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THE TERM SPREAD, INFLATION AND ECONOMIC ACTIVITY IN A SIMPLE MODEL OF THE MONETARY TRANSMISSION MECHANISM

By

MUREKEZI GAJU BRIGITTE

A thesis submitted to the School of Economic and Business Sciences at the University of the Witwatersrand, Johannesburg, in partial fulfillment of the requirements for the degree of Masters of commerce in Economics.

Johannesburg, 2006.

Declaration

I, Murekezi Gaju Brigitte declare that this thesis is my own, unaided work. It is being submitted for the degree of Master of commerce in Economics at the University of the Witwatersrand, Johannesburg. It has not been submitted for examination before for any degree at any other university.

Signed at ***Johannesburg*** on this ***1st*** day of ***December***, 2006.



Dedication

To my father and mother, a special thanks for your support. I trust that it has all been worth it.

To my sisters and brothers, I fell pleased to being your sister again.

To my friends, you are a gift from heaven.

Acknowledgements

I would like to express my deepest gratitude to my supervisor Dr Christopher Malikane. This thesis could never come to fruition without your expertise, endless patience and advice.
I also want to acknowledge Kigali Independent University for having supported my MA degree.
Finally I am indebted to my companion of prayers for the spiritual support. May you receive my genuine appreciation!

Abstract

This paper presents a simple and transparent framework for the monetary transmission mechanism of the South African economy based on the model by Rudebusch and Svensson (1999). This model is extended to consider the long rate and the credit channel in the transmission mechanism. Firstly, we find that the credit channel plays a significant role in the transmission mechanism. Secondly, despite the backward looking nature of the model, impulse responses reveal that the term spread predicts output and inflation in the South African economy.

Keywords: term spread, credit channel, interest rate channel.

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1. INTRODUCTION

In order to conduct an appropriate monetary policy, the central bank needs to have a better understanding of how monetary policy affects the real economic activity. This paper presents a simple model of monetary transmission mechanism - the channel through which monetary policy decisions are transmitted to real economic activity and inflation. Two of the critical variables in the transmission mechanism are the term spread, which is the difference between the interest rate on long and short term bonds, and the credit extension to firms and households.

The term spread may be the most important variable which predicts future economic activity and inflation. As noted by Estrella (2005), the importance of this variable in predicting the future economic activity and inflation lies in the fact that policymakers react to the change in inflation and output gap by adjusting interest rates. Estrella and Mishkin (1997) argue that common factors for both term structure and real activity are determined by current monetary policy. For instance, tighter monetary policy would tend both to flatten the yield curve and to slowdown real economic activity. In recent macroeconomic models, the relationship between the term spread and the economic structure (IS curve and Philips curve) has been investigated in the context of a closed economy. In this paper, we seek to extend one such model to an open-economy context.

The predictive power of the term spread is, however, not without problems. Using backward looking and forward looking models for aggregate demand and aggregate supply Estrella et al. (2003) point out that the predictive power of the term structure for inflation may be unstable over time. This finding may differ across countries and models. The predictive power of the term spread on the real economic activity also depends on the horizon over which the future is forecasted by households.

An additional channel through which monetary policy affects the economy is the credit channel (Smal and Jager, 2001). However Guariglia and Mateut (2006) point out that trade credit may weaken the credit channel, at least in the case of the UK. Kakes and Sturm (2002) also note that borrowers may react according to the commercial banks' response to a monetary shock. When loan supply falls, borrowers may search for other alternative sources of finance. Therefore, part

of the complication behind the credit channel is that it may operate together with the interest rate channel as pointed out by Bernanke and Gertler (1995), Hubbard (1995) and Hülsewig (2006). The credit channel shifts loan supply and the interest rate channel shifts loan demand.

The framework presented in this paper is similar to the one developed by Svensson (1997) and Rudebusch and Svensson (1999) for a closed economy, and Ball (1999) who extends the above model to an open economy context. The contribution of the framework used in this paper is threefold. First, this paper develops a transparent and simple model of the monetary transmission mechanism for South Africa. Second, it attempts to explicitly introduce the long term interest rate in monetary transmission mechanism following Taylor (1995) and McGough at al. (2005). According to Taylor (1995), the long term rate should have a great impact on consumption and investment, rather than the short term rate. McGough et al. (2005) document that the short term rate is not an important determinant of the economic decisions of the majority of consumers and businesses, as a result they propose the long term interest rate to be included in modeling aggregate demand.

Third, the paper introduces the credit channel in conjunction with the long term rate. To understand how this monetary transmission mechanism works, we focus our attention on a backward-looking model that uses long-term interest rates and credit channels as envisaged by Hülsewig (2006) to show the impact of monetary policy on output gap and inflation. The extent to which credit and long-term interest rate complement each other in monetary transmission mechanism depends on economic structure, and thus remains largely an empirical question.

In the case of South Africa, research relating to the impact of monetary policy on real activity has been conducted by Aron and Muellbauer (2001). They find that, using a moving average for the interest rate, it takes four quarters for the interest rate to affect output. These long lags in monetary transmission were also found by Smal and Jager (2001), who document four quarters for the monetary policy to affect the level of real economic activity, and another four quarters before the monetary policy could affect the domestic price level. However, all these studies did not present an explicit model of the monetary transmission mechanism in South Africa.

In addition Malikane (2006) finds eight quarters for monetary policy to affect economic activity. Nevertheless, according to Moll (1999) and Aron and Muellbauer (2000), there is a strong effect of interest rate on real activity. The problem is the time lag of interest rate to affect the economy. As noted by Batini and Haldane (1999), such a problem may create instability and cyclical effect. Therefore, in formulating this model an alternative way will be sought that will not generate instability on the behavior of macroeconomic aggregates when simulated. Such a way is provided by introducing the credit channel and consequently, the response is exhibited after two quarters. Although we use backward-looking model, we find that the term spread continues to generate impulse responses that show the predictive power of the term spread on both real economic activity and inflation.

The rest of the paper is organized as follows: Section 2 presents a small macro economic model of an open economy. Motivated by the literature review, the model illustrates the channels through which monetary policy affects output and inflation in an open economy. Section 3 estimates the model. Section 4 is the conclusion.

2. SMALL MACRO-MODEL OF AN OPEN ECONOMY

This section uses the extension of the monetary model developed by Rudebusch and Svensson (1999), to assess the monetary transmission mechanism in South Africa. Theoretically, when the interest rate rises, investment and consumption credit costs will increase which slows down investment, consumption, and economic growth. As McGough et al. (2005), Taylor (1995 and 2001) note, the relevant interest rate that directly affects these macro-aggregates is the long-term interest rate.

The term spread is defined as the difference between the long term and the short term rate. This may be one of the monetary transmission mechanisms. Mishkin (1990a) argues that the yield curve of monetary policy may predict inflation. In another study (1990b), he shows that the term structure of interest rate may predict inflation. In addition, Estrella and Hardouvelis (1991) assume that the yield curve of the term spread affect the real activity. They are however not certain whether the slope of the yield curve will continually predict the economic activity and

inflation in the future. According to Estrella and Mishkin (1997) and Estrella et al. (2003), the term structure should predict the real economic activity and inflation. As documented by Estrella (2005) the positive relationship between the term spread and real economic activity and inflation may depend on monetary reaction function and combining it with other data should closely predict inflation and output.

The relationship between the long and the short terms rate is examined first. According to Taylor (1995); Clarida et al., (2000); Biefang et al., (2002); Angelis, Aziakpono and Faure, (2005); Chirwa and Mlachila, (2004), the high central bank short term rates raise long term or bond rates. As the short term rate is the rate at which liquidity is made available to the banking sector, banks through high interest payments shift the high cost of the short term rate to consumers on loans. Another reason may be that according to expectations theory of the term structure, the long term interest rate represents the average of future expected short term rates plus a risk premium[1]. Thus, an increase in short term rate will increase the long term rate.

Based on these arguments, the long term rate is as follows:

$$rl_t = \varphi_0 + \pi_t + \varphi_1(rl_{t-1} - \pi_{t-1}) + \varphi_2(rp_t - \pi_t) \qquad (1)$$

With $0 \le \varphi_1 < 1$, the current central bank rate is represented by rp_t and the current inflation rate by π_t. The constant φ_0 captures other factors that affect the long term rate such as the risk premium. The third term captures financial market imperfections or persistence in long term rate (Mankiw and Miron, 1986; Rudebusch, 1995). Then the real long term rate is positively driven by the real central bank rate or the short term rate.

Second, the IS curve is defined. This equation is an extension of Svensson (1997) and Ball (1997) to an open economy. The output is a decreasing function of the interest rate and an increasing function of the real exchange rate and its own lag and demand shocks as documented by Ball (2002) and Eichengreen (2002). Moreover, in the Canadian economy, Giordani (2004)

[1] See Kamin et al. (1998)

assumed the output gap to be affected by the movement in the real interest rate, the real exchange rate and the foreign output gap.

