MONETARY POLICY TRANSMISSION IN SOUTH AFRICA: A COMPARATIVE ANALYSIS OF CREDIT AND EXCHANGE RATE CHANNELS

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A thesis submitted in partial fulfilment of the requirements for the degree of

MASTER OF COMMERCE (FINANCIAL MARKETS)

DEPARTMENT OF ECONOMICS
RHODES UNIVERSITY, GRAHAMSTOWN

July 2010

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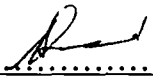
[1] The financial assistance from the Allan Gray Foundation Scholarship towards this research is hereby acknowledged. Opinions and views expressed, and conclusions arrived at, are those of the author and do not necessarily reflect those of Rhodes University or the Allan Gray Foundation.

DECLARATION

Except for references specifically indicated in the text, and such help as has been acknowledged, this thesis is wholly my own work and has not been submitted to any other University, Technikon or College for degree purposes.



NATHANIEL SEBITSO

ABSTRACT

This thesis focuses on monetary policy transmission and particularly seeks to examine the impact of credit and exchange rate channels of monetary policy transmission in the South African economy. South Africa's monetary policy has gone through several changes over the past thirty years. In this respect, there is a need for robust empirical evidence on the effects of these channels on inflation and output. The thesis employs a structural vector autoregressive (SVAR) model to identify monetary transmission in South Africa for the period 1994:q4 - 2008:q2. The form of the SVAR used in this thesis is based on the fact that South Africa is a small open economy, which means that external shocks are an important driver of domestic activity. The impulse responses and variance decomposition results show that the repo rate, credit and exchange rate play a role in terms of their impact on inflation and output.

The dynamic responses to the identified monetary policy shock are consistent with standard theory and highlight the importance of the interest rate channel. A shock to the interest rate, increasing it by one standard deviation, results in a persistent fall in credit. The response of output is immediate as it falls and bottoms out within the second year. Inflation shows a lagged response, it is positive within the first year as the exchange rate depreciates but in subsequent quarters inflation responds negatively as expected. Inflation falls and reaches a minimum by approximately eight quarters then moves towards baseline. The exchange rate shows delayed appreciation. The shock to the repo interest rate leads to an immediate depreciation of the exchange rate in the first two quarters as output declines, followed by an appreciation in the third and sixth quarter. Due to larger error bounds the impact of the repo rate on the exchange rate could be less effective within the first two years.

The impulse responses suggest that monetary policy plays an effective role in stabilising the economy in response to a credit shock, notwithstanding large standard error bounds. Hence, the monetary authority reacts by increasing the repo rate as a result of inflation. The impact of credit on output is positive but is offset to some extent by the rising repo rate. In response to the rand appreciation, the monetary authority reduces the repo rate significantly during the first year with the maximum impact in the second year and then returns to baseline thereafter. Therefore the monetary authority reduces the repo rate, probably to stabilise falling inflation. The result shows that inflation falls as a result of the rand appreciation. A shock to the exchange rate causes a rise in output, though small in magnitude, which is persistent but reaches baseline at the end of the period. This result could reflect the effects of the resultant fall in the repo rate and a persistent rise in credit over the whole period, which tends to increase output. The exchange rate shows an obvious and stronger immediate impact

on inflation compared to credit impact on inflation. However, the credit shock has an obvious and stronger impact on output compared to an exchange rate impact on output.

However, the large standard error bounds may imply that credit and exchange rate channels are not as effective in the short run. It is important to note that the results are based on the SVAR model estimated with percentage growth rate of the variables. The variance decomposition result is in line with the impulse responses and shows that the exchange rate and credit channels could be important transmission channels in South Africa over the chosen sample period. The exchange rate and credit shocks show a stronger effect on inflation than on output, looking at both the impulse responses and variance decomposition results. The reaction of the repo interest rate to the credit and exchange rate shocks comes out as expected. The repo rate increases as a result of an increase in the credit and falls as a result of the currency appreciation.

ACKNOWLEDGEMENTS

I would like to extend my special thanks and appreciation towards the following people and institutions:

My parents, who raised me and encouraged me to study economics,

The Department of Economics, Rhodes University. Thank you for giving me a chance to study in the department. Memories of studying in the department will last forever.

My supervisor, Professor M. Aziakpono, who is a very important person in my academic life. He taught me monetary economics and supported me in my MCom course. I am indebted to him for his help. Thank you very much for your understanding, commitment and patience and your advice regarding my academic studies.

My colleagues who encouraged me and assisted me, I enjoyed the time we spent discussing and studying together.

Fellow Oakdene students, I thank you and I will always cherish the moments we had together.

Last, but not least, I thank Ms Sheila Hicks for proof-reading my thesis.

