THE SOUTH AFRICAN ECONOMY AND ITS ASSET MARKETS -AN INTEGRATED APPROACH-

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Abstract

This paper considers the development and estimation of a structural econometric model of the South African economy by attempting to identify the most important forces and feed back effects that link the real South African economy to the global economy and asset markets. The model developed captures the relationships between an important set of South African economic variables including the domestic share and housing markets with a relatively small number of equations, but despite the simplicity of its structure, it is shown that the model can consistently forecast the growth rate turning points of these variables up to one-year ahead. The out of period forecasts of the model compare favourably to those of 2 naïve time series models. The model is distinctive in that it incorporates wealth effects, proxied by the cycle of the domestic share market and domestic housing market, to help explain the growth in private consumption and investment spending and incorporates important feed back loops between the balance of payments, interest rates and the growth in the money supply.

Introduction

In this paper we attempt to identify and measure many of the most important forces and feed back effects that link the real South African economy to the global economy and to global and domestic asset markets. We show that the essentials of the relationships between the South African economy and its domestic share and housing markets can be captured in a general equilibrium model with a relatively small number of equations. Despite the simplicity of its structure, convenient for heuristic purposes, it is demonstrated that the model can consistently forecast the growth rate turning points of an important set of economic variables up to one-year ahead. The model is distinctive in that it incorporates wealth effects proxied by the .cycle of the domestic share market and domestic housing market to help explain the growth in private consumption and investment spending. The model also incorporates the important feed back loops between the balance of payments, interest rates and the growth in the money supply.

The paper has the following structure . In section 1 we offer a description of the South African business and financial cycles and explain how the real economy and its financial markets interact with and react to each other. We provide a diagram to summarise the links and feed back effects between the important economic magnitudes. In section 2 we present the formal model and examine some of the key exogenous and endogenous variables. In section 3 we present the econometric results, including the results of a set of dynamic out of period forecasts, and comment upon them.

1. Modelling the South African economy

1.1 Overview

There have been several attempts to model and forecast the SA economy that have been published in the SA economic literature. They were primarily developed and evaluated according to their within-period fit and none were rigorously tested according to their out-of-period forecasts. A number of these models and their derivatives were used as forecasting models in the eighties, particularly the Standard Bank model (Shostak (1979)), the Pretoria University model (De Wet and Dreyer (1978)) and the BER model (Smit & Meyer (1985)) with varying degrees of success but their forecasting performance has never been systematically ex-post tested against the reality. With the change in government in the early nineties, most of these models fell away except the BER model which was reformulated within a cointegration framework (Smit & Pellisier (1997)). The GEAR team under Finance Minister Trevor Manuel based a number of their earlier formulations and forecasts on an economic model developed by the team. Although parts of this model have been alluded to, for example in SARB quarterly bulletins, it has never been published. Again, as the GEAR thrust has lost focus more recently, the model and its associated forecasts have been side lined.

1.2 The Modelling paradigm

In the cointegration paradigm, economic variables are modelled in non-differenced (level) terms with a focus on the long-term equilibrium relationships between these levels. In the pre-cointegration[1] era, an area of concern with modelling variables as levels was the problem of spurious regression, whereby variables which were not stationary could exhibit strong but completely mis-leading correlations. Hence the thrust to modelling variables within a strict stationary framework, which itself suffered from the disadvantage that the actual process of making variables stationary required one to transform them. This necessity to transform the variables would of itself change the model specification and hence the interpretation of the model.

The cointegration framework considers economic systems from the perspective of simultaneous stable long-term equilibrium relationships between the economic variables in the system. An important implication of this cointegration framework is that economic variables with similar patterns of long term behaviour (those which are integrated of the same order) can sensibly be related, without the problem of spurious regression, as long as the residual series from the cointegrating regression is stationary. This mode of modelling has gained great currency in the econometric literature for its theoretical elegance, but has a natural applicability to large relatively closed economies where shocks are smoothed out within the system. In smaller open economies, generally subject to relatively larger and more frequent shocks the equilibria themselves will be continually disturbed (see, for example, Moll (2000)). An economy like South Africa's, dependent upon resource prices, politically vulnerable and categorised as an emerging market with its related susceptibility to market flows experiences continual shocks to its economic system. We thus felt that a more classical approach that focuses on the lagged relationship between growth rates rather than that between cointegrated levels was more appropriate for modelling such an economy.

1.3 The SA economic system

Any economic system that is part of a global market for goods and services and savings, is subject to a complex mix of exogenous real shocks and the reactions to them. The resultant matrix of reactions, interactions and feedbacks to these shocks determines the level and growth rates of output, incomes and the prices of goods, services and assets in the system. Among the more important sources of shocks and reactions to these shocks are the events that occur in asset markets, both local and foreign. We attempt to identify and measure many of the most important forces and feedback effects that link the real South Africa economy with the global economy and with global and domestic asset markets. Our focus in this paper has been to integrate these spending, corporate earnings, wealth and interest rate effects into an explicit model of the markets for goods and services and assets in South Africa. South Africa's political vulnerability, relatively small open economy and characterisation as an emerging market have led to high levels of volatility in key economic magnitudes and the business cycle. We directly addresses these difficulties and the model constructed is able to

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[1] *Generally recognised as prior to the publication of the 1985 review issue of the Oxford Bulletin of Economics and Statistics under the editorship of Hendry, although the introduction of the notion of cointegration is generally attributed to Granger (1981).*

generate forecasts which to a large extent encapsulate the behaviour of the South African economy. The essentials of the interactions between the real SA economy and the important asset markets can be captured by a model with a small number of equations. Such a parsimonious representation greatly assists the understanding and interpretation of the causes and effects of the South African business cycle.