In addition, the credit channel may work in conjunction with the interest rate channel to affect the level of investment and consumption (Bernanke and Gertler, 1995; Hubbard, 1995; Kakes and Sturm, 2002; Holtemöller, 2002; Hülsewig, 2006). When there is a monetary shock from the loans supply or the loans demand, the amount of loans shift. According to Hülsewig (2006), the credit channel may affect the output through loans supply while the interest rate channel should affect the output through loans demand. The point at which these two variables complement each other in the transmission mechanism depends on the economic structure.

Combining both interest rate and credit channels, the IS curve equation is taking the following form:

$$y_t = \beta_0 + \beta_1 y_{t-1} + \beta_2 c_{t-1} - \beta_3 (rl_{t-1} - \pi_{t-1}) + \beta_4 e_{t-1} \qquad (2)$$

With $0 \leq \beta_1 < 1$, the output gap, the credit gap and the real exchange rate gap are represented by y_t, c_t and e_t respectively. The equation implies that an increase in the real long term rate will discourage potential borrowers. This will then lead to a fall in real output. As addressed by McGough et al. (2005), the long term or bond rate may be used as a monetary policy instrument. The last term captures the effect of exchange on output. The real exchange rate movements affect the real output through exports which in turn have an effect on international competitiveness of domestic products (De Wet, 2002). Again, an increase in the credit gap will raise the output above the potential.

Third, the credit equation is estimated. The demand for loans decreases with the loan rate and an increase in the output level (Holtemöller, 2002 and Hülsewig et al., 2006). Due to the existence of market imperfections, the capital cost will be high and will influence the financing decisions. Then the interest rate has a negative impact on the financial market and a positive impact on money market, which will increase the output. Based on this argument, the credit gap equation is formulated as follows:

$$c_t = \gamma_0 + \gamma_c c_{t-1} + \gamma_y y_{t-1} - \gamma_r (rl_{t-1} - \pi_{t-1}) \qquad (3)$$

With $0 \le \gamma_c < 1$ and $\gamma_r > 0$. The equation implies that an increase in output will raise the demand for credit. Also, an increase in the long term rate or in the cost of capital will discourage the potential borrowers. Hence the credit demand falls.

Fourth, the Taylor's rule is estimated. The short-term central bank interest rate, which is assumed to be proxied by the repo rate, is an extension of Taylor (2001) considering an open economy. To set the interest rate, the central bank considers the macro economic environment such as the inflation rate, the output gap and in the case of an open economy, the exchange rate is added. According to Mohanty and Klau (2004) the central bank reacts to the actual inflation rate, the output gap, and the depreciation of exchange rate. Taylor (2001) confirms that the appreciation of current exchange rate leads to a decrease in future interest rate to be practised by the central bank. Moreover the central bank reacts to an increase in the credit extension by raising the repo rate. To prevent inflation the central bank raises the repo rate to discourage borrowers and to reduce the amount of credit granted.

Assuming that the central bank follows the Taylor rule and introducing the credit channel, the repo rate equation in an open economy will be:

$$rp_t = rp^* + \phi_\pi (\pi_{t-1} - \pi^*) + \phi_c c_{t-1} + \phi_y y_{t-1} + \phi_e \Delta e_{t-1} \qquad (4)$$

Where ϕ_π, ϕ_y, ϕ_c and ϕ_e are positive policy reaction coefficients. The variable Δe_{t-1} is the rate of depreciation of exchange rate. The variable π^* is the targeting inflation rates, rp^* is the equilibrium repo rate and c_t represents the real credit extension.

Substituting (4) into (1)**,** and rearranging the terms we get the following equation**:**

$$rl_t = \alpha_0 + \alpha_1 \pi_t + \alpha_2 (rl_{t-1} - \pi_{t-1}) + \alpha_3 (\pi_{t-1} - \pi^*) + \alpha_4 c_{t-1} + \alpha_5 y_{t-1} + \alpha_6 \Delta e_{t-1} \qquad (5)$$

Where $(\varphi_0 + \varphi_2 rp^*) = \alpha_0$, $1 - \varphi_2 = \alpha_1$, $\varphi_1 = \alpha_2$, $\varphi_2\phi_\pi = \alpha_3$, $\varphi_2\phi_c = \alpha_4$, $\varphi_2\phi_y = \alpha_5$, $\varphi_2\phi_e = \alpha_6$.
Therefore, the long term rate is positively determined by the inflation rate, the credit gap, the real output gap and the exchange rate depreciation through the central bank rate.

Fifth, the exchange rate equation is approximated. Following Ball (1999, 2002) a negative relationship should exist between the interest rate and the exchange rate depreciations. Certainly, there are other factors which affect the exchange rate depreciation and they are captured by the error term.
Then the exchange rate equation may be set as:

$$\Delta e_t = -\sigma\left([rp_t - \pi_t] - [rp_t^* - \pi_t^*]\right) \qquad (6)$$

Where the difference between domestic and foreign short term rates is represented by $\left(rp_t - rp_t^*\right)$ and π_t^* represents the foreign inflation rate. The highest short term rate makes the domestic asset more attractive and encourages capital inflows. This causes the exchange rate to appreciate.

Finally, the Philips curve is estimated. The inflation rate may be related to different sources such as past inflation rates, output gaps and exchange rates. The exchange rate affects the inflation through imports prices. If the exchange rate depreciates, the price for imports increases, which drives the inflation up. As pointed out by Svensson (2000) and Gerlach and Peng (2006), the output gap is the major determinant of domestic inflation. It may affect inflation through excess demand of goods, which pushes prices up, and consequently raises inflation. Following Taylor (1999) and Mohanty and Klau (2004) and including the effects of the exchange rate on inflation. The Philips curve is therefore given by:

$$\pi_t = \vartheta_0 + \vartheta_1\pi_{t-1} + \vartheta_2 y_{t-1} + \vartheta_3\Delta e_{t-1} \qquad (7)$$

With $0 \leq \vartheta_1 < 1$, the inflation rate is positively driven by the previous inflation, the output and the exchange rate.

According to Ho and Cauley (2003), Karasoy et al. (2005) the differential of exchange rates is of more concern in emerging countries. They argue that emerging economies are usually net importers, hence influence more the consumer price index in comparison to their developed counterparts. In addition, being a net importer results in a real exchange rate appreciation which in the long run triggers higher rates of inflation. As addressed by Burger and Marinkov (2006), the monetary policy influences the inflation gap through the output gap.

To summarize, the reduced form to estimate will be:

$$rl_t = \varphi_0 + \pi_t + \varphi_1(rl_{t-1} - \pi_{t-1}) + \varphi_2(rp_t - \pi_t) \quad (8.1)$$

$$y_t = \beta_0 + \beta_1 y_{t-1} + \beta_2 c_{t-1} - \beta_3(rl_{t-1} - \pi_{t-1}) + \beta_4 e_{t-1} \quad (8.2)$$

$$c_t = \gamma_0 + \gamma_c c_{t-1} + \gamma_y y_{t-1} - \gamma_r(rl_{t-1} - \pi_{t-1}) \quad (8.3)$$

$$rp_t = rp^* + \pi_t + \phi_\pi(\pi_{t-1} - \pi^*) + \phi_c c_{t-1} + \phi_y y_{t-1} + \phi_e \Delta e_{t-1} \quad (8.4)$$

$$\Delta e_t = -\sigma\left([rp_t - \pi_t] - [rp_t^* - \pi_t^*]\right) \quad (8.5)$$

$$\pi_t = \vartheta_0 + \vartheta_1 \pi_{t-1} + \vartheta_2 y_{t-1} + \vartheta_3 \Delta e_{t-1} \quad (8.6)$$

The above regressions point out a simple model for a small open economy, which identifies the monetary transmission mechanism on both economic activity and inflation.

3. EMPIRICAL ESTIMATIONS

In this section the results from the econometric analysis of the South African economy are presented. However in this model, the econometric method to be used following Rudebusch and Svensson (1999), is the Ordinary Least Squares (OLS). Before we delve into econometric analysis, the source of the data will be presented. Thereafter, an interpretation of the results is provided, and a calibration is checked to compare the impulse responses of our model with those of an unrestricted VAR. To test for robustness over sample period of a structural change, the Chow's test is normally used to determine whether the coefficients in a regression model are the

same as those in a separate subsample. The Chow's breakpoint will be used to test the stability of the Philips curve parameters and the Taylor rule parameters. To test the stability over time, the Chow's forecast test and the recursive least square may be appropriate for such a situation as pointed out by Mohanty and Klau (2004).

3.1 DATA COLLECTION AND ANALYSIS

The data sources in this work are the South African Reserve Bank (SARB) and the Federal Bank. It is very important to specify that all empirical data used are drawn on a quarterly basis since 1990:1 up to 2005:4. The standard errors coefficients are given in parentheses, and the standard error of the residuals (SE) and Durbin-Watson (DW) statistics are reported following Rudebusch and Svensson (1999). However, the DW loses validity when lagged dependent variables on the right-hand side of the regression model are employed. The Breusch-Godfrey Serial Correlation Lagrange Multiplier (LM) test may be appropriate to deal with first or higher order autocorrelation. Therefore, the Q-statistic is also reported for those that have a serial correlation.