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LIST OF ACRONYMS AND ABBREVIATIONS

ADF	Augmented Dickey Fuller
AIC	Akaike's information criterion
AR	Autoregressive
CPI	Consumer Price Index
CPIX	Overall consumer price index, excluding mortgage interest cost
ECB	European Central Bank
ERPT	Exchange rate passes through
EU	European Union
FPE	Final prediction error
G7	Group of seven
GDP	Real Gross Domestic Product
GL	Generalised least squares regression
HQ	Hannan-Quinn information
KPSS	Kwiatkowski, Phillips, Schmidt, and Shin
LM	Lagrange multiplier test
M1	Narrow monetary aggregate (M1)
M3	Broad money supply (M3)
MTM	Monetary policy transmission mechanism
NIR	Non-factorised one standard deviation impulse response
OLS	Ordinary least squares regressions
PP	Phillips-Perron
SARB	South African Reserve Bank
SIC	Schwarz information criterion
SIR	Residual structural one-standard error impulse response
SVAR	Structural vector autoregressive
US	United States of America
VAR	Vector autoregressive
VECM	Vector error correction models

CHAPTER ONE:
INTRODUCTION

1.1 CONTEXT OF RESEARCH

It is well accepted that monetary policy can, at least in the short-term, influence the course of the real economy (Bernanke and Gertler, 1995:26, Fontana, 2006:3)[2]. However, there is somewhat less agreement about how monetary policy exerts its influence in the economy (Bernanke and Gertler, 1995:27). In principle, there are several channels of the transmission of monetary policy (see Mishkin, 1995 for a summary). This thesis focuses on monetary policy transmission and particularly seeks to examine the impact of credit[3] and exchange rate channels of monetary policy transmission in the South African economy. South Africa's monetary policy has gone through several changes over the past thirty years. In this respect, there is a need for robust empirical evidence on the effects of these channels on inflation and output. This thesis provides this evidence for South Africa.

Monetary policy transmission mechanism (MTM) describes how changes in the nominal money stock or the short-term nominal interest rate impact on the rest of the economy, in particular, output and inflation (Ireland, 2005:1). The effect of monetary policy actions on the rate of inflation and economic activity has been the subject of intense study over many years (see Hicks, 1967 and Taylor, 1999). Several studies of MTM[4] concur that monetary authorities must have a correct assessment of the timing and consequence of their policies on the economy to be successful in the conduct of monetary policy. This requires a complete understanding of the transmission mechanism. Two classifications of MTM are highlighted in Chapter Three, namely in terms of monetary transmission channels and in terms of stages[5]of monetary transmission. This thesis follows the monetary policy transmission classification based on Mishkin (1995:5-9) which is widely employed in international monetary economics and also applied by the South African monetary authority (Small and de Jager, 2001:5).

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[2] This is also suggested in Friedman and Schwartz (1963), Sargent (1986) and others.
[3] According to Bernanke and Gertler (1995), the credit channel makes a distinction between banks and non-banks as sources of funds, and between internal and external finance. This thesis follows Berkelmans' (2005) methodology which modelled the broad credit channel of monetary transmission.
[4] These include Bernanke and Gertler (1995), Mishkin (1995), Taylor (1999), Schmidt-Hebbel (2003), Ireland (2005), and others.
[5] See Faure (2006b) who outlines the MTM stages and Mishkin (1995) who outlines different channels.

In many central banks, including the South African Reserve Bank (SARB), monetary policy is conducted by adjusting short-term nominal interest rates to achieve a rate of monetary expansion consistent with maintaining a low and relatively stable rate of inflation (Faure, 2005:122, Safae and Cameron 2003:267). The monetary policy framework currently implemented in South Africa is inflation-targeting, which was formally adopted in February 2000 (Faure, 2006b:117), while the main instrument used to achieve the inflation target is the repurchase rate (repo rate). As in other developing economies, monetary policy in South Africa has gone through major changes in its operating procedures and instruments, reflecting to some degree the process of financial liberalisation (Aron and Muellbauer, 2006:20). However, South Africa's monetary authority continues to face challenges in the conduct of its monetary policy, especially emanating from external shocks such as rapid escalation in oil and food prices.

Several features make understanding monetary policy transmission mechanism in South Africa interesting. Firstly, the flexible exchange rate regime exposes the currency to severe volatility. The South African foreign exchange market is very liquid, which makes it an easy target for portfolio re-alignment by international investors (Mboweni, 2006:6). Thus the potential impact on the exchange rate of the rand emanating from this source is great. Secondly, given that South Africa is a small open economy, there is a high likelihood that a major external shock (such as oil prices) could hit the economy and this could lead to negative economic effects as witnessed by the emerging market contagion in the 1990s. A third issue that should be taken into consideration is the way the monetary policy stance influences or is influenced by other financial variables, especially credit and exchange rate changes, and their impact on the economy. As such, the macroeconomic effects of monetary policy are of interest to both policymakers and the public. This interest is further amplified by the fact that the effects of unpredicted monetary policy disturbances in open economies have remained an unsettled empirical issue (Cushman and Zha, 1997:446).

Economists in general (Nualtaranee, 2007) underscore that distinguishing the relative importance of different[6] channels of monetary policy transmission is useful for several reasons. First, understanding which financial variables (such as interest rates, exchange rates, asset prices, credit and monetary aggregates) are impacted by policy would improve understanding of the links between the financial and the real sectors of the economy. Second, a better understanding of the transmission mechanism would help policy-makers and the public to interpret movements in financial variables more precisely. Finally, more knowledge about the transmission mechanism

[6] A symposium on the Monetary Transmission Mechanism (*Journal of Economic Perspectives*, 1995, 9(4), 3-72) contains five papers representing different MTM views.

might lead to a better choice of policy targets. For instance, if the credit channel is an important part of the transmission mechanism, bank portfolios should be the focus of more attention. On the other hand, if the interest rate or exchange rate channels are crucial, then the central bank may need to focus more on these channels.