1.4 The links between the financial markets and the real economy- wealth effects.

Changes in the rate of growth of consumption and investment spending clearly have an impact on the earnings of stock exchange listed companies and thus their market value. These changes in market value will in turn have an effect on personal or corporate balance sheets of value and thus have a feedback wealth effect on consumption and investment spending. One can identify a number of ways in which changes in wealth may influence spending decisions.

Household balance sheets as well as those of listed companies improve or deteriorate as share prices rise and fall. It is not only the value of shares held directly by the households that will have wealth effects. The value of household claims on pension funds and also the value of their retirement annuities are directly influenced by the performance of the share markets. In the case of defined benefit pension schemes the surplus value accrued in the pension fund belongs to shareholders. More important for most households than the value of shares in their portfolio will be the net value of their equity in the homes they own and occupy. These wealth effects are especially likely to have an impact on the willingness of households to save or spend more of their disposable incomes. Furthermore the willingness of listed firms to undertake investment spending and in many cases to take on more debt to do so, will also be affected by their stock market value.

1.5 The interest rate cycle

When interest rates rise, asset prices fall, other things being equal. But other things seldom remain as they were. Higher interest rates may also accompany rising levels of demand for goods and services as investors compete more actively for scarce capital when prospects for corporate and household earnings growth improve. Interest rate movements may be as much pro- cyclical as they are anti-cyclical. Thus interest rates may rise or fall with the South African earnings cycle with unpredictable (net) effects on asset prices. Yet higher levels of spending will sooner or later, depending largely on the trends in export and import prices, be associated with a deterioration in South Africa's balance of trade. The South African monetary authorities typically responded to a deterioration in the balance of payments by raising short term interest rates, a tendency which will become more pronounced if the deterioration in the balance of trade is accompanied by exchange rate weakness (see De Wet *et al* (1997)).

Higher interest rates accompanied by slower growth in the money supply would then, with a lag, slow the economy down with negative effects on its asset markets. Asset markets would tend to remain under the pressure of high or rising interest rates and falling earnings until the danger to the balance of payments passed. The lower turning point in the business cycle would be reached when the South African resources' price cycle bottoms out. A recovery

process would then begin in the economy and be followed in due course by growing company earnings and higher interest rates.

1.6 Political vulnerability and its real effects

There were episodes in South Africa's economic history when perceptions of greater political risks have led to rapid withdrawals of capital and placed severe pressure on the balance of payments and the exchange rate. The South African monetary policy response to these supply side shocks ha usually been to raise interest rates to support the Rand (see Moll (1999).. This in turn has often discouraged spending and further weakened the economy through a loss of confidence in the future of South Africa. In addition, higher interest rates and slower rates of growth of spending and hence company and household earnings will all lead to much weaker domestic housing and share markets with concomitant negative wealth effects.

Political uncertainty and economic growth have always been negatively associated in South Africa. Strong growth was likely to encourage foreign direct and portfolio investment helpful to both employment and income prospects and hence political stability while the disappointments caused by slower growth in incomes and higher levels of unemployment could lead to direct political action that threatened wealth owners. Such developments encouraged a flight of capital from South Africa.

1.7 The resource based economy

Perhaps the most important and persistent force leading the South African economy up or down is the behaviour of South African resource prices. Exports from South Africa are mostly of metals and much manufacturing activity and the exports of manufactured goods reflect the energy intensive- that is coal intensive- processing of metals. Thus a typical South African Business Cycle might take the following form. A sustained recovery in the rate of growth of the world economy implies increased demands for resources produced in South Africa. [2] Higher prices and revenues would naturally greatly improve their profitability and share market valuations.