The time series data includes the short term rate (Discount rates on 91 day treasury bills), the Consumer Price Index (CPI), the real Gross Domestic Product (GDP), the nominal exchange rate, the long rate (10 years yield), the total credit extended by all monetary institutions, the USA-CPI, the real USA-real GDP, the USA-short rate (3-Month Treasury Bill: Secondary Market Rate). The nominal exchange rate is the South African Rand per US-dollar. The real GDP at market prices is the constant 2000 prices, seasonally adjusted at the annual rate. The total CPI collected for metropolitan areas is the index 2000=100, seasonally adjusted.

The output gap is obtained by taking the actual output minus potential output. All variables were detrended using Hodrick Prescott (HP) Filter. The HP filter may be one the most common method used to extract a trend from macroeconomic data (Gerlach and Peng (2006) among others). The HP filter minimizes the following expression:

$$\sum_{t=1}^{T}\left(y_t - y_t^*\right)^2 + \lambda\sum_{t=2}^{T}\left[\left(y_{t+1}^* - y_t^*\right) - \left(y_t^* - y_{t-1}^*\right)\right]^2$$

Where y and y^* are the actual and potential output respectively, and λ is a weighting factor that determines the degree of smoothness of the trend (Cerra and Saxena 2000). For quarterly data λ is set to be $\lambda = 1600$. The HP filter has an advantage to make the output gap stationary over a wide range of smoothing values (Hodrick and Prescott 1997).

3.2. EMPIRICAL RESULTS

3.2.1. MODEL ESTIMATION

First, the real long rate equation, following the post Keynesian theory where banks have a monopolistic power to set and smooth the interest rates, has been estimated. Initially, the R-squared and DW were low and we test for the serial correlation by forecasting the residuals. Therefore, the R-squared and DW are improved, the signs are as expected, all parameters are positive.

$$rl_t = \underset{(0.003)}{0.013} + \underset{(0.06)}{0.37}(rl_{t-1} - \pi_{t-1}) + \underset{(0.06)}{0.53}(rp_t - \pi_t)$$

SE = 0.009 R-squared=0.89 DW=1.91 Q-squared=7.49 (Prob. =0.11)

The above results show that, the bond market positively reacts to a change in the short term rate. As noted by Hubbard (1995), the change in short term rate influences the bond market which in turn influences household and business spending preferences.

Second, the credit gap was difficult to estimate for instance, after one lag period, the long term rate had an unsatisfactory sign which in addition was statistically insignificant. However, after a series of runs we obtained a satisfactory sign at the eighth quarter which again turned out to be statistically insignificant. The period after which a satisfactory sign was found is too long for the monetary policy transmission. As argued by Batini and Haldane (1999) the central bank has to determine with some degree of certainty the effects of the lags of inflation and output. Failure to do so may set off instability or cause a cyclical effect on the behavior of macroeconomic aggregates. Hence, the credit gap is estimated in two stages. The first stage is given by the

relationship between the growth rate of credit ($\hat{c}_t$) and the credit gap. The parameter estimated are:

$$\hat{c}_t = 0.06 + 1.05c_t$$

(0.01) (0.13)

SE= 0.02 R-squared=0.83 DW=1.67

In the second stage we estimate the credit growth rate as follows:

$$\hat{c}_t = 0.016 + 0.79\hat{c}_{t-1} - 0.257(rl_{t-1} - \pi_{t-1}) + 0.47\hat{y}_{t-1}$$

(0.008) (0.09) (0.14) (0.18)

SE=0.027 R-squared=0.70 DW=1.74 Q-squared=12.69 (Prob. =0.01)

Where $\hat{c}_t$ and $\hat{y}_t$ represent the credit growth rate and output respectively. Combining the two stages, the relationship between the credit gap and its explanatory variables is similar to that relationship as specified in the theoretical section.

The parameter estimates are reported as:

$$c_t = 0.0007 + 0.79c_{t-1} + 0.55y_{t-1} - 0.24(rl_{t-1} - \pi_{t-1})$$

The result suggests that an increase of a percentage of the output gap increases the credit demand by 0.55 percent while an increase of a percentage of the long rate reduces credit demand by 0.24 percent.

Third, some complications were faced in estimating the IS curve. In estimating the IS curve by combining the interest rate channel and credit channel, an unsatisfactory sign for the interest rate effect on output gap was obtained. As in the credit gap, the response was observed after eight quarters and turned out to be statistically insignificant. For this reason, the long term rate is excluded in this model. However, according to the credit channel, monetary policy may be transmitted to the real economy through its effects on bank loans as noted by Guariglia and

Mateut (2006). So, the IS curve is estimated in two stages. In the first stage, the growth rate of output and the output gap is related, as given by:

$$\hat{y}_t = 0.03 + 1.23 y_t$$
$$(0.05) \quad (0.14)$$

SE=0.04 R-squared=0.96 DW=1.92

In the second stage we estimated the growth rate of output as follows:

$$\hat{y}_t = 0.02 + 1.49\hat{y}_{t-1} - 0.67\hat{y}_{t-2} + 0.04\hat{c}_{t-1} + 0.04 e_{t-1}$$
$$(0.001) \quad (0.10) \quad (0.10) \quad (0.002) \quad (0.008)$$

SE= 0.006 R-squared=0.91 DW=1.94 Q-squared=13.91 (Prob. =0.07)

Combining the two stages and replacing the growth rate credit by its relationship, the regression is given by the following specification:

$$y_t = 0.014 + 1.49 y_{t-1} - 0.67 y_{t-2} + 0.034 c_{t-1} + 0.032 e_{t-1}$$

In the above analysis the hypothesis that the sum of the lagged output gap is less than one is taken into consideration. As one of the aims of this research was to explicitly introduce the long term rate in the monetary transmission mechanism, we confirm that the high interest rate slows the South African economy through the credit channel. The results are different from those obtained by Aron and Muellbauer's (2001). They found that in South Africa, the real interest rate negatively affects the output after four quarters. In this study the effect comes after two quarters through the credit channel effect.

Fourth, the repo rate by taking into account the effect of the credit demand is estimated. The inflation rate influences the repo rate after four quarters while other variables influence the repo rate after one quarter. The real repo rate will be:

$$rrp_t = 0.87 rrp_{t-1} + 0.14\pi_{t-4} + 0.05 c_{t-1} + 0.33 y_{t-1} + 0.03\Delta e_{t-1}$$
$$(0.04) \quad (0.06) \quad (0.03) \quad (0.17) \quad (0.01)$$

SE =0.011 R-squared=0.87 DW=1.69 Q-squared=6.91 (Prob. =0.14)

The real repo rate is represented by $rrp_t = rp_t - \pi_t$. The estimated policy rule attributes a large coefficient to the lagged repo rate. Mohanty and Klau (2004) confirms my result by finding a high degree of interest rate smoothing in South Africa. Through excess demand for goods, a percentage increase of output gap increases the repo rate by 0.33 percent. The response of the repo rate to an increase in the exchange rate and credit demand is low but significant.

Fifth, the exchange rate is estimated following Ball (1999). In his estimation, other factors influencing the real exchange rate were captured under the shock. In this analysis, following Malikane (2006) one period of depreciation as one of the variables driving the real exchange rate is used. However, the problem faced is that of a low R-squared and D-W. Then the serial correlation is corrected by using the Breusch-Godfrey Serial Correlation LM test. The real exchange rate depreciation is given by:

$$\Delta e_t = \underset{(0.01)}{0.03} - \underset{(0.11)}{0.73}(rrp_t - rrp^*_t - \Delta e_{t-1})$$

SE = 0.07 R-squared=0.77 DW=2.07

The real foreign short rate is represented by $rrp_t^* = rp_t^* - \pi_t^*$.

In the above equation, the exchange rate is driven by the interest rate. A percentage increase in the interest rate appreciates the exchange rate by 0.73 percent. Such a result can be explained by the fact that a rise in the interest rate pushes aside foreign investment and attracts domestic investment, which causes the local currency to appreciate. Ball (2002) attributes the exchange rate depreciation to shocks in net exports and financial markets. As confirmed by De Wet (2002), the financial market is one of the factors that influence the South African economy.