1.2 OBJECTIVES OF THE STUDY

The primary purpose of this thesis is to undertake a comparative analysis of the credit and exchange rate channels of monetary policy transmission in terms of the following:

- To test the empirical relevance of the credit and exchange rate channels of MTM in South Africa, primarily to find whether monetary policy (change in the policy rate) affects these variables in the way that standard monetary policy strategies predict (for instance, tighter monetary policy is associated with a fall in credit and an appreciation of the currency).
- To investigate the dominance of each channel, in terms of the impact of its shocks and innovations on output and inflation.

Finally, policy recommendations will be proposed based on the findings of the study.

1.3 MOTIVATION FOR THE STUDY

In addition to issues already raised in the introduction regarding the importance of studying MTM in South Africa, Schmidt-Hebbel (2003) draws attention to the difficulties faced in attempting to identify the transmission channels of monetary policy in emerging economies. First, economic theory and empirical analysis have mostly been applied to developed countries. Second, emerging economies are subject to greater volatility and monetary policy regime changes, which is the case in South Africa. Schmidt-Hebbel (2003) also makes the point that there are few empirical studies in emerging countries due to lack of relevant data. MTM, focusing on either the credit or exchange rate channel, has been formally studied in South Africa by Bhundia (2002); Aron and Muellbauer (2006); and Ludi and Ground (2006) among others. These studies mostly employed structural vector autoregressive (SVAR) and vector error correction models (VECM). However, none of these studies compare the credit and exchange rate channels[7]. Further research to examine this aspect of the MTM would be a major contribution to the MTM literature.

A further motivation for this thesis is the fact that major changes in the South African financial system have been observed since the 1980s (see detailed review in Chapter Two). According to

[7] The fact that the MTM remains a grey area in the South African literature is somewhat surprising and problematic given that monetary policy is currently the primary policy used to influence macroeconomic outcomes in the country.

Small and De Jager (2001:2-3) the relationship between changes in interest rates, money supply and the inflation rate had become far more obscure as a result of the period of financial liberalisation. It was essentially this observable fact that eventually affected the credibility of the money supply as the intermediate guideline of monetary policy in South Africa. Hence, the South African Reserve Bank moved away from formally targeting the money supply and began with the 'informal inflation targeting' framework (Small and De Jager, 2001:2-3) which paved the way for the inflation targeting framework under an environment of flexible exchange rates. It is necessary to study other channels, in addition to the conventional interest rate channel, in order to understand MTM better. Based on the outcomes of this research, policy implications that would further assist monetary authorities to improve the effectiveness of the monetary policy transmission channels will be proposed.

1.4 METHODS OF THE STUDY

In order to achieve the objectives laid out above, this thesis will start with an in-depth review of the relevant theoretical and empirical literature about MTM. Regarding empirical analysis, the thesis utilises data for the period 1994:q4 - 2008:q2. The starting period is selected because years 1991-1994 are the period in which the apartheid regime fell, which signalled the end of sanctions and the opening of the economy. The end date is informed by the fact that the global economic downturn deepened during the latter half of 2008, primarily due to the financial market crisis. The world trade contraction in the last quarter of 2008 is seen as worse than suggested by historical relationships linking world trade to either short-term leading indicators or economic growth (OECD, 2009 q1:20). Prior to the application of formal econometric methodology, several descriptive statistical tests will be done, such as the stationarity tests of the data, in order to check the behaviour of the data before applying formal econometric methodology.

In order to address the objectives of the thesis a structural vector autoregressive model is utilised in an attempt to understand the effects of a monetary policy shock on the credit and exchange rate channels using both impulse responses and variance decomposition analyses. Lütkepohl and Ktratzig (2004:159) defines SVAR models as dynamic systems of equations in which the current level of each variable in the system depends on past movements in that variable and other variables in the system. The effects of credit and the exchange rate on the real economy and inflation will also be tested using an SVAR model. In order to examine the reaction of monetary policy to credit and exchange rate shocks, this thesis also employs an SVAR technique.

1.5 ORGANISATION OF THE STUDY

Chapter Two provides a historical perspective on South Africa's monetary policy from 1960 to the present period. This chapter shows that monetary policy in South Africa has been through major evolutionary changes. Chapter Three reviews and presents the theoretical framework regarding MTM and describes its empirical counterpart. Chapter Four describes the econometric methodology used in this thesis (SVAR model within an open economy specification). The results of the empirical analysis are presented and discussed in Chapter Five. The presentation and discussion of the results are done chronologically as per each of the methodologies discussed in the preceding chapter. Chapter Six provides the conclusions, policy and recommendations as well as suggesting further research areas.

CHAPTER TWO:
MONETARY POLICY IN SOUTH AFRICA

2.0 MONETARY POLICY PRIOR TO INFLATION TARGETING

This chapter highlights the importance and evolution of monetary policy in South Africa. The De Kock Commission (1985:13) defined monetary policy as all deliberate actions by the monetary authorities to influence the monetary aggregates, the availability of credit, interest rates and exchange rates, with a view to affecting money demand, income, output, prices and the balance of payments. The mandate of the SARB is defined in the Constitution of the Republic of South Africa[8] as the protection of the value of the currency in the interest of balanced and sustainable economic growth in the Republic. Deriving from this constitutional mandate, the SARB regards its primary goal in the South African economic system as the achievement and maintenance of price stability (Mboweni, 2006:4).

