirmed by the results in Figures 1h and 1i. From these graphs in these figures, we can see that the foreign inflation shock (a one standard error shock to changes in the US CPI) and the foreign monetary shock (which is approximated by the US nominal interest rate shock) have literally no effect on the real GDP (real output) over the given horizon.

The final hypothesis is apparently shot down. The results in Figures 1j and 1k show that in both figures there are no effects on South African tax rate and nominal interest rate due to the foreign shocks – represented by the US inflation and nominal interest rate shocks - over the entire horizon. On the other hand, the South African money stock and total government expenditure begin to respond to the foreign shocks at the beginning of quarter 19. At the beginning of quarter 19, the effects on these monetary and fiscal variables begin to rise above zero in the case of the US inflation shock and to fall in the case of the US nominal interest rate. Thus, as evidenced from these figures, the external shocks do not have profound effects on the South African monetary and fiscal policies.

## **8. Summary of Findings and Conclusions**

The results of estimating of a simultaneous equation system show that real income growth is positively related to gross domestic savings, changes-in-the-money-stock variable, total mining production and its own past values. On the other hand, the growth in real income is negatively related to imports, total government expenditure, tax, USA interest rate, changes in the USA CPI and changes in the South African nominal interest rate.

On the other hand, from the same results of simultaneous-equation system, changes in the real effective exchange rate are negatively related to changes in the money stock and its own past values, and positively related to changes in the foreign price and domestic nominal interest rate. We note that the negative effect of changes in the nominal money stock on the real effective exchange rate is in accordance with theoretical expectations. If there is an increase in the domestic nominal money stock, this should lead to an appreciation of the exchange rate through a transmission mechanism of the rising domestic prices. We also find that net investment is significantly positively influenced by imports expenditure, domestic interest rate and its own past values.

The hypothesis that imports growth hinders economic growth is confirmed by the simultaneous equation regression since the estimated coefficient of the natural logarithm of imports is negative. The estimated negative coefficient on the imports variable is significant at 10% significance level and can be interpreted as follows: a 1% increase in



the Rand value of imports is followed by a decrease of about 0.02% of a unit change in real income growth. Thus, imports growth pushes down economic growth in South Africa.

However, the hypothesis that monetary policy shocks are more important in changing the course of long-run economic growth than are fiscal policy shocks is not confirmed as evidenced by the impulse response functions of the real economic growth variable due to shocks triggered in both the monetary and fiscal equations – nominal interest rate and money stock are monetary variables, and total government expenditure and corporate income tax rate are fiscal variables. Our results do not delineate clearly the impulse responses of the real economic growth due to monetary shocks from those due to fiscal shocks.

Foreign inflation shock (approximated by a one standard error shock to changes in the US CPI) and the foreign monetary shock (approximated by the US nominal interest rate shock) have literally no effect on the real GDP (real output) over the given horizon. This result confirms the hypothesis that external shocks have a minimal effect on the long-run course of economic growth in the South African economy.

The results also fail to confirm the hypothesis that external shocks have a very profound effect on South African monetary and fiscal policies. The impulse response functions show that there are no effects on South African tax rate and nominal interest rate due to the foreign shocks – represented by the US inflation and nominal interest rate shocks - over the entire horizon. And the South African money stock and total government expenditure begin to respond to the foreign shocks at the beginning of quarter 19. At that point, the effects on these monetary and fiscal variables begin to rise above zero in the case of the US inflation shock and to fall in the case of the US nominal interest rate.

In general, these results tell us that domestic nominal interest rate, corporate income tax, money stock domestic savings and imports determine economic growth in South Africa. On the other hand, total mining production and total government expenditure do not influence economic growth. Both monetary and fiscal policy shocks are not important in determining the long-run course of economic growth. While net capital inflow shocks have a small positive effect on economic growth, imports shocks have a negative one. External shocks do not affect the long-run path of economic growth, and fiscal and monetary policy variables.

However, our results should be received with some caution. The method of simultaneous-equation system has a number of shortcomings. First, it is noted that the classification of variables as exogenous or endogenous is subjective in this method. Second, the restrictions used to identify the parameters can lead to the exclusion of relevant variables from some equations. Third, the system parameters are assumed to be independent of changes that would make them subject to the Lucas critique. Lastly, in order to be tractable, the systems have to be relatively simple.