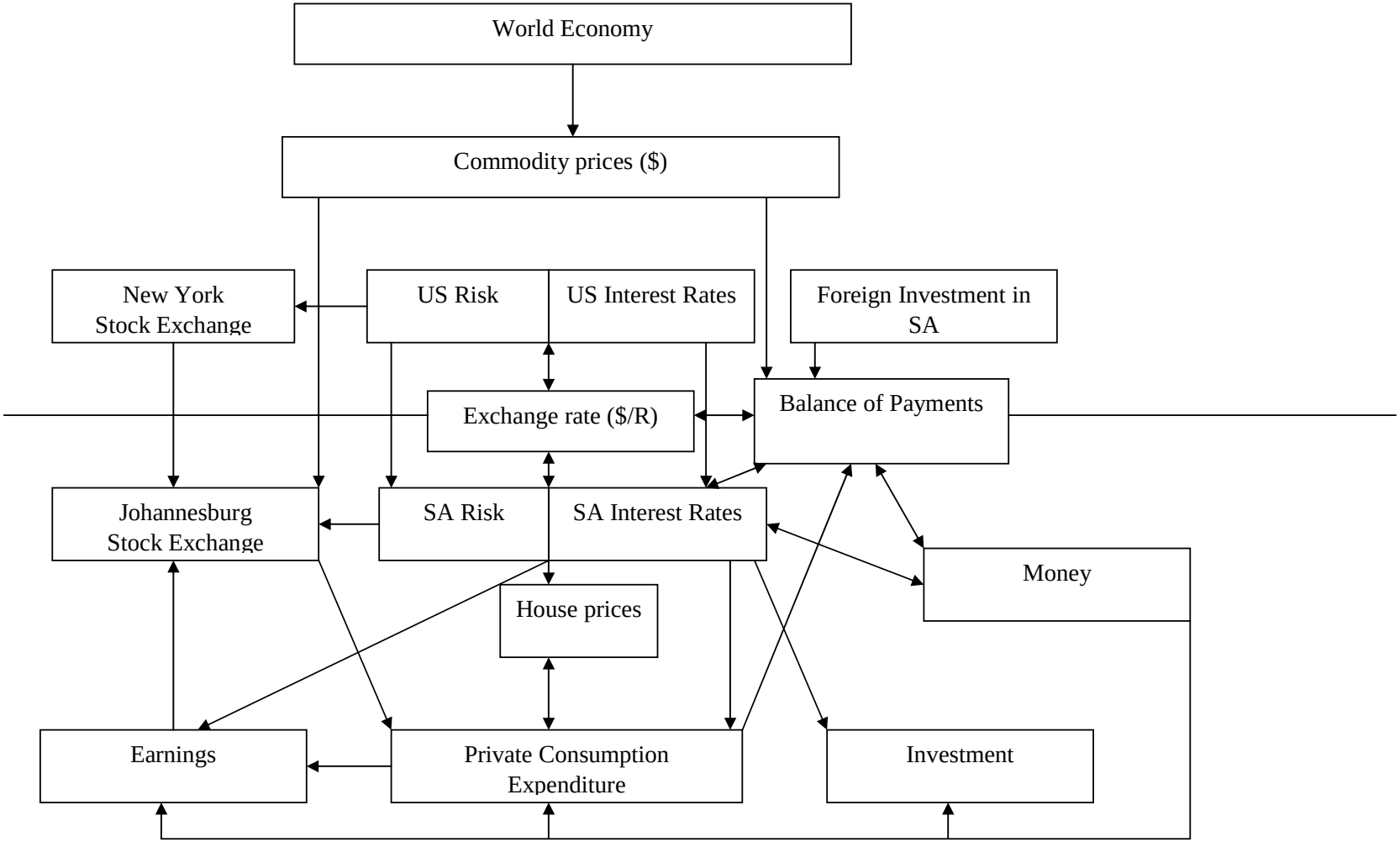
These developments would clearly also be good for the South African balance of trade as well as the capital account of the balance of payments as foreign portfolios began to include a larger proportion of South African resource stocks. In addition, the foreign exchange value of the Rand, would benefit from an improved state of the balance of payments. With support for the Rand from the balance of payments, short term and also long-term interest rates would decline. As interest rates came down, consumption and investment spending would be encouraged. Money and credit supplied by the banking system would grow rapidly during the upswing phases of the business cycle, which would further stimulate increases in private spending. The housing market would be boosted by these developments and rising house

[2] *In the nineteen seventies and early eighties, when the increase in demand for metals and other resources was usually accompanied by heightened fears of inflation in the major developed economies, this could be associated with sharply higher prices for the resources supplied by South African firms.*

prices would add impetus to the favourable wealth effects on domestic spending emanating from the share and bond markets.

These favourable trends would tend to persist until the resource price cycle sooner or later reversed themselves as the world economy slowed down. Then all the pressures would be in the opposite direction. The balance of trade would deteriorate, as demand for imported goods remained strong even after export growth had slowed down. The prospects for the earnings outlook for JSE listed companies would become much less promising with associated share price weakness. The exchange rate would tend to weaken and interest rates would rise in response to capital outflows. Money supply growth would slow down dramatically, further amplifying the forces causing slower growth in earnings and weaker asset markets.

A summary of these relationships and feedback loops in the South African economy may be represented diagrammatically as follows.



Schematic Representation of the main causal links and feedback loops in the South African economy

2. The Formulation of the Model

The model formulated below encapsulates the economic inter-relationships discussed above. The real endogenous variables explained by the model include the growth in private consumption (GCON95) and private investment spending (GPRI95), real share prices (GRALSH) and real house prices (GRHP). Also explained by the model is the growth in real JSE all share index earnings, (GREAL) real money supply growth (GRMB), real short term interest rates (RINT) and the real balance of trade (BOT95). All the variables are measured as year-on-year real growth rates with the exception of real interest rates, which are measured as the 90 day BA rate less CPI inflation, and the quarterly real balance of trade which is expressed in 1995 prices rather than as a growth rate.

2.1 Resource price Index

The exogenous variables of the model include (the growth rate of) a US dollar price index of those resources produced by JSE listed companies and denoted as GMETSA. The index encapsulates gold, diamonds, coal, platinum and chemical prices weighted by the market values of the different companies listed on the JSE that produce these resources.[3]

2.2 Gold and the South African Economy

For much of the period under review the gold price cycle (GGPDL) and this resource price index behaved very similarly. The correlation between the 2 series over the period 1975-99 is 0.966. as may be seen in the Table of Correlations set out below. Thus over a large portion of the period considered the US dollar gold price could be taken as a very good proxy for South African resource prices.. However, from 1999, the gold price has parted company with the prices of most other metals, particularly platinum.

The share of gold in South Africa's GDP and its export basket has also fallen dramatically over the years. The ratio of gold exports to GDP when both are measured in current prices is now about 3% but was as much as 12% in 1981. The share of gold in the total exports of goods , measured in current prices, was 46.5% in 1981 and was only 13% in Q3, 2000[4]. Indeed in 2000, revenue from high priced platinum exports have matched, or even exceeded, those from the gold mines. Thus a focus on the impact on the South African economy of the gold price alone, which has behaved very differently compared to the prices of platinum and diamonds recently, would no longer be helpful for a full understanding of the impact of the world economy and the resource price cycle on the JSE and the real economy.