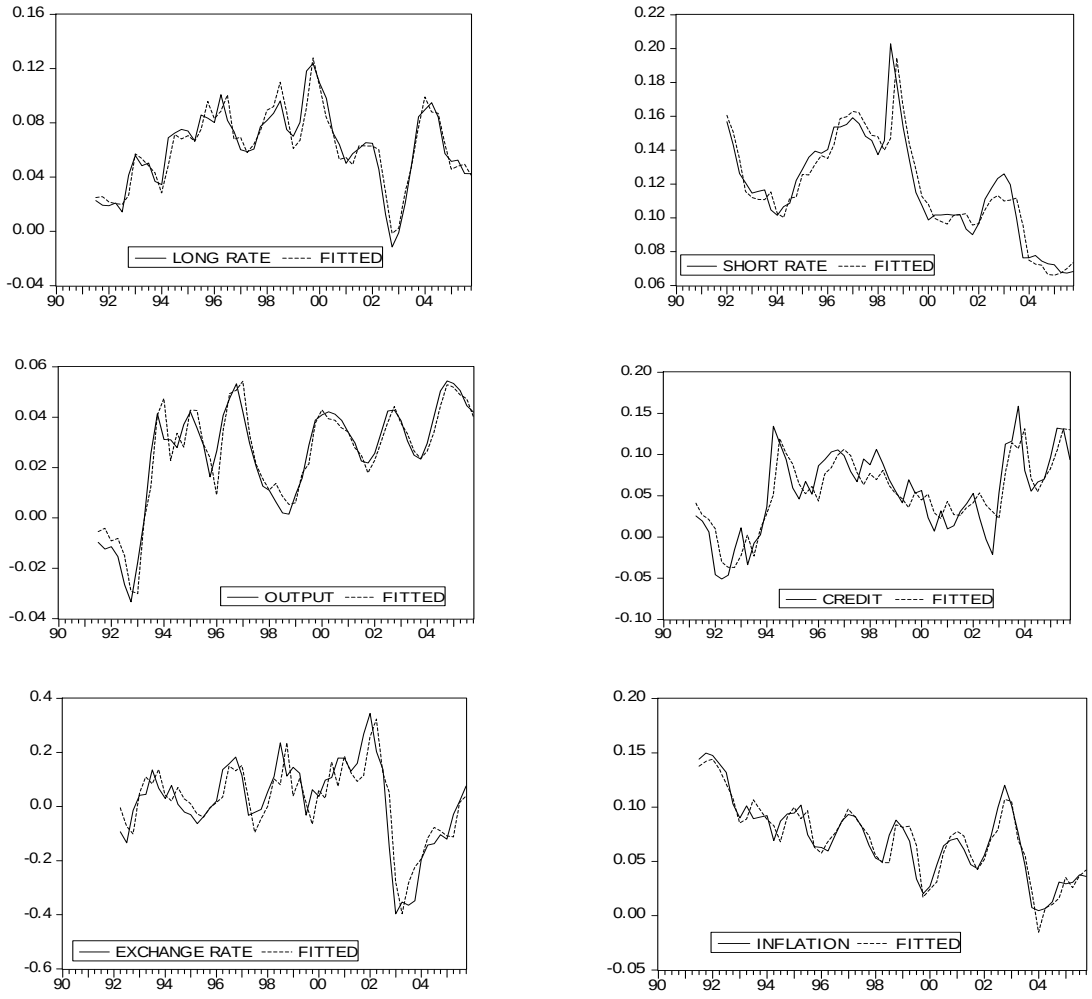
Finally, the inflation rate equation is estimated following Rudebusch and Svensson (1999).

$$\pi_t = \underset{(0.12)}{1.26}\pi_{t-1} - \underset{(0.12)}{0.29}\pi_{t-2} + \underset{(0.3)}{0.83}y_{t-1} - \underset{(0.29)}{0.75}y_{t-2} + \underset{(0.018)}{0.07}\Delta e_{t-1} - \underset{(0.019)}{0.04}\Delta e_{t-2}$$

SE = 0.01 R-squared= 0.90 DW= 1.95

In the analysis above, the hypothesis that the sum of the lagged inflation is less than one is considered. The output gap captures the factors which show the response of inflation to aggregate demand. In this estimation the response is high (0.97%) and statistically significant. In the Gerlach and Peng (2006) estimations for Mainland China's economy, the response was found to be 0.788%. One reason may be the fact that they use more lags for the inflation rate, which may reduce the degrees of freedom.

FIGURE 3.1: ACTUAL AND FITTED VALUES FROM MY ESTIMATIONS



3.2.2. Robustness checks

In order to test the robustness results and test whether they stand up to alternate specification and whether the parameters are stable across a variety of subsamples of the data, different methods are used.

3.2.2.1. Chow's breakpoint test

This test checks whether the equation fits individually for each subsample and observe whether there are a major differences in the estimated equations. The key assumption is that the disturbance variance of Chow test is the same in all regressions.

The Chow's test will be used in this paper to test the stability of the parameters for the Philips curve and the Taylor rule. The breakpoint is the beginning of the inflation targeting and has been done for the first quarter of 2000.

TABLE 3.1: CHOW BREAKPOINT TEST 2000:1

	Philips curve	Taylor rule
F-Statistic	2.05 (0.07)	3.29 (0.01)
Log likelihood ratio	13.77 (0.03)	17.12 (0.004)

Probabilities are reported in parentheses.

Results show that the null hypothesis of no structural break has been rejected and they reveal the instability of parameters during the above mentioned period.

3.2.2.2. Chow's forecast test

This test estimates two models, one with the full sample and another one for a subsample. After specifying a first observation in the forecast period, the test re-estimates the equation before the subperiod and computes the prediction error for the remaining subperiod. The specified period is the time of the inflation targeting.

TABLE 3.2: CHOW FORECAST TEST 2000:1

	Philips curve	Taylor rule
F-Statistic	0.79 (0.71)	0.67 (0.84)
Log likelihood ratio	30.07 (0.18)	26.10 (0.34)

The probabilities are reported in parentheses.

Results indicate that the null hypothesis of no structural break has been accepted and they confirm the stability over the period. The two tests illustrate the possibility of a conflicting yield. Thus the recursive least square was used.

3.2.2.3. RECURSIVE LEAST SQUARES

This technique is suitable for time series data and might be used when there is uncertainty about the time that a structural change might have occurred as pointed out by Greene (2003). In the Philips curve, the parameters were chosen according to their importance in our modelling. In the Taylor equation, the short rate, the output and the inflation were chosen respectively because of their importance in short term rate estimation over time.

FIGURE 3.2: TEST OF STABILITY-RECURSIVE COEFFICIENT- TAYLOR RULE

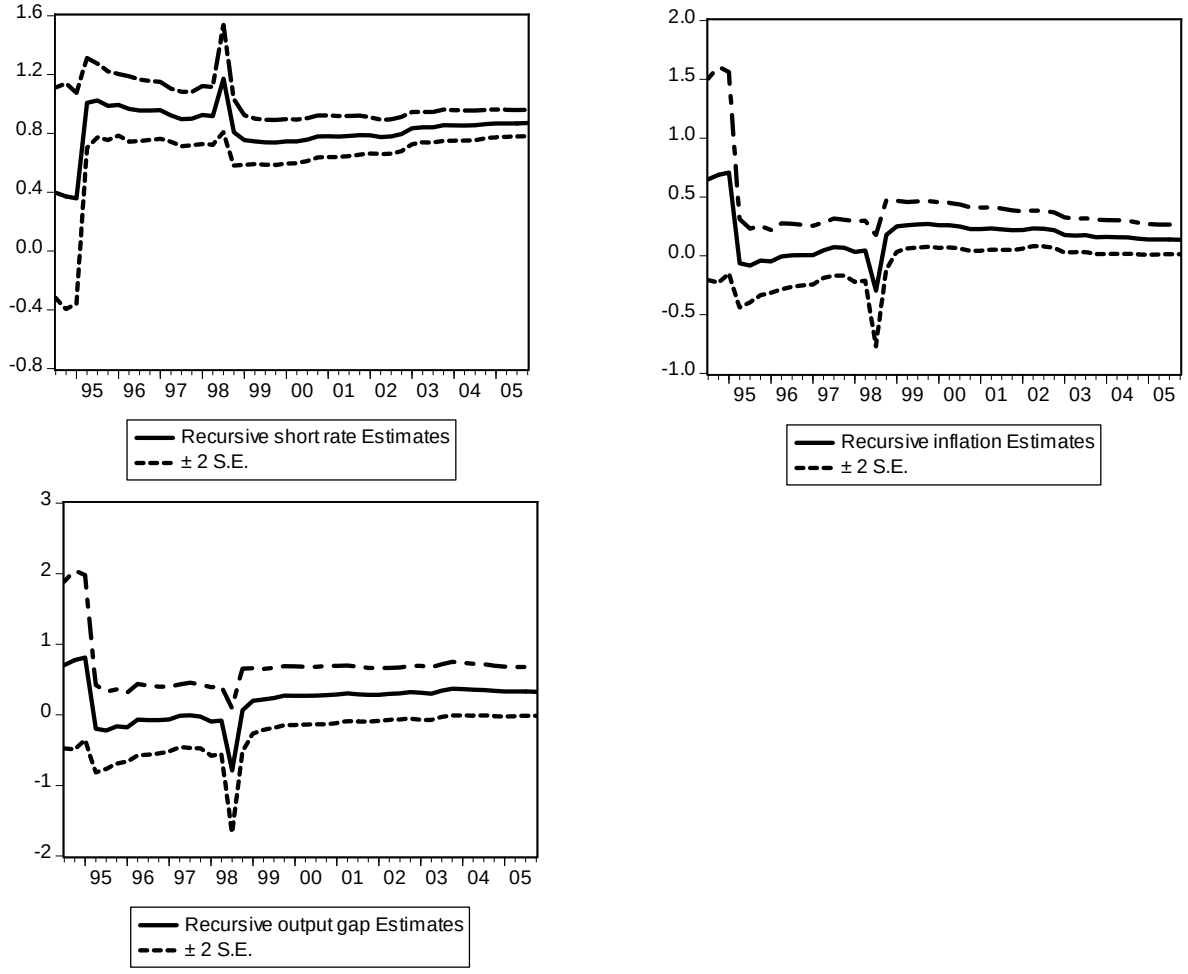
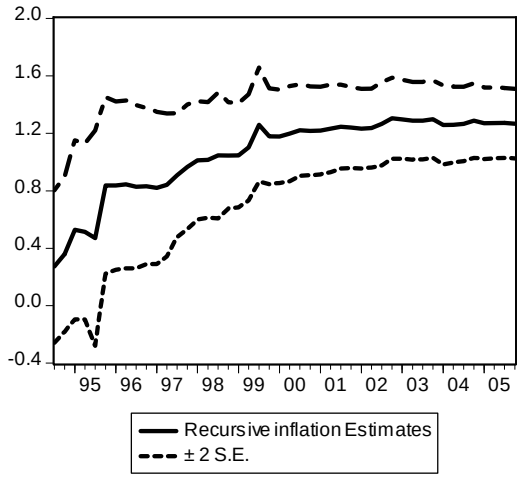
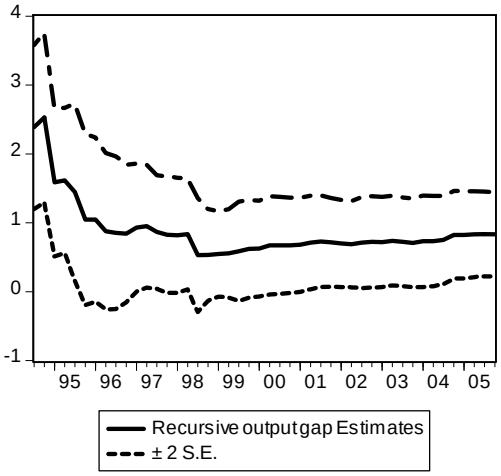