On the other hand, the results on the impulse response functions may not capture the reality of how the economy is responding to policy shocks. For example, an impulse response function for real GDP (economic growth) to a monetary or fiscal policy shock would reflect both the effect of the initial innovation and the effect of the predictable subsequent move in the policy instrument. In the case where only unanticipated changes in a policy variable affect economic growth, the impulse response function simply would show the impact of the innovation. However, anticipated movements in interest rates almost affect economic growth. The response of economic growth to a surprise change in the nominal money supply would be different if a surprise change were typically followed quickly by additional shifts in policy in the same direction than if it were typically followed by large offsetting policy moves.

What policy implications can we draw from the outcome of our analysis? By the look of things, the South African government is not doing enough to stimulate economic growth in the economy. Its current fiscal and monetary policies have not produced desirable robust results. A solution could emerge from the monetary side: the monetary authorities can afford to cut down the nominal interest rate during recession periods in order to stimulate capital inflow for domestic investment so as to boost economic growth. The optimal reduction in the nominal interest rate would still ensure that the ex-post real exchange rate does not rise above the ideal real exchange rate. One fiscal solution is offering foreign investors substantial tax holidays or tax cuts.

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## APPENDIX

### A1: Definition of Variables

CPISA	= consumer price index for South Africa
CPIUSA	= consumer price index for USA
TMPROD	= total mining production $r$ = real interest rate
logNCAPF	= net capital flows
GLOPRC	= London price of Gold
GDS	= gross domestic saving
IMPTS	= imports
RGDP	= real gross domestic product
M1	= nominal money stock measure
$\Delta$ CPISA	= first-differenced consumer price index for South Africa
$\Delta$ CPIUSA	= first-differenced consumer price index for USA
logIMPTS	= natural logarithm of imports
logGDS	= natural logarithm of gross domestic saving
logTMPROD	= natural logarithm of total mining production
$\Delta$ GLOPRC	= first-differenced London price of Gold
logNCPF	= natural logarithm of net capital flows
$\Delta$ RGDP	= first-differenced real gross domestic product
$\Delta$ M1	= first-differenced nominal money stock measure
IRATE	= domestic nominal interest rate
REER	= real effective exchange rate
$\Delta$ REER	= first-differenced real effective exchange rate
USAINT	= nominal interest rate for USA
TGREV	= total government revenue
TGEXP	= total government expenditure
GDEXP	= gross domestic expenditure
TAX	= corporate income tax rate

## A2: Cointegration and Vector Error Correction Model

Cointegration occurs when the variables in a model are nonstationary, but the trends of the variables are related in a way so that the error term observations are stationary. The presence of cointegration enables us to proceed as if the variables were stationary. For cointegration to take place, the variables must be nonstationary to the same extent, and this nonstationary aspect from the different variables must cancel each other out.

Suppose that we have two nonstationary time series,  $x$  and  $y$ , which are precisely integrated of order 1. If  $x$  and  $y$  are cointegrated with parameter  $\beta$ , then we have additional variables that we can include in the following first-difference equation

$$\Delta y_t = \alpha_0 + \alpha_1 \Delta y_{t-1} + \gamma_0 \Delta x_t + \gamma_1 \Delta x_{t-1} + u_t \quad (\text{A2.1})$$

Let  $s_t = y_t - \beta x_t$ , so that  $s_t$  is  $I(0)$  (i.e., stationary), and assume for the sake of simplicity that  $s_t$  has zero mean. Now we can include lags of  $s_t$  in equation (A2.1). In the simplest case we include one lag of  $s_t$ :

$$\begin{aligned} \Delta y_t &= \alpha_0 + \alpha_1 \Delta y_{t-1} + \gamma_0 \Delta x_t + \gamma_1 \Delta x_{t-1} + \delta s_{t-1} + u_t \\ &= \alpha_0 + \alpha_1 \Delta y_{t-1} + \gamma_0 \Delta x_t + \gamma_1 \Delta x_{t-1} + \delta (y_{t-1} - \beta x_{t-1}) + u_t \end{aligned} \quad (\text{A2.2})$$

where  $E(u_t | I_{t-1}) = 0$ , and  $I_{t-1}$  contains information on  $\Delta x_t$  and all past values of  $x$  and  $y$ . The term  $\delta(y_{t-1} - \beta x_{t-1})$  is called the *error correction term*, and equation (A2.2) is an example of an **error correction model**. An error correction model allows us to study the short-run dynamics in the relationship between  $y$  and  $x$ . For simplicity consider the model without lags of  $\Delta y_t$  and  $\Delta x_t$ :