2.3 Risk and the South African economy

The exogenous variable representing South African political risk is taken to be the year on year changes in the difference between South African government long bond yields (RSA150's) and equivalently dated US treasury bonds. (GGAPQ) Clearly the greater the risk of default or exchange rate weakness the larger must be the difference between South African and US government bond yields. This extra yield is partly the compensation for the risks of the Rand weakening-which

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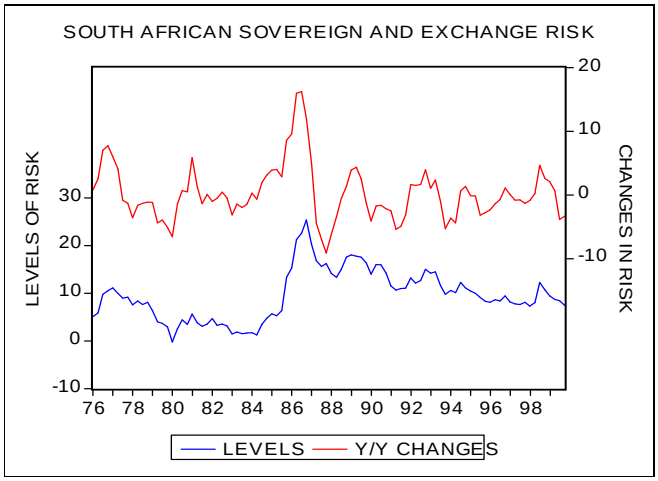
[3] *This Index is compiled by Investec Securities and was kindly supplied to us.*

[4] *Source Quarterly Bulletins of the SA Reserve Bank, December 2000 and June 1986.*

would mean less dollar income and wealth for the owner of the Rand bond. There is also the risk that the hard currency conversion of interest payments to foreign debt holders may be blocked

Sovereign risk, that is the risk of default on (hard currency denominated) debt obligations is usually measured by the difference in yields on a foreign currency denominated government debt instrument. The difference between the yield on a South African Government dollar bond (locally referred to as a Yankee bond) and the equivalent US government treasury bond is compensation for sovereign risk. There is clearly no exchange rate risk in holding a foreign currency denominated South African bond. We regard the difference in the yields available to the off shore investor between a Rand bond and the equivalent US bond as the total risk premium that compensates for the risks of both default and exchange rate depreciation. This nominal yield gap is adjusted for the lower value of the Financial Rand when that applied which is for much of the period under review. The existence of the Financial Rand which was always worth less than the commercial Rand, raised the effective yield to foreign investors. Dollar and other foreign currency South African government bonds only become available to foreign investors after 1995 with the removal of investment sanctions against South African. Thus it has only recently become possible to separate the yield gap into an exchange risk and sovereign risk component.

Figure 1



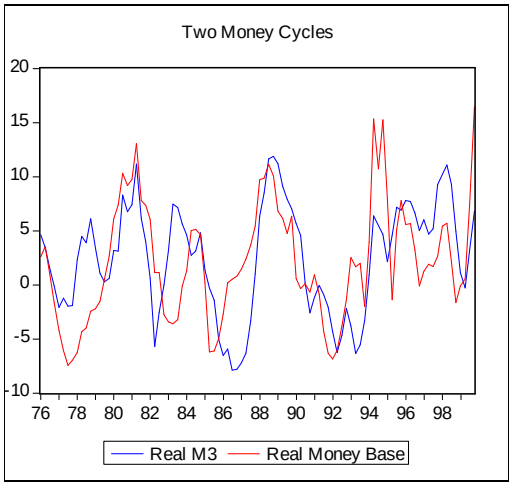
The movements in the international equity markets are represented by year on year changes in the Dow Jones Industrial Index of the New York Stock Exchange, (GDJ). The influence of the level of interest rates in the major money market centres on South Africa is picked up in the model through GGAPQ.

2.3 Money Base used as a monetary Indicator

The measure of real money supply growth used in the model is one of South African Reserve Bank money base (GRMB) rather than private bank money or real M3 (GRM3). Narrow money is preferred because it is much more directly affected by Reserve Bank action . Money Base is not affected by banking sector intermediation or disintermediation which affect the magnitude of M3 but can have little impact on the real economy or financial markets. In the diagram below we

compare the cycle of the real money base with that of real M3. The correlation of the two series over the period 1975- 1999 is only 0.55.

Figure 2 The Money Base and Money Supply cycles



It may be noticed that the money base reflects two recent phases of very dramatic increases.. which may in fact be attributed to changes in the demand to hoard money rather than the usual cyclical responses. The demand for cash by the banks and the public increased sharply before the elections of 1994 and also in anticipation of Y2K problems in the second half of 1999. It may be seen below when actual and expected money growth is compared that the model has some understandable difficulty in predicting such shock changes to the demand to hoard money. Most importantly, as may be seen in the table of correlations below, it should be noted that narrow money growth is more strongly correlated with measures of real economic activity than its wider counterpart M3.

Table 1 Correlation between key economic magnitudes

	GRMB	GRM3	GREAL	GMETSA	GGPDL	GPRI95	GCON95
GRMB	1.000	0.549	0.458	-0.087	-0.073	0.654	0.681
GRM3	0.549	1.000	0.312	-0.114	-0.131	0.537	0.475
GREAL	0.458	0.312	1.000	0.557	0.558	0.513	0.535
GMETSA	-0.087	-0.114	0.557	1.000	0.967	0.148	0.133
GGPDL	-0.073	-0.131	0.558	0.967	1.000	0.164	0.150
GPRI95	0.654	0.537	0.513	0.148	0.164	1.000	0.723
GCON95	0.681	0.475	0.535	0.133	0.150	0.723	1.000

It is seen that alternative measures of economic activity, that is growth in the real money supply, earnings, and private spending and hence the business cycle in general, are all highly correlated. This high degree of collinearity mitigates against any two of these series being used together as explanatory variables in a single regression equation. The high correlation between growth in the dollar prices of metals and gold should also be noted, as should the high correlation between real earnings growth and the gold price or metal price cycles.

2.4 Balance of payments and real interest rates

As discussed above, higher spending levels in the economy will ultimately lead to a deterioration in South Africa's balance of trade. The South African monetary authorities have typically responded to a deterioration in the balance of payments by raising short term interest rates to protect their reserves, especially when the deterioration in the balance of trade is accompanied by exchange rate weakness. Similarly, when the balance of payments position has improved, the monetary authorities have generally relaxed interest rates.