Since the 1960s South Africa has gone through several different monetary policy regimes, and the monetary policy regime applied from 1960 until the early 1980s was the liquid asset ratio-based system (see Franzsen, 1983). Under this system the SARB used direct controls over the ability of the banking system to supply money and credit, especially varied liquid asset requirements and credit ceilings in order to influence domestic liquidity and the inflation rate (Franzsen, 1983). However, during this time the usefulness of the liquid asset ratio-based monetary policy stance was sharply reduced by large money supply and interest rate changes. After ongoing technical changes on liquid assets requirements as well as redefining the role of the discount rate, the second monetary policy regime moved towards a cash reserves-based system which was enacted from the early 1980s (see Gidlow, 1995b).

Under the cash reserves system, the discount rate influenced the cost of overnight collateralised lending and hence market interest rates. The supply of credit was influenced by open market operations and various other policies acting on overall liquidity (Aron and Muellbauer, 2006:3). By creating a persistent money market shortage and setting the discount rate at a relatively high level, the commercial bank rates were usually closely linked to the discount rate[9]. The bank rate became the main operational variable for the implementation of monetary policy and the SARB's strategy

[8] Constitution of the Republic of South Africa Third Amendment Act 26 of 1996 and the South African Reserve Bank Act 90 of 1989.
[9] Monetary control was deemed to operate indirectly through the slowing of demand (Aron and Muellbauer, 2006).

was to keep the banking system indebted to itself, and thereby influencing short-term rates through adjusting the bank rate (Gidlow, 1995b).

The formal money supply targets for a broad definition of money (M3) were introduced in 1985 following recommendations by the de Kock Commission (Aron and Muellbauer, 2006:3). The use of these targets was based on the assumption of a stable relationship between changes in money supply and inflation. Monetary policy was therefore aimed at controlling the rate of expansion in total money supply as an intermediate objective, the supportive objective being to influence the amount of bank credit extension in order to achieve the ultimate objective of protecting the value of the currency. Target ranges were set yearly using a three-month moving average of M3 growth, and were announced yearly in the March Budget. The M3 growth rate targets were designed as guidelines rather than strict rules (see Aron and Muellbauer, 2006:3). According to Aron and Muellbauer (2006:3) target setting was aimed at accommodating anticipated real gross domestic product growth and containing inflation, although the procedure used to choose the target was not transparent.

However, the usefulness of money supply targets as an indicator of inflation was sharply reduced by extensive financial liberalisation[10]. After the end of apartheid in 1994, South Africa opened its economy which led to an increase in financial market transaction volumes. According to Stals (1999) these developments made the relationship between money supply and inflation unstable. Hence, from 1990 until 1999, the eclectic approach to monetary policy was implemented, whereby an eclectic set of indicators, including the yield curve, interest rates, actual and expected movements in inflation, exchange rate, asset prices, output gap, balance of payments, wage settlements, bank credit extension, and the fiscal stance were used to supplement the money supply targets (see Stals, 1997:1). However, monetary policy was seen as very unclear in this period, thus reducing the accountability of the South African monetary authority (SARB, 2006:6).

The repo rate system of monetary accommodation, which is perceived as a more transparent system, was introduced in March 1998 whereby the repo rate[11] was market-determined in daily tenders of liquidity through repurchase transactions Stals (1999). A full provision of the estimated daily liquidity requirement of banks signified a neutral position on the part of the SARB, while marginal over- or under- provision indicated a preference for stabilising the repo rate at prevailing levels. The

[10] It was observed by Small and de Jager (2001:2) that the relationship between M3 and the demand for goods and services was changed by the growing integration of global financial markets, the liberalisation of the South African capital market, the relaxation of exchange controls, and financial deepening in the form of the extension of banking services to the previously unbanked.

[11] The repo rate replaced the bank rate.

auction system with a predetermined fixed repo rate was used in the early days of this new system. Due to a poorly functioning money market, dominated by a few large banks, interest rates proved rigid and the interbank market did not always clear effectively. Various changes were made to the system from September 2001 and in May 2005[12] which helped increase market participation (see SARB, 2006 for more details).

2.1 INFLATION TARGETING

New Zealand was the first country to implement the inflation targeting strategy in 1990 and was soon followed by a number of other industrialised and emerging-market economies, including Australia, Brazil, Canada, Chile, Mexico, Sweden and the United Kingdom (van der Merwe, 2004:5). In February 2000, South Africa formally adopted the inflation targeting framework[13] for monetary policy. Inflation targeting implies a responsibility on the part of the central bank to achieve a predetermined inflation outcome, sometimes expressed as a range, and in some countries as a point target[14] (Van der Merwe, 2004:5). When inflation targeting was introduced in South Africa, the first target was specified as a calendar year average (for 2002) for CPIX inflation. Subsequent targets were also specified in terms of an average for a particular calendar year. In November 2003 the Minister of Finance announced that the calendar-year averaging would fall away and that the target would apply continuously (SARB, 2005:6).