FIGURE 3.3: TEST OF STABILITY-RECURSIVE COEFFICIENT- PHILIPS CURVE


2.0
1.6
1.2
0.8
0.4
0.0
-0.4
95 96 97 98 99 00 01 02 03 04 05
Recursive inflation Estimates
± 2 S.E.


4
3
2
1
0
-1
95 96 97 98 99 00 01 02 03 04 05
Recursive output gap Estimates
± 2 S.E.

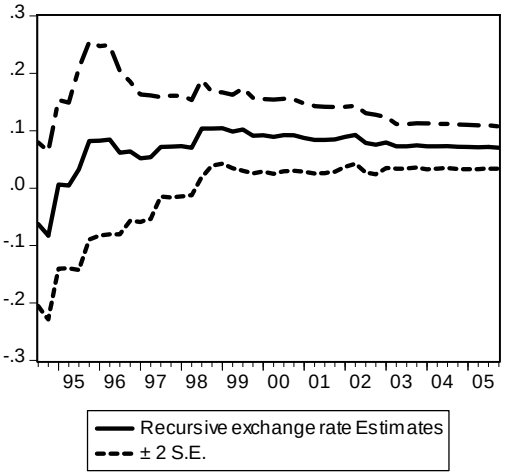

.3
.2
.1
.0
-.1
-.2
-.3
95 96 97 98 99 00 01 02 03 04 05
Recursive exchange rate Estimates
± 2 S.E.

FIGURE 3.4: RECURSIVE RESIDUAL FOR THE SHORT RATE

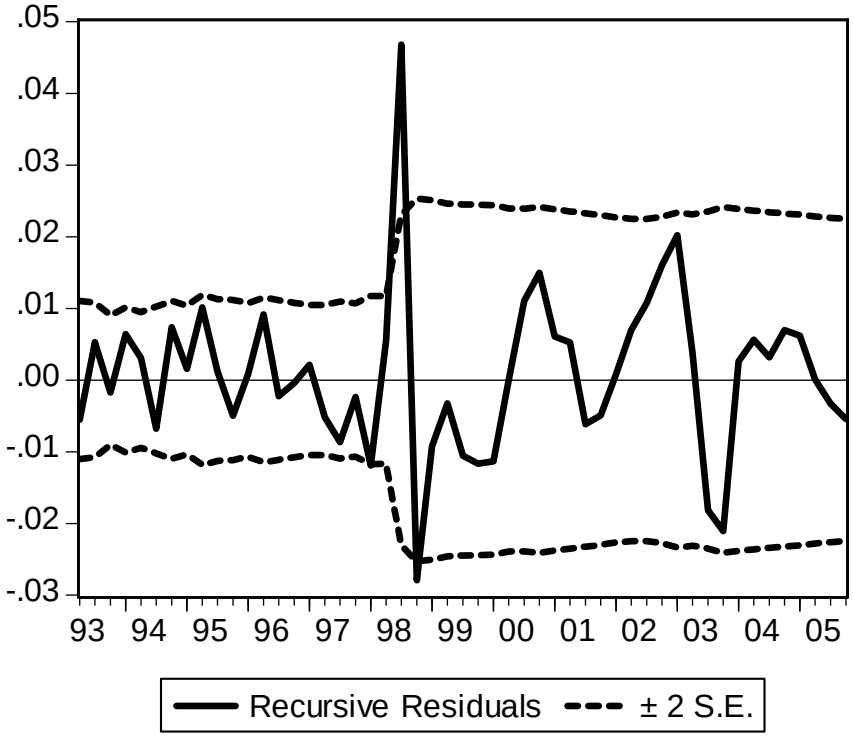
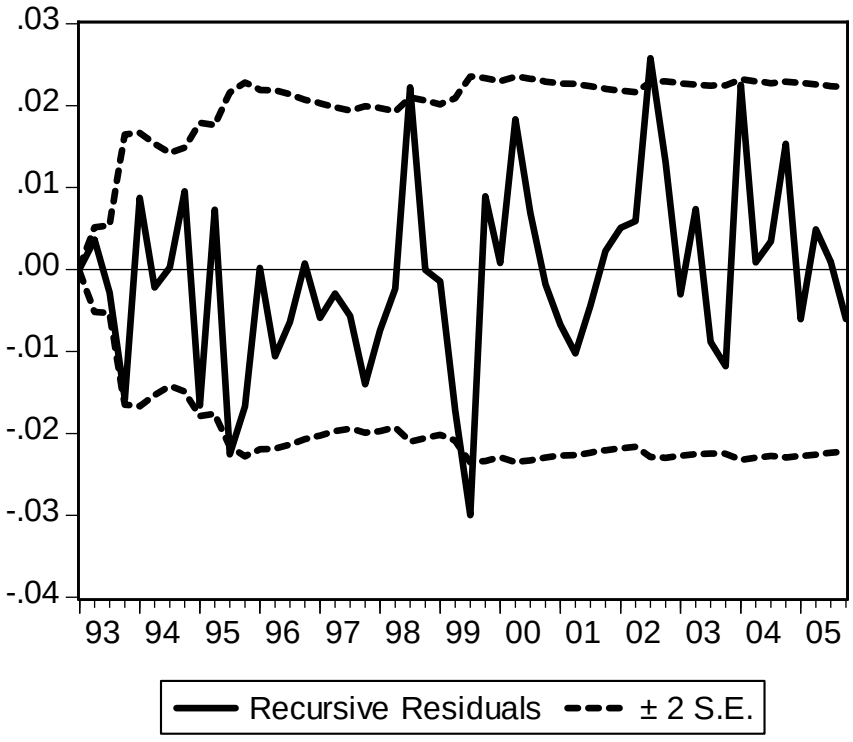


FIGURE 3.5: RECURSIVE RESIDUAL FOR THE INFLATION RATE



As a conclusion, the inflation did not change the structure of the economy, the recursive least square supports Chow's test but does not support Chow breakpoint test. These results should be interpreted with caution as the recursive test for coefficients as well as for the recursive residual above reveal the small instability around 1998. Instability was caused by the East Asian financial crisis in 1998.

3.2.3. Impulse responses analysis

A shock on a dependent variable does not affect only that variable, but it may also be transmitted to all of the other endogenous variables at a point in time as well as expected future values of the variables of the dynamic system through time.