2.5 Formal mathematical structure of the model

The model comprises an 8 endogenous variables simultaneous system. Variables are expressed in real year-on-year growth rate terms (rates of interest and the Balance of Trade in expressed in real but not growth rate terms). The year-on-year growth rate transformation induces some smoothing and autocorrelation to the transformed series but remains the standard quantitative measure used to assess economic magnitudes.

Each equation includes a lagged dependent variable. This captures the natural economic momentum of the economy, as well as removing some of the technical autocorrelation effects induced when measuring the economy on a year-on-year basis. Such a specification can cause some bias in the estimation procedure of the coefficient of this lagged dependent variable, but these coefficients are not of primary focus. The coefficients of interpretative importance are the remaining independent variables of each equation. Although a robust statistical structure remains an important goal, we feel that the predictive power of the model should be judged primarily according to its out-of-period forecasting performance.

The model was estimated with 3-stage least squares. This takes into account cross-equation relationships between the error structures of the model, is conceptually straightforward and does not require the strict assumptions of normality in the error term for Maximum likelihood methods.

The model can be formally written (stochastic error terms are omitted) as:

GCON95=C(1)+C(2)*GRALSH+C(3)*GRMB+C(4)*GRHP+C(5)*GCON95(-1)+C(6)*RINT
GPRI95=C(7)+C(8)*GGAPQ+C(9)*GRMB+C(10)*GPRI95(-1)+C(11)*RINT
GRALSH=C(12)+C(13)*GDJ+C(14)*GMETSA+C(15)*GRALSH(-1)
GRHP= C(16)+C(17)*GGAPQ+C(18)*GRMB+C(19)*GRHP(-1)
GREAL=C(20)+C(21)*GRMB+C(22)*GMETSA+C(23)*GREAL(-1)
GRMB=C(24)+C(25)*BOT95+C(26)*RINT+C(27)*GRMB(-1)
BOT95=C(28)+C(29)*GRMB+C(30)*BOT95(-1)
RINT=C(31)+C(32)*BOT95+C(33)*RINT(-1)

Results are given for the model estimation over the whole data set from 1980:1 to 1999:4. (80 quarters). Note, however, that when the forecasting verification procedures were run, the model was estimated as a set of rolling estimation windows over 40 quarter periods.

3. The Econometric Results

Table 2 Estimated Coefficients of Model (1980.1 to 1999.4)

	Coefficient	Std. Error	t-Statistic	Prob.
C(1)	0.891	0.272	3.27	0.001
C(2)	0.015	0.006	2.77	0.006
C(3)	0.063	0.038	1.67	0.096
C(4)	0.046	0.019	2.39	0.017
C(5)	0.63	0.072	8.99	0.000
C(6)	-0.043	0.033	-1.29	0.198
C(7)	0.146	0.741	0.20	0.844
C(8)	-0.499	0.132	-3.77	0.000
C(9)	0.579	0.135	4.29	0.000
C(10)	0.606	0.063	9.59	0.000
C(11)	-0.295	0.111	-2.65	0.008
C(12)	-2.45	1.92	-1.27	0.204
C(13)	0.399	0.101	3.94	0.000
C(14)	0.663	0.085	7.78	0.000
C(15)	0.513	0.055	9.33	0.000
C(16)	-0.557	0.425	-1.31	0.191
C(17)	-0.169	0.083	-2.03	0.043
C(18)	0.158	0.071	2.22	0.027
C(19)	0.852	0.041	20.79	0.000
C(20)	-0.546	0.928	-0.59	0.557
C(21)	0.295	0.159	1.86	0.064
C(22)	0.353	0.043	8.14	0.000
C(23)	0.757	0.044	17.22	0.000
C(24)	2.86	0.825	3.46	0.001
C(25)	0.000	0.000	-2.75	0.006
C(26)	-0.107	0.068	-1.57	0.117
C(27)	0.689	0.078	8.82	0.000
C(28)	7530	1490	5.04	0.000
C(29)	-654	151	-4.33	0.000
C(30)	0.589	0.076	7.70	0.000
C(31)	1.36	0.304	4.47	0.000
C(32)	-0.0000677	0.0000242	-4.34	0.000
C(33)	0.943	0.033	28.64	0.000

Table3 Individual Equation summary statistics: (1980.1 to 1999.4)

Equation	Dependent Var.	S.E. of regression	$\overline{R}^2$	L-M statistic (2 lags)	Prob. (L-M)
1	GCON95	1.52	0.745	2.64	0.282
2	GPRI95	5.41	0.778	1.69	0.431
3	GRALSH	13.6	0.789	28.0	0.000
4	GRHP	3.21	0.889	42.7	0.000
5	GREAL	7.55	0.866	6.59	0.041
6	GRMB	3.39	0.594	4.30	0.127
7	BOT95	6770.	0.580	3.42	0.184
8	RINT	1.65	0.900	2.26	0.323

3.1 Comments on the Estimates of the Model.

The wealth effects of changes in share prices and house prices on consumption are significant. As may be seen the elasticity of the wealth effects emanating from the housing market C(4) appear far stronger, nearly double, that of the share market effect C (2) Every one per cent increase in real house prices appears to raise consumption growth rates by an average 0.019%. It may be noticed also that the negative real short term interest rate effect on consumption, C(6) is only signiifcant at the 10% level. It is possible that the impact of interest on consumption spending occurs over a longer lag than the one indicated. It was thought appropriate not to experiment with a variety of lags for the independent variables and to express all the variables of the model in year on year growth rate form. Data mining the individual lag structures would have improved the fit of the equations but would have taken away from the heuristic elegance of the model.