According to SARB (2005:6) the rationale for the adoption of inflation targeting in South Africa was mainly based on the ineffectiveness of the money supply guidelines and the eclectic approach of the 1990s: (a) Money supply targeting in the eclectic approach did not work well partly because the velocity of circulation of M3 fluctuated significantly due to financial innovations; (b) The objective of monetary policy was not clear and seemed to change from time to time; (c) There was no clear accountability of the SARB under the eclectic approach; (d) Although an informal inflation target range of 1-5 percent was stated, there was no specified time frame in which this target was to be achieved; and (e) The eclectic approach caused a high degree of real interest rate variability. Other reasons that necessitated the move to inflation targeting include the need for the creation of

[12] The repo rate was fixed to eliminate any uncertainty of SARB monetary policy signals. Daily auctions were replaced by weekly repurchase auctions with a seven-day maturity, and the amounts allotted are announced after the tender rather than before as had been the case previously (SARB, 2006).

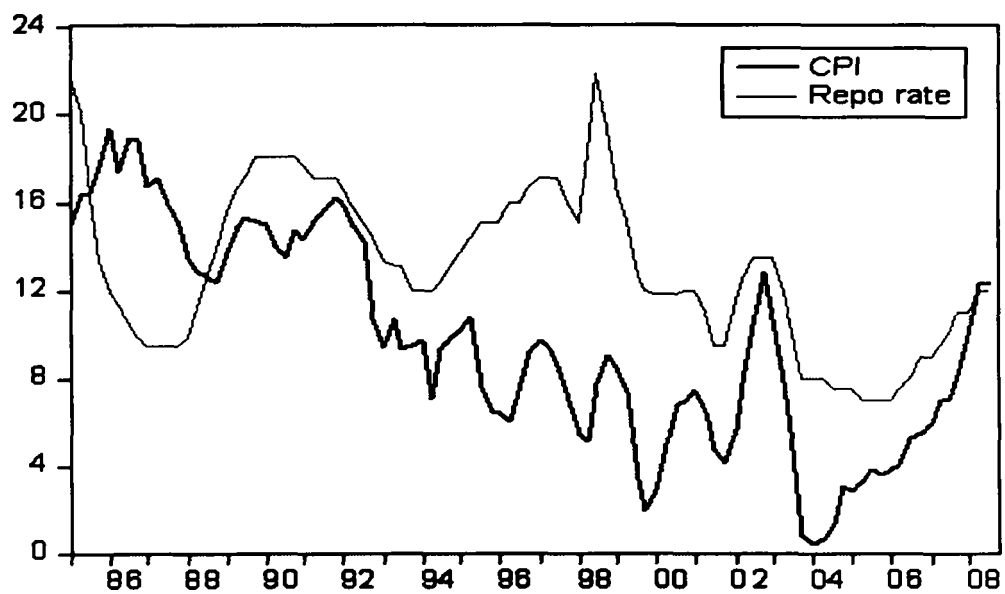
[13] Before the formal inflation targeting, "informal inflation targeting" was already applied by the South African Reserve Bank. Considerable emphasis was placed on the attainment of price stability, but the time period over which this would be achieved was not specified (Van de Merwe, 2004:5).

[14] In South Africa the inflation target has been specified as achieving an average rate of increase in the overall consumer price index, excluding mortgage interest cost (the CPIX), of between 3 and 6 per cent.

financial stability and also the fact that by February 2000, South Africa had met most of the pre-requisites of inflation targeting (SARB, 2005:7)[15].

In October 2008 the Minister of Finance announced in his Medium Term Budget Policy Statement (MTBPS, 2008) that the targeted inflation measure would be changed from 25 February 2009, when the January 2009 consumer price index (CPI) data was released. Following revisions to the methodology employed to compile the CPI which resulted in a change in the treatment of housing index, the year-on-year increase in the consumer price index excluding mortgage interest cost for metropolitan and other urban areas (CPIX) was replaced as the targeted measure with the headline CPI (CPI for all urban areas). The continuous inflation target range for headline CPI remained at 3 to 6 per cent[16]. It was argued that the new CPI measure brings into alignment the two most commonly cited measures of inflation in South Africa, namely the CPI (for metropolitan areas) and the CPIX. The new index will serve as both the headline measure and the inflation target measure, and will realign the geographic collection and reporting areas of the measures (SARB, 2009).

Figure 1: Interest rate and inflation rate



[15] It is important to note that the concentration on achieving the inflation target does not mean that the SARB is not concerned with economic growth and employment creation. The SARB makes an analysis of current and projected international and domestic economic conditions in the determination of the monetary policy stance. However, the primary objective of the SARB in determining interest rate levels is the impact that its actions will have on inflation (SARB, 2005:7).

[16] Inflation has been outside the target range since April 2007. It is generally accepted that a flexible inflation-targeting regime should allow for a deviation from the target in the event of exogenous shocks that are beyond the control of the monetary authorities. This framework also allows for deviations from the target in such instances, to avoid an excessive impact on output variability. According to (SARB, 2009) under such circumstances it is appropriate to focus on a reasonable time horizon for bringing inflation back to within the target range.

The SARB indicated that in its current monetary policy regime it targets inflation directly using the repo rate to achieve the ultimate objective of price stability but considers a range of other factors that affect inflation, thus satisfying the information-inclusive strategy condition of inflation targeting. According to Mboweni (2003) these factors include among others the growth in money supply, bank credit extension, changes in salaries and wages, nominal unit labour costs and exchange rate developments. Figure 1 shows the relationship between the repo rate and inflation rate under different monetary policy regimes. The visual inspection of Figure 1 shows the correlation between the inflation rate and repo rate which seems to have improved since 2002. Aron and Muellbauer (2006:1) argue that the inflation targeting framework introduced in 2000 has improved the credibility and effectiveness of macro-economic policy. Small and de Jager (2001) found that monetary policy can be expected to have an impact on inflation after a period between twelve to twenty-four months.