3.2.3.1. Structural model impulse responses

FIGURE 3.6: RESPONSE OF INFLATION, OUTPUT AND SPREAD TO A SHORT RATE SHOCK

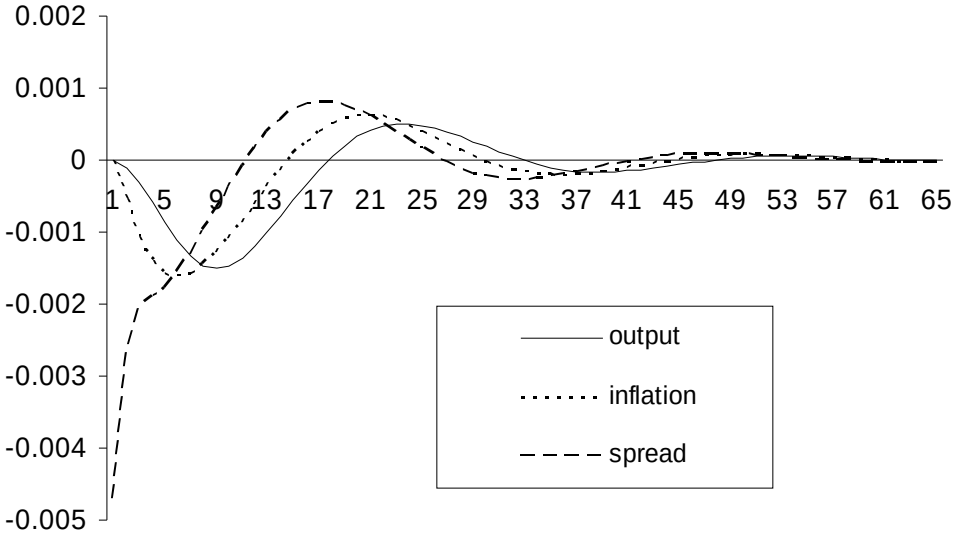


FIGURE 3.7: RESPONSE OF INFLATION, OUTPUT AND SHORT RATE TO AN OUTPUT SHOCK

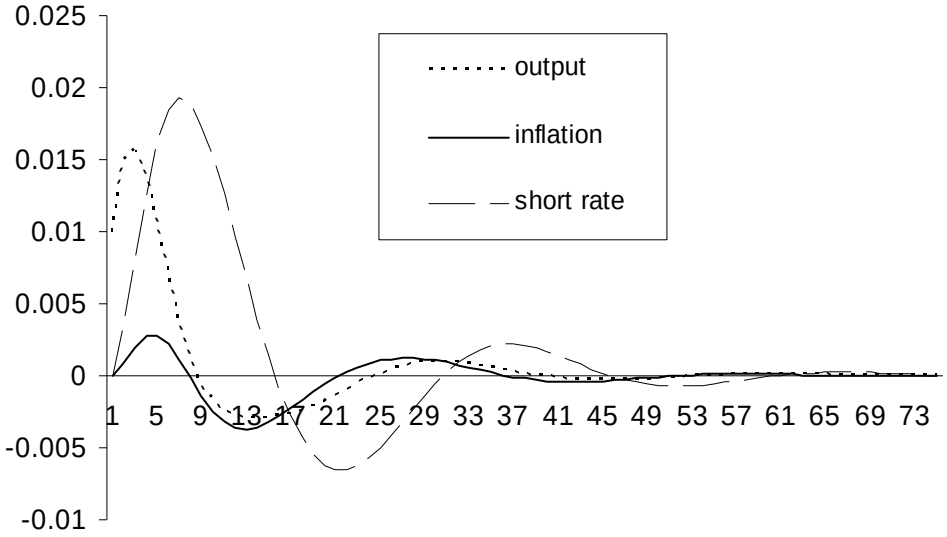
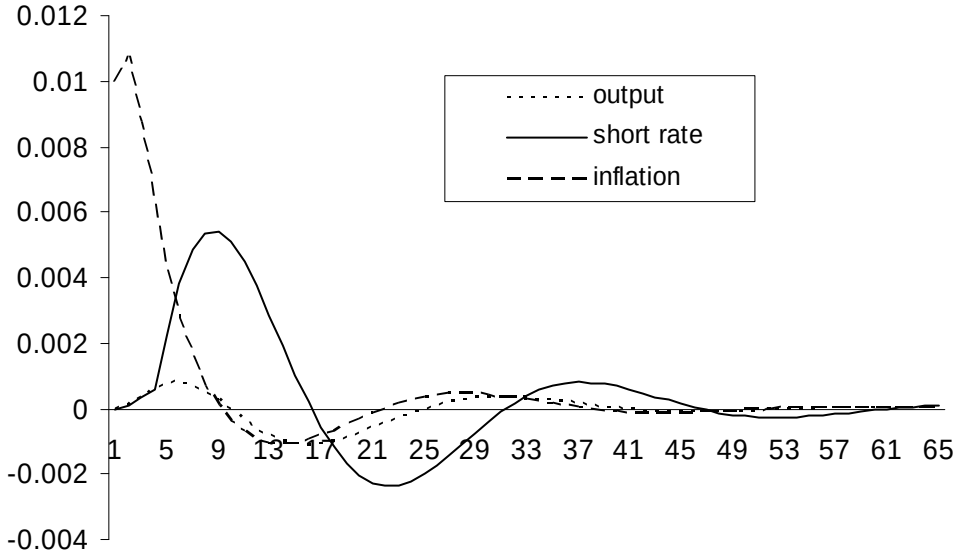


FIGURE 3.8: RESPONSE OF INFLATION, OUTPUT AND SHORT RATE TO AN INFLATION SHOCK



The first figure provides the predictive results that have been found in the earlier empirical literature (Mishkin, 1990a; Estrella and Hardouvelis, 1991; Estrella and Mishkin, 1997; Estrella

et al., 2003 and Estrella, 2005). A positive percentage shock on short term rate leads to a decrease of the spread by 0.5%. The shock converges after 4 years and dies out after 8 years. Output is decreased by 0.1%. The shock then converges after 5 years and dies out after 10 years. The inflation is decreased by 0.1%. Similarly, the shock converges after 5 years and dies out after 9 years. The term spread predicts inflation through Fisher effect. Another explanation may be that if the bond holders expect for example investment spending or inflation to rise, they sell bonds whose price will fall which lead to an increase of the current money market interest rates.

The second figure is similar to that produced by Rudebusch and Svensson (1999). A positive shock to the output leads to a jump in the short term rate and an increase in inflation. For instance, if there is an increase in the government expenditure, output increases and the prices rise which leads to inflation. The central bank reacts by increasing the short term rate or repo rate in the South Africa economy.

The third figure shows the impact of an inflation shock to output, inflation and short term rate in South Africa economy. In the period of high inflation, the output reacts slowly while the short term rate reacts strongly and this stabilizes prices. A temporary inflation shock like a change in oil prices leads to a jump in the short term rate of almost 5% followed by a decrease to 2%. These results are similar to those by Rudebusch and Svensson (1999). They found an increase of 2% followed by a decrease of 5%. These impulse responses reveal that the short term rate shock will converge after 16 quarters while in USA it is after 20 quarters and the shock will be eliminated within 60 quarters while in USA it will die out after 44 quarters.

3.2.3.2. Unrestricted VAR impulse responses

It is better to compare the structural impulse response to those from unrestricted VAR in order to judge its plausibility and its conformity to our model. The number of lag intervals is chosen for a model which minimizes both Akaike and Schwarz (in absolute value). Thus VAR equations regresses the gap on three lags of all variables.