In fact as may be seen by the forecasting results the model specified in this way nonetheless generates highly plausible results. The elasticity of private investment spending with respect to political and exchange rate risk (C(8)) with respect to real money supply (C(9)) and with respect to real interest rates (C(11)) all show up strongly in the appropriate direction. It may have seemed more plausible to have included real earnings rather than real money supply to explain investment spending. The equation was estimated in this form with less satisfactory results. As may be seen from the Correlation Table above, the growth in real earnings and real money supply are quite highly correlated and so could not be regarded as independent of each other and be included together in the same equation. Both may be thought to reveal similar business cycle effects and clearly have an impact on the willingness and ability of private firms to undertake investments. Every one per cent growth in the real money supply has been associated with a highly procyclical 0.58% increase in the rate of growth of investment. The money supply effect on consumption spending C(3) appears far more muted.

The metal price C(13) and world market effects C(14) significantly influence quarterly changes in the real value of the JSE. Current metal prices will be the best proxy the market has for the expected earnings of metal producing companies. . The behaviour of world markets, as represented by the Dow Jones Industrial Index of the New York Stock Exchange, appears to have represented very adequately the substitution effects of world equity markets that act on the JSE. The expected earnings elasticity of the JSE, as represented by changes in the world metal and resource prices is 0.66, while the world equity market elasticity is 0.4.

The measure of exchange rate and political risk which helps explain investment spending and house prices did not add to the explanatory power of the share market equation and so is not included in the model. It may be that exchange rate risk- given the exchange controls that have operated in South Africa over the period – was not a particular concern of South African investors. It may however be of interest to recognise that it is possible to model very successfully monthly changes in the dollar value of the All Share Index of the JSE, using as explanatory variables, monthly changes in the value of the Dow Jones Industrial Index, monthly changes in the dollar value of JSE earnings and changes in the exchange and political risk premium. All the variables are statistically significant and the fit of the model of highly random fluctuations in the JSE is very good with an R squared of close to .0.70. The same variables also have a statistically significant effect on monthly changes in the rand value of the JSE as may also be seen. However the fit of this model is not nearly as good. The estimates of these single regression equation are indicated below.

Deleted: . (should this be included???)Yes because it is of interest to know we do have a good monthly model of the JSE. The monthly model does better than the quarterly one¶

The Housing price equation is a satisfactory one. Both the risk variable and the business cycle as represented by the growth in the real money base help explain house prices. Again, somewhat surprisingly, real interest rates did not appear to improve the fit of this equation and have therefore been excluded. It is possible that the interest rate effects on house prices have a more complicated lag structure given the procyclical nature of the real interest cycle. It is however possible that the impact of changes in real interest rates have been explained by the lagged dependent variable. House prices, it should be appreciated, are a highly autocorrelated series.

The model is completed satisfactorily by the highly interdependent but much simplified set of equations that explain money supply growth, the balance of payments and real interest rates.

3.2 Testing the Model's Forecasting Performance

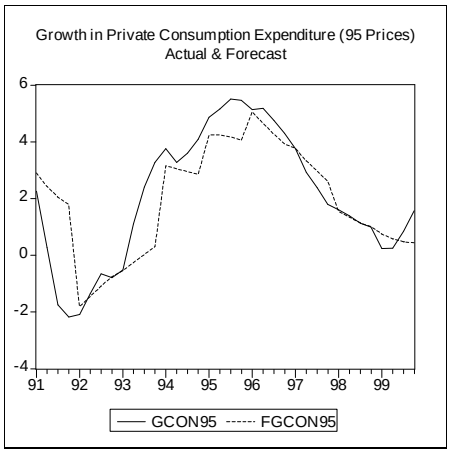
The only meaningful structural validation for a model of this type lies in its ability to forecast the set of endogenous variables over a period in which the values of the model variables over this period (endogenous as well as exogenous) have not influenced the values of the estimated coefficients. To test the model in this way, we use a process of moving out-of-period-forecast windows. At the first pass of this procedure, we estimate the model simultaneously from the first quarter of 1981 to the last quarter of 1990 (40 quarterly observations) using 3-stage least squares. The estimated parameters of the model are then used in the model structure to solve, using a Gauss-Seidel method, for the set of endogenous variables (generate a forecast for the set of endogenous variables) for the 4 quarters of 1991, using the *actual* values of the exogenous variables that pertained in 1991. Note importantly, in the context of the lagged endogenous variables, that these forecasts are *dynamic*. That is, it is not assumed that the values of the lagged endogenous variables (which act as explanatory variables) are known over the 1991 period when forecasting the 1991 endogenous variables. Thus, for example, in the solution of the forecasts for the second period of 1991 the value for the lagged (one) endogenous is the *forecasted value (*of that endogenous variable*)* for the first period of 1991.

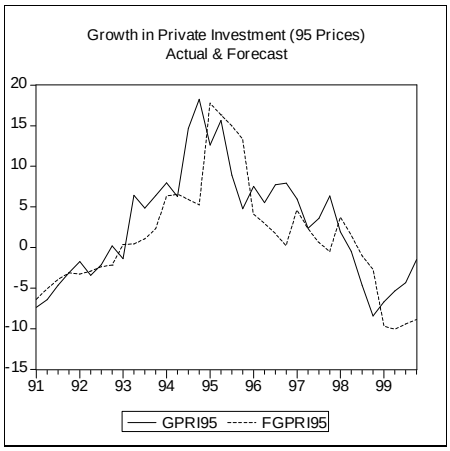
The window of the estimation and forecast period is then moved forward one year. The estimation period thus becomes the first quarter of 1982 to the last quarter of 1991 (again, 40 quarterly observations). The endogenous variables of the model are now solved for the 4 quarters of 1992, using the actual values of the exogenous that pertained in 1992. A set of forecasts for the