2.2 EXCHANGE RATE MANAGEMENT

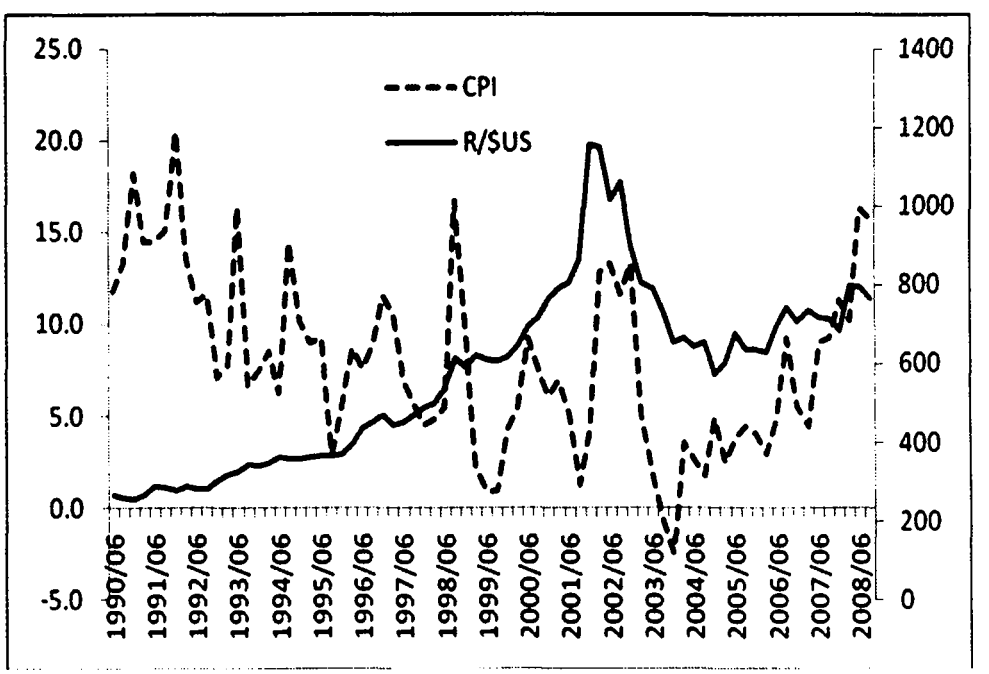
The exchange rate system in South Africa has changed considerably since the early 1980s from a highly administered to a more freely-floating exchange rate regime (van der Merwe, 2004). The system of exchange controls was introduced in South Africa over many years, starting in 1961, as it was planned to provide protection to the domestic economy against the adverse effects of international reactions due to apartheid policies (van der Merwe, 1996:7). Since these non-economic factors were removed during 1993-94, following major social and political reforms in South Africa, justification for the continuation of exchange controls also vanished. After 1994, exchange controls on residents were gradually eased.

South Africa adopted a dual exchange rate system in January 1979, with the commercial rand as a rate of exchange for current account and loans transactions while the financial rand was an exchange rate for equity capital and applied to non-residents who were free to move their capital (Gidlow, 1985). This dual exchange rate regime was terminated during February 1983 and simultaneously exchange controls on non-residents were eradicated (Gidlow, 1985). Therefore a unitary floating exchange rate regime with the Reserve Bank intervening in the foreign exchange market was implemented, while exchange controls on resident emigrants remained in force. Due to South Africa's increased political isolation, the initiative was unsuccessful and the financial rand had to be reintroduced in August 1985 (Gidlow, 1985). However, these interventions did not

stabilise the rand exchange rate and this failure compelled South Africa to opt for a flexible rather than some form of fixed exchange rate regime after 1994[17] (van de Merwe, 2004).

Currently, the determination of the value of the rand has been left to supply and demand conditions in the foreign exchange market[18]. Although the authorities would prefer to have greater exchange rate stability, they realise that under current circumstances – under inflation targeting in an open economy environment – it is unavoidable that the exchange rate will fluctuate periodically. Large fluctuations in financial flows, sometimes caused by developments in other countries, make the achievement of exchange rate stability hard. In fact, since the adoption of a floating exchange rate regime together with the inflation-targeting monetary policy framework, substantial swings have occurred in the exchange rate of the rand (see Figure 2). The nominal exchange rate shock in the last quarter of 2001 (see Figure 2), together with increases in regional grain prices, raised inflation in 2002-2003. The exchange rate depreciation in 2007 together with rising commodity prices also raised inflation during the first half of 2008. Events like these pose a challenge in the conduct of monetary policy.

Figure 2: Rand dollar exchange rate (rhs) and CPI (lhs)



[17] In the 1980s and 1990s large swings were recorded in the exchange rate of the rand. In the present international monetary system fluctuations in the exchange rate of a currency are unavoidable. The monetary authorities can only aim at creating underlying economic conditions that are conducive to exchange rate stability (van de Merwe, 2004).

[18] The unsuccessful and costly policy of intervening in the foreign exchange market has convinced the SARB that it is better to leave the determination of the exchange level of the rand to the market (Mboweni, 2006:7).