FIGURE 3.9: VAR IMPULSE RESPONSES TO A POSITIVE INFLATION SHOCK

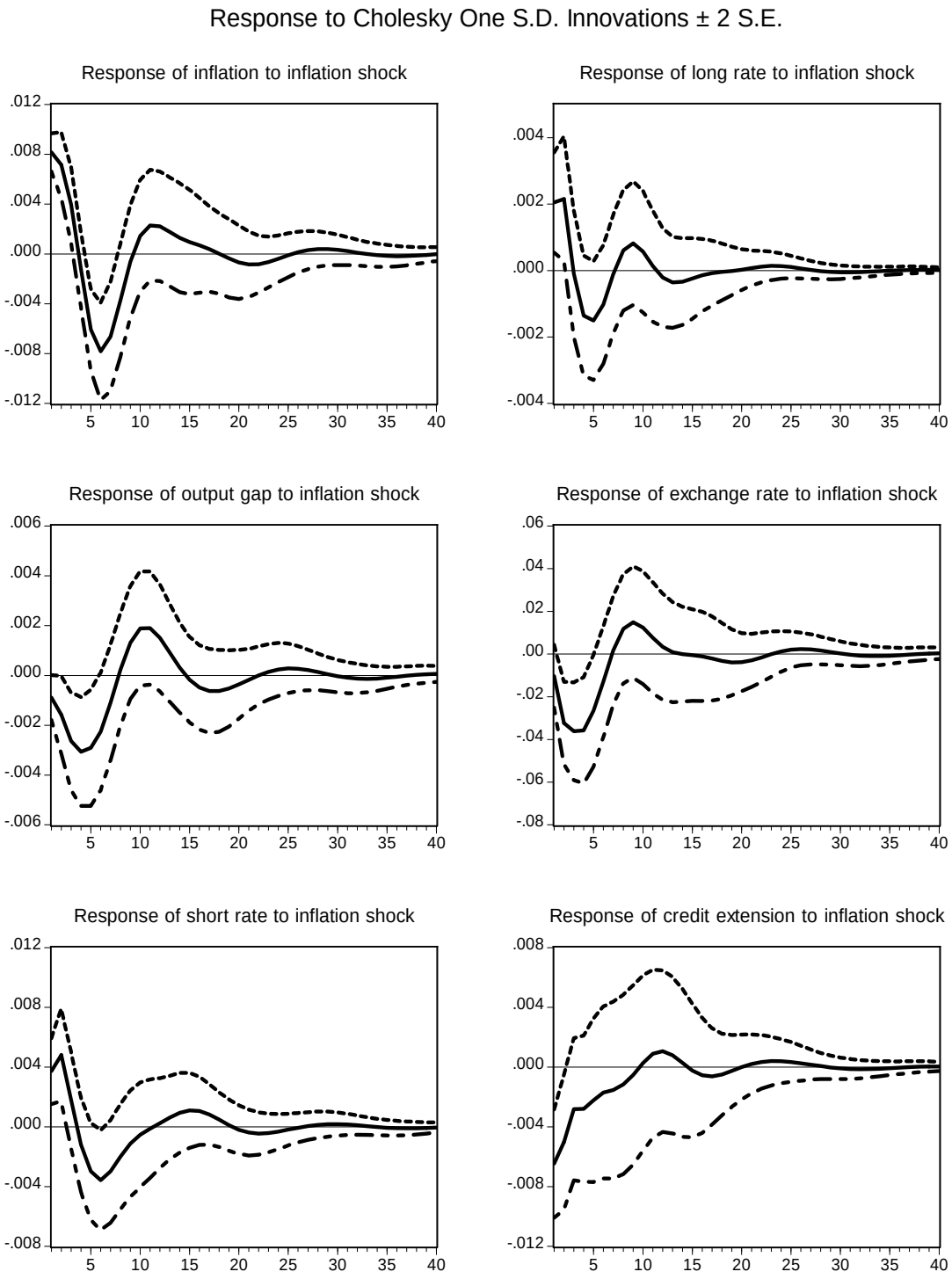


FIGURE 3.10: VAR IMPULSE RESPONSES TO A POSITIVE OUTPUT SHOCK

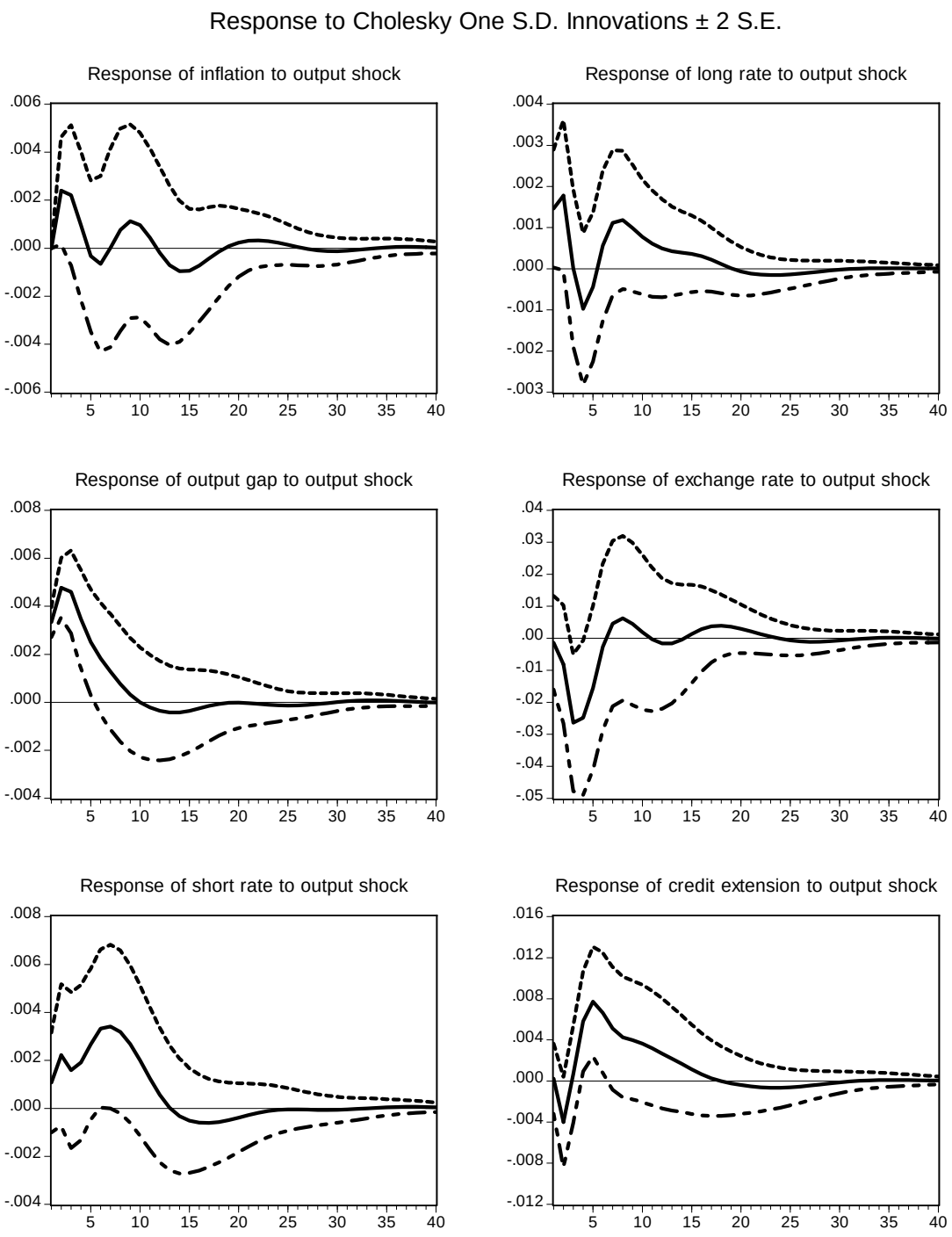
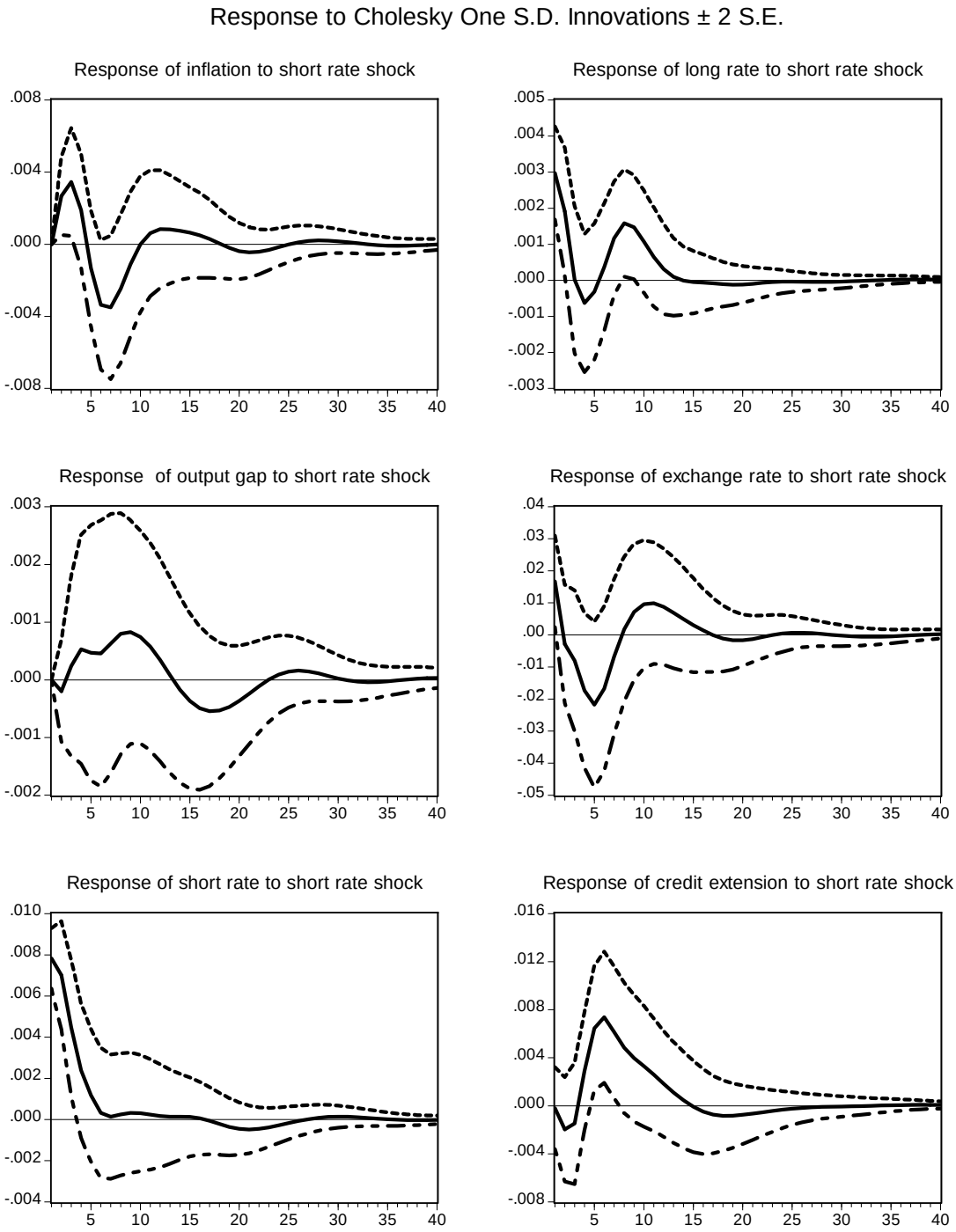