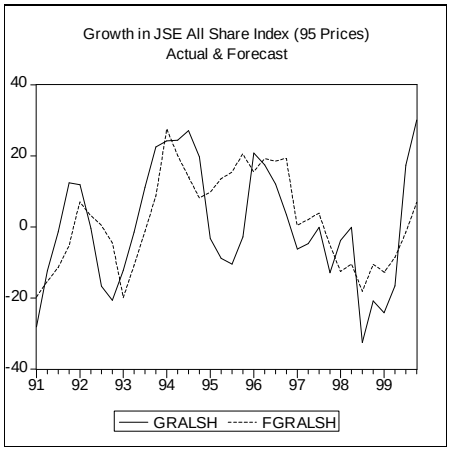
endogenous variables in 1992 are thus produced. The window of estimation and forecast is then moved forward in this way a total of 9 times, so that 9 different estimation periods are used for the same model structure, and 9 different sets of four quarterly forecasts produced for each endogenous variable.

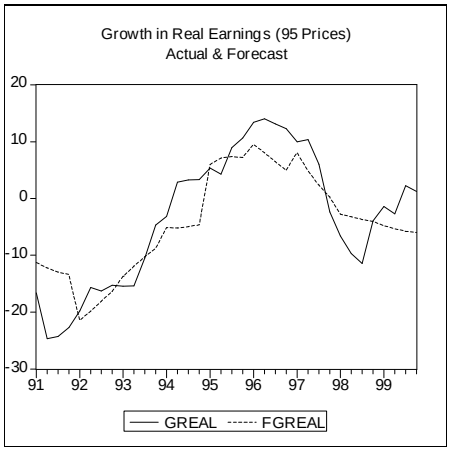
3.3 Comment on the Forecasting Performance of the model

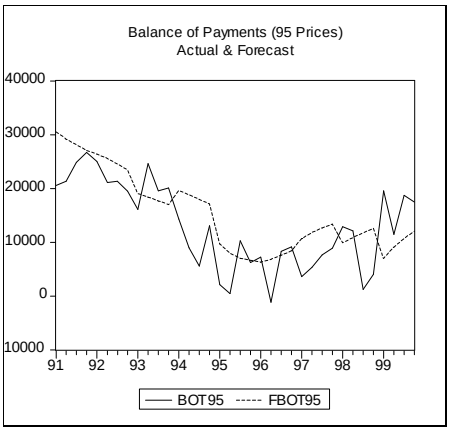
The set of growth forecasts of the endogenous variables are generally good, and in the correct direction, as indicated in the graphs below:

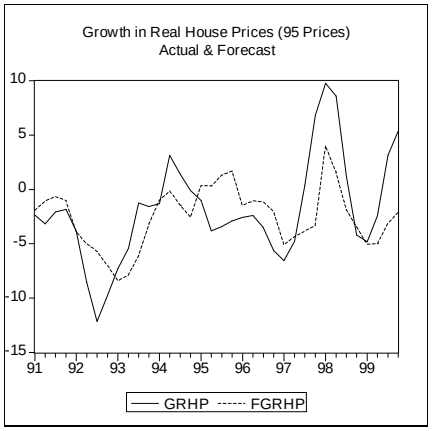


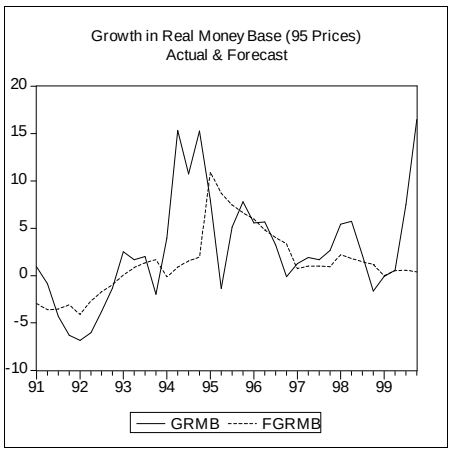


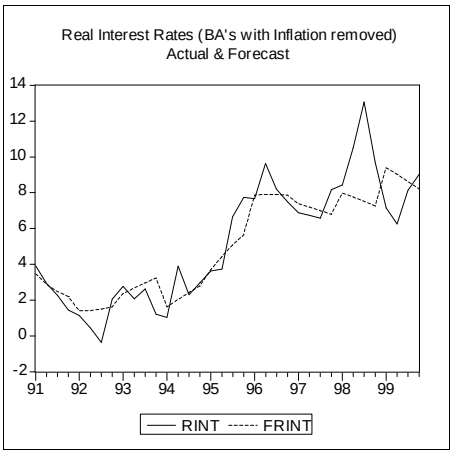












The South African economy is an open and relatively small economy, classified as an emerging market and sensitive to a range of external and internal shocks. As such, those variables which are related to perceptions of riskiness tend to be volatile and subject to a changing structure; these include private Investment, the levels of the JSE and house prices. These variables tend to be relatively poorly forecast, whereas those which are more being closely related to expenditure and tend to exhibit greater momentum, such as PCE and Earnings tend to be relatively well forecast.

3.4 Comparing the out of period forecasts with those of naïve time series models

To put these forecasts into an objective[5] context, we will compare the forecasts produced with those produced from 2 naïve time series models, using an identical procedure of out-of-period moving windows. The two models used were:

1. A random walk (RW) model with specification $y_t = y_{t-1} + a_t$, and
2. A time series model with a fixed autoregressive specification with 4 lags (AR(4)), that is, $y_t = \phi_0 + \phi_1 y_{t-1} + \phi_2 y_{t-2} + \phi_3 y_{t-3} + \phi_4 y_{t-4} + a_t$.