2.3 CONCLUSION

Major changes in the financial system of South Africa since the 1960s have been observed, including various interest rate controls, credit restrictions and barriers to competition in the early 1960s. The monetary policy strategy followed by the SARB since 1985, in its pursuance of protecting the value of the currency, was initially that of monetary targeting (Small and De Jager, 2001:2). During the period of financial liberalisation the relationship between changes in interest rates, money supply and the inflation rate had become far more obscure. It was against this background that the SARB started to move away from formally targeting the money supply and began with the 'informal inflation targeting' framework (Small and De Jager, 2001:2-3) which formally paved the way for the inflation targeting framework under an environment of flexible exchange rates. This led to the repo rate being the dominant instrument of monetary policy employed by the SARB. This became the instrument of monetary policy in South Africa at which the central bank refinances the liquidity requirement of the banking sector through repurchase agreements.

Majority of contributions to the empirical analysis with regard to MTM have applied data of large and small open economies such as the US, Germany, Australia, Canada, Ireland and others. Generally most of these countries have implemented an inflation targeting framework under an environment of flexible exchange rates (for more information on these observable facts see the papers cited in the next two chapters). Together with this chapter, which provides an overview on the monetary policy stance in South Africa, Chapter Two lays the foundation for the empirical analysis. It considers both the theoretical and empirical literature on various monetary transmission channels, especially the credit and exchange rate channel, with a view to establishing whether there are any effects on output and inflation. It is imperative to understand the recent monetary policy developments in order to form a considered opinion about the analytical approach to adhere to.

CHAPTER THREE:
THEORETICAL AND EMPIRICAL LITERATURE

3.0 INTRODUCTION

This chapter considers both the theoretical and empirical literature on various monetary transmission channels, focusing mainly on the credit and exchange rate channels. The chapter is divided into two sections. The first part provides a theoretical overview of various channels through which monetary policy affects output and prices, and the second part examines the empirical evidence on MTM. The interaction of theory and evidence is an important element of applied macroeconomic research. According to Dungey and Pagan (2008:1) empirical models should reflect theoretical models in their design while the design itself should also react to what is in the data.

3.1 CHANNELS OF MONETARY POLICY TRANSMISSION

The analysis of different channels of monetary transmission helps describe their specific characteristics, such as their relative dominance, significance, and their speed of propagating policy initiatives[19]. There are different approaches to the study of MTM in the economic literature (for instance there is an approach based on transmission stages and another based on various transmission channels). Faure (2006b:223-246) identifies six stages of the transmission process as follows: Stage 1: transmission of central bank lending to the private-to-bank interbank market; Stage 2: transmission of interbank rates to other market interest rates; Stage 3: transmission of interest rate changes to asset prices, expectations and the exchange rate; Stage 4: transmission of changes in asset prices, expectations and the exchange rate to aggregate demand; Stage 5: transmission of changes in aggregate demand to money in circulation; Stage 6: transmission of changes in aggregate demand, money, etc. to prices. This transmission flows from one stage to another, however, they can follow different channels.

The monetary policy transmission mechanism widely employed by central bankers is based on monetary transmission channels described in Mishkin (1995) and is classified as follows: the interest rate channel, exchange rate channel, credit channel (which comprises two channels, namely the narrow credit channel, and the broad credit channel), and other asset price channel. This thesis bases its analysis of the transmission channels on this view, particularly focusing on the exchange

[19] Knowledge of monetary policy transmission mechanism underpins effective conduct of monetary policy, and understanding the channels through which monetary policy exerts its influence on real economic activity has long been an important research topic in economics and a fundamental aspect of economic policy analysis (Mishkin, 1995 and Ireland, 2005).

rate and credit channels. In this approach, the interest rate channel becomes the key channel of transmission as depicted in Small and de Jager (2001:5).

3.1.1 INTEREST RATE CHANNEL

According to the interest rate channel view in Mishkin (1995:4), a policy induced increase in the short-term nominal interest rate given nominal rigidities (sticky nominal wages and prices in the short-run), translates into higher real interest rates. Higher real interest rates then affect consumption spending and investment behaviour of individuals as well as firms. Thus by reducing disposable income higher real interest rates depress current consumption as households facing higher real borrowing costs cut back on their purchases of durable goods. At the same time, higher real interest rates encourage current savings. In a similar manner an increase in interest rates reduces profits of firms. As firms find that their real cost of borrowing over all horizons has increased, they cut back on their investment expenditures as new investments become less attractive. Overall, consumption and investment decline and then contracts output. This, in turn, pulls prices (wages and goods prices) downwards. As prices adjust over time, real GDP returns to the potential level and the real interest rate and the real exchange rate also return to their fundamental levels. The interest rate channel is perceived as the basis of the traditional Keynesian IS-LM model (Mishkin, 1995:4) and it is represented in the schematic diagram as follows:

$$M\downarrow \Rightarrow i\uparrow \Rightarrow I\downarrow \Rightarrow Y\downarrow$$

According to (Mishkin, 1995:4) $M^{\downarrow}$ indicates a contractionary monetary policy leading to a rise in real interest rates ($i^{\uparrow}$), which in turn raises the cost of capital, thereby causing a decline in investment spending ($I^{\downarrow}$), therefore leading to a decline in aggregate demand and a fall in output ($Y^{\downarrow}$). Although Keynes originally emphasised this channel as operating through businesses' decisions about investment spending, later research (see Meltzer, 1995) recognised that consumer's decisions about housing and consumer durable expenditure are also investment decisions.