$$\Delta y_t = \alpha_0 + \gamma_0 \Delta x_t + \delta (y_{t-1} - \beta x_{t-1}) + u_t \quad (\text{A2.3})$$

where  $\delta < 0$ . If  $y_{t-1} > \beta x_{t-1}$ , then  $y$  in the previous period has overshot the equilibrium; because  $\delta < 0$ , the error correction term works to push  $y$  back towards the equilibrium. Similarly, if  $y_{t-1} < \beta x_{t-1}$ , the error correction term induces a positive change in  $y$  back towards the equilibrium.

Consider the following model.

$$y_t = \alpha_0 + \alpha_1 y_{t-1} + \alpha_2 y_{t-2} + \dots \quad (\text{A2.4})$$

The model in equation (A2.4) is one equation in what is known as a **vector autoregressive (VAR) model**. In an autoregressive model, we model a single series  $\{\Delta y_t\}$ , for example, in terms of its own past. In vector autoregressive models, we model several series – which is where the word vector comes from – in terms of their own past. If we have two series,  $y_t$  and  $z_t$ , a vector autoregression consists of equations that look like

$$y_t = \delta_0 + \alpha_1 y_{t-1} + \gamma_1 z_{t-1} + \alpha_2 y_{t-2} + \gamma_2 z_{t-2} \dots$$

and

$$y_t = \eta_0 + \varphi_1 y_{t-1} + \lambda_1 z_{t-1} + \varphi_2 y_{t-2} + \lambda_2 z_{t-2}, \dots \quad (\text{A2.5})$$

where each equation contains an error that has zero expected value given past information on  $y$  and  $z$ . We can extend this to the  $n$ -variable model. Formally, the  $(n \times 1)$  vector  $x_t = (x_{1t}, x_{2t}, \dots, x_{nt})'$  has an error-correction representation if it can be expressed in the form:

$$\Delta x_t = \pi_0 + \pi x_{t-1} + \pi_1 \Delta x_{t-1} + \pi_2 \Delta x_{t-2} + \dots + \pi_p \Delta x_{t-p} + \varepsilon_t \quad (\text{A2.6})$$

where  $\pi_0 = (n \times 1)$  vector of intercept terms with elements  $\pi_{i0}$   
 $\pi =$  matrix with elements  $\pi_{jk}$  such that one or more of the  $\pi_{jk} \neq 0$   
 $\pi_i = (n \times n)$  coefficient matrices with elements  $\pi_{jk}(i)$   
 $\varepsilon_t = (n \times 1)$  vector with elements  $\varepsilon_{it}$

Note that the disturbance terms are such that  $\varepsilon_{it}$  may be correlated with  $\varepsilon_{jt}$ .

Let all variables in  $x_t$  be  $I(1)$ . Now, if there is an error-correction representation of these variables as in (A2.6), there is necessarily a linear combination of the  $I(1)$  variables that is stationary. Solving (A2.6) for  $\pi x_{t-1}$  yields

$$\pi x_{t-1} = \Delta x_t - \pi_0 - \sum \pi_i \Delta x_{t-i} - \varepsilon_t \quad (\text{A2.7})$$

Since each expression on the right hand side of (A2.7) is stationary,  $\pi x_{t-1}$  must also be stationary. Since  $\pi$  contains only constants, each row of  $\pi$  is a cointegrating vector of  $x_t$ . For example, the first row can be written as  $(\pi_{11} x_{1t-1} + \pi_{12} x_{2t-1} + \dots + \pi_{1n} x_{nt-1})$ . Since each series  $x_{it-1}$  is  $I(1)$ ,  $(\pi_{11}, \pi_{12}, \dots, \pi_{1n})$  must be a cointegrating vector for  $x_t$ . If this is true, equation (A2.6) is known as **vector error correction model (VECM)**.

Now, if an unanticipated shock hits any one of the error terms  $\varepsilon_{it}$  in the VECM, the shock will affect the dependent variable  $x_{it}$  in that equation and, since the error terms in the system may be correlated with each other, the other equations of VECM. The responses of the dependent variables in the VECM to the initial shock to  $\varepsilon_{it}$  are known as **impulse responses**. We can then draw graphs, **impulse response functions**, for these impulse responses.