[5] *The authors would like to thank an anonymous referee for this suggestion*

The statistic used to compare the forecasts from the different models is the (square root of) the Mean Squared Error (SMSE), that is

$$\sqrt{\frac{\sum_{i=1}^{k}(y_i - y_f)^2}{k}},$$

where y_f represent the out-of-period forecasts of y_i over k periods (see, for example, Hendry and Ericsson (1991)).

Table 4
Square Root of Mean Squared Errors for the Structural Model and two naïve Time Series models.

	Structural Model	RW Model	AR(4) Model
GCON95	1.32	1.97	1.62
GPRI95	2.93	6.48	3.52
GRALSH	12.87	12.99	12.63
GRHP	3.83	5.24	4.55
GREAL	5.60	8.62	6.18
GRMB	5.37	7.70	6.64
BOT95	6130	9560	7590
RINT	1.54	2.43	2.10

The structural model developed here performs well comparatively, although the AR(4) specification has forecasting power which is comparatively close to that of the structural model. Black box time series model generally do well in forecasting exercises (see, for example, Jenkins (1979)) and if the structure of the time series model was optimised for each endogenous variable (rather than being fixed as an AR(4) specification) the forecasting performance of the time series alternative could be improved even more. In comparison, the random walk model performs poorly, except in the case of the All Share Index, where efficient markets would dictate that percentage changes of share price movements were close to random. Structural econometric models, which may not necessarily deliver superior forecasting performance to that of a well tuned time series model and are markedly more costly to develop have, the important advantage of possessing a structure which relates directly to our economic theory.

Conclusion

The model presented above of the South African economy encapsulates its critical features, namely those of a small and open economy, sensitive to a range of external and internal shocks. The model includes variables, such as the Johannesburg Stock Exchange and domestic house prices which are directly related to perceptions of riskiness, but these are inclined to be quite volatile and tend to be relatively poorly forecast by the model. By contrast, consumption spending, earnings and to a lesser extent private investment, which exhibit a much higher degree of sustained momentum, are relatively well forecast by the model. In addition, the forecasts of money supply growth are entirely satisfactory but for the understandable inability of the model to forecast the demand to hoard

money before the elections of 1994 and at the time of the Y2K scare at the end of 1999. The model may also be seen to forecast the broad trends in short term interest rates and the balance of trade very effectively, model predictably underforecast the levels to which interest rates would go during 1998 when emerging markets were especially hard hit by the liquidity crisis of that year. Many regarded the interest rate settings of the South African Reserve Bank during this period as excessive and misjudged.

The set of forecasts of the endogenous variables are generally good, and in the correct direction, as indicated in the graphs above, and compare well with forecasts from naïve time series models. We believe that the point has been made that it is possible to capture the essence of the interactions between the real South African economy and its financial markets with a limited number of equations. The model can help observers make better sense of the past and perhaps also help them predict more of the future of important features of the South African economy and its share and housing market.

References

Barr, GDI and Kantor, B. (1990) *The application of a vector autoregressive model to money, income and price links in the South African economy*, JSEE, 14, 39-49.

De Wet, G. and Dreyer, J. (1978) *A Quarterly Econometric model of the South African economy (and a simulation exercise on the price effect of the 1975 devaluation*), JSEE, 2, 19-51.

De Wet, G.L.; Jonkergouw, E.; Koekemoer (1995), R. *An econometric model for monetary policy in South Africa*, SAJE, 63(4), 577-597.

Engle, RF and Granger CWJ (eds.) (1991*) Long-Run Economic relationships: Readings in Cointegration*, Oxford : Oxford University Press.

Granger, CEW (1981*) Some problems of Time Series data and their use in Econometric Model specification*, Journal of Econometrics, 16, 121-130.

Hendry, D.F. and N.R. Ericsson (1991). *An econometric analysis of UK money demand in `Monetary Trends in the United States and the United Kingdom by Milton Friedman and Anna J. Schwartz'*. American Economic Review, 81, 8-38.

Jenkins, G.M. (1979) *Practical Experiences with Modelling and Forecasting Time Series*, Gwilym Jenkins & Partners Publications, Lancaster, England.

Moll, P.G. (1999) *Money, interest rates, income and inflation in South Africa*, SAJE, 67(1), 34-64.

Moll, P.G. (2000*) The demand for money in South Africa: parameter stability and predictive capacity*, SAJE, 68(2), 199-211.

Muellbauer, JNJ and Aron, J (1998*) Estimates of Personal Sector Wealth for South Africa*, research mimeo for the project "*New Monetary Policy Challenges for Sustainable Growth in South Africa"*

Shostak, E. (1978) *The monetary block of the Standard Bank econometric model: An application of the portfolio approach to monetary analysis in South Africa*, JSEE, 4, 20-50.

Smit, .E (1983) *'n Ekonometriese model van die Suid-Afrikaanse ekonomie gebaseer op kwalitatiewe data-insette*, JSEE, 15, 37-52.

Smit, E. and Wesso, G. (1988*) Structural stability in South African econometric models - Some empirical results*, JSEE, 12(1), 51-77.

Smit, BW and Meyer, B. (1985) *The BER Quarterly Econometric model of the South African economy*, JSEE, 23, 99-140.

Smit, BW and Pellisier, GM (1997)) *The BER Quarterly Econometric model of the South African economy : A Cointegration version*, JSEE, 21(1), 1-36.

Van den Heever, J. P. and M. A. van Deventer (1997) *Notes on an Integrated Analysis of Instalment Credit Flows and Balances, Quarterly Bulletin*, South African Reserve Bank, June, 1997.

Van der Walt, B. F. and J. W. Prinsloo (1993) *Consumer Credit in South Africa, Quarterly Bulletin*, South African Reserve Bank, September, 1993