FIGURE 3.11: VAR IMPULSE RESPONSES TO A POSITIVE SHORT RATE SHOCK



The impulse responses match with economic intuition. Figure 3.9 shows the responses to an inflation shock. A positive shock to inflation like an increase in oil prices leads to an increase in the short term rate then the long term rate increases which contracts output and hence inflation falls. Moreover the exchange rate appreciates because of an increase in the short term rate. The credit first contracts and rises after a certain period.

Figure 3.10 displays the responses to an output shock. A positive shock to output like an increase in investment spending leads to inflation. The central bank reacts, by increasing the short rate, thus the long rate rises which reduces the credit granted. The exchange rate appreciates as a result of an increase in the short term rate.

Figure 3.11 exhibits the responses to a short rate shock. A positive shock to a short term rate leads to an increase in long term rate. In general the inflation rate may fall but in this case it is increasing. That should be explained by the fact that the consumer price index includes mortgages then an interest rate rise leads to an increase in CPI which increases the inflation rate. The credit extension reacts to the increase in short term rate by falling because of the increase in the long rate. This fall is followed by an increase which raises output. The exchange rate reacts to an increase in short rate by an appreciation.

As a conclusion, the model produced the same impulse response as those produced by unrestricted VAR.

4. CONCLUSION

This dissertation has examined critical variables in the monetary transmission mechanism in South Africa. In order to understand the effects of monetary policy effects on economic real activity, a transparent and simple model of the monetary transmission mechanism was formulated. Individual equations were estimated using Ordinary Least Squares. To check the robustness of both results and parameters stability over the sample period, the Chow's test and recursive coefficient estimates were used. The study uses quarterly data for the South African economy from 1990 to 2005.

The macroeconomic framework was built on the model by Rudebusch and Svensson (1999) and Ball (1999). First, the backward looking model was extended to an open economy considering exchange rate effects on interest rate, inflation and output. Second, the long term rate was introduced in the IS curve estimation as a variable in the monetary transmission mechanism. Third, the credit channel was introduced in the monetary transmission mechanism by allowing credit to directly affect output and for the central bank to react to the credit gap among other variables.

The major findings and conclusions of the study are as follows: First, long lags in monetary policy transmission on the real economic activity found in the previous studies are destabilising. This was resolved by introducing the credit channel in the model. Second, the interest rate and credit channel do not complement each other in the monetary transmission mechanism in the South African economy. Third, monetary policy affects the level of the economy activity after two quarters and affects inflation after three quarters through the credit channel. The conclusion is that the short term rate influences the output and mainly inflation through the credit channel.

The model formulation also investigates whether the term spread predicts inflation and real economic activity. The simulation of impulse responses confirms that the predictive power of the term spread on output and inflation holds in the South African economy, despite the backward looking nature of our model. The implication of the predictive power of the term

spread for monetary policy is that the central bank should pay particular attention to the yield curve in order to stabilise the economy.

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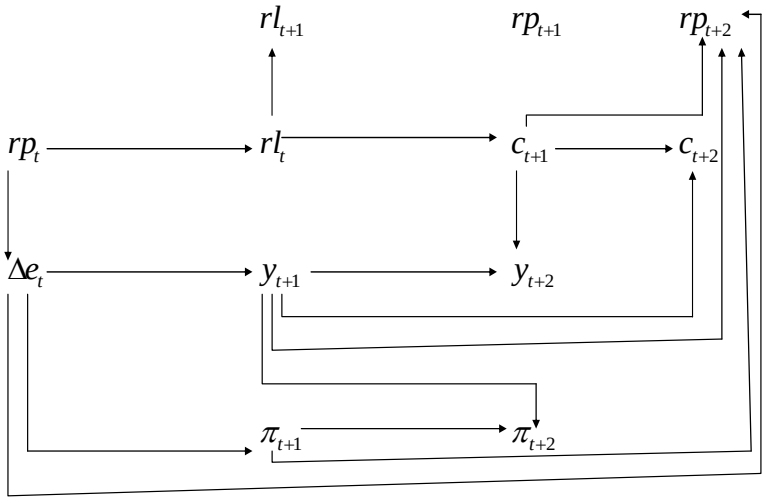
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APPENDIXES

Appendix 1

Schematic structure of the transmission mechanism



Appendix 2

Chow forecast test for the short rate

Chow Forecast Test: Forecast from 2000:1 to 2005:4			
F-statistic	0.668026	Probability	0.839365
Log likelihood ratio	26.10281	Probability	0.347969

Test Equation:
Dependent Variable: SHORTR
Method: Least Squares
Date: 11/23/06 Time: 20:33
Sample: 1992:1 1999:4
Included observations: 32
SHORTR=C(2)*SHORTR(-1)+C(3)*INF(-4)+C(4)*LRGDPGAP(-1) +C(5)
*DLRCRED(-1)+C(6)*LREXCHD1(-1)

	Coefficient	Std. Error	t-Statistic	Prob.
C(2)	0.737616	0.076362	9.659519	0.0000
C(3)	0.270808	0.097415	2.779944	0.0098
C(4)	0.272863	0.208588	1.308142	0.2019
C(5)	0.175459	0.056655	3.096993	0.0045
C(6)	0.017677	0.034744	0.508794	0.6150
R-squared	0.752828	Mean dependent var		0.136408
Adjusted R-squared	0.716210	S.D. dependent var		0.022926
S.E. of regression	0.012213	Akaike info criterion		-5.830012
Sum squared resid	0.004027	Schwarz criterion		-5.600991
Log likelihood	98.28020	Durbin-Watson stat		1.977654

Appendix 3

Chow forecast test for the inflation rate

Chow Forecast Test: Forecast from 2000:1 to 2005:4

F-statistic	0.792928	Probability	0.716214
Log likelihood ratio	30.07805	Probability	0.182178

Test Equation:
Dependent Variable: INF
Method: Least Squares
Date: 11/23/06 Time: 20:49
Sample: 1991:3 1999:4
Included observations: 34
INF=C(1)*INF(-1)+C(2)*INF(-2)+C(3)*LRGDPGAP(-1)+C(4)
*LRGDPGAP(-2)+C(5)*LREXCHD1(-1)+C(6)*LREXCHD1(-2)

	Coefficient	Std. Error	t-Statistic	Prob.
C(1)	1.179558	0.166627	7.079037	0.0000
C(2)	-0.211240	0.161271	-1.309845	0.2009
C(3)	0.623523	0.354956	1.756623	0.0899
C(4)	-0.459908	0.346684	-1.326593	0.1954
C(5)	0.091388	0.032799	2.786300	0.0095
C(6)	-0.075143	0.032674	-2.299776	0.0291

R-squared	0.872673	Mean dependent var	0.086643
Adjusted R-squared	0.849936	S.D. dependent var	0.030142
S.E. of regression	0.011677	Akaike info criterion	-5.903682
Sum squared resid	0.003818	Schwarz criterion	-5.634325
Log likelihood	106.3626	Durbin-Watson stat	2.181332

Appendix 4

Chow's test

Chow Breakpoint Test for the interest rate: 2000:1

F-statistic	3.290201	Probability	0.012699
Log likelihood ratio	17.12150	Probability	0.004275

Chow Breakpoint Test for the Philips curve: 2000:1

F-statistic	2.055670	Probability	0.077151
Log likelihood ratio	13.77756	Probability	0.032222

Chow Forecast Test for the short rate: Forecast from 2000:1 to 2005:4

F-statistic	0.668026	Probability	0.839365
Log likelihood ratio	26.10281	Probability	0.347969

Chow Forecast Test for the inflation rate: Forecast from 2000:1 to 2005:4

F-statistic	0.792928	Probability	0.716214
Log likelihood ratio	30.07805	Probability	0.182178