3.1.2 EXCHANGE RATE CHANNEL

In open economies, additional real economy effects of a policy-induced increase in the short-term interest rate come about through the exchange rate channel. Taylor (1995) and Obstfeld and Rogoff (1995) emphasise the importance of the exchange rate channel of monetary transmission. According to these authors the exchange rate channel describes the effect of the exchange rate on the domestic economy through both aggregate demand (net exports, *NX*) and supply (domestic value of imports).

The exchange rate channel effectiveness depends on the extent of exchange rate pass-through and on capital flows Musa (1982). For instance, when domestic real interest rates rise, domestic currency deposits become more attractive relative to deposits denominated in foreign currencies, leading to a rise in the value of the domestic currency deposits relative to other currency deposits, causing an appreciation of the domestic currency Mishkin (1995:5). The appreciation of the exchange rate (E) lowers domestic prices of imports. At the same time, appreciation of the domestic currency adversely affects the external competitiveness of the economy. The higher value of the domestic currency makes domestic goods more expensive than foreign goods, thereby causing a fall in net exports and, hence, a fall in aggregate demand and output leading to a decline in prices Mishkin (1995:5). Mishkin (1995:5) represent the exchange rate channel in a schematic diagram as follows:

$$M \downarrow \Rightarrow i \uparrow \Rightarrow E \uparrow \Rightarrow NX \downarrow \Rightarrow Y \downarrow$$

3.1.3 CREDIT CHANNEL

Two distinct credit channels, the bank lending channel (also called the narrow view) and the balance sheet channel (also called the broad view), also allow the effects of monetary policy actions to propagate through to the real economy (see Bernanke and Gertler, 1995 for more details on the mechanism of the credit channel). These channels come about by means of the effect of interest rates on borrowers and banks' balance sheets. According to Bernanke and Gertler (1995) the credit channel is seen as an enhancement mechanism, not a truly independent or parallel channel. They perceive that the credit view of monetary transmission emphasises the way asymmetric information and costly enforcement of contracts creates agency problems in financial markets.

Bernanke and Gertler (1995) showed that an external financial premium, which is a wedge between the cost of funds raised externally (by issuing equity or debt) and the opportunity cost of funds raised internally (by retaining earnings), has an important role in economic activities[20]. They showed that the size of an external finance premium reflects imperfections in credit markets that drive a wedge between the expected return received by lenders and the costs faced by potential borrowers. According to Bernanke and Gertler (1995), monetary policy which alters the interest rate tends to affect the external finance premium in the same direction. Hence, the direct effects of monetary policy on interest rates are amplified by changes in the external financial premium[21].

[20] Borrowers' financial positions affect the external finance premium and thus the overall terms of credit that they face, and fluctuations in the quality of borrower's balance sheets should affect their investment and spending decisions (Bernanke and Gertler, 1995).

[21] According to Bernanke and Gertler (1995) this complementary movement in the external finance premium may help

3.1.3.1 BANK LENDING CHANNEL

According to Kashyap and Stein's (1994) bank lending[22] view, banks play a special role in the economy not just by issuing liabilities – bank deposits – that contribute to the broad monetary aggregates, but also by holding assets – bank loans – for which few close substitutes exist. More specifically, theories and models of the bank lending channel emphasise that for many banks, particularly small banks, deposits represent the principal source of funds for lending and that for many firms, particularly small firms, bank loans represent the principal source of funds for investment (Kashyap and Stein, 1995). Hence, an open market operation that leads first to a contraction in the supply of bank reserves and then to a contraction in bank deposits requires banks that are especially dependent on deposits to cut back on their lending and firms that are especially dependent on bank loans to cut back on their investment spending. Financial market imperfections confronting individual banks and firms thereby contribute, in the aggregate, to the decline in output and employment that follows a monetary tightening.

Banks play a key role in the financial system because they are especially well suited to deal with certain types of borrowers, especially small firms where the problems of asymmetric information can be especially pronounced (Kashyap and Stein, 1994). The larger firms can directly access the funds through the stock and bond markets. Thus, a contractionary monetary policy that decreases bank reserves and bank deposits will have an impact predominantly through its effect on small firms. An important implication of the bank lending view is that monetary policy will have a greater effect on expenditures of smaller firms that are more dependent on bank loans than on large firms that can access the stock and bond markets directly. Schematically, the monetary policy effect on bank lending channel is as follows:

$$M \downarrow \Rightarrow bankdeposits \downarrow \Rightarrow bankloans \downarrow \Rightarrow I \downarrow \Rightarrow Y \downarrow$$

3.1.3.2 BALANCE SHEET CHANNEL

Bernanke and Gertler (1995) described a broad credit channel, the balance sheet channel[23], where financial market imperfections play a key role. The balance sheet channel of monetary policy arises because the changes in monetary policy affect not only market interest rates but also the financial positions of borrowers, both directly and indirectly. They emphasised that in the presence of

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explain the strength, timing, and composition of monetary policy effects better than a reference to interest rates alone.

[22] The bank lending view rests on the assumption that a monetary contraction drains loanable funds from the banking sector.

[23] The balance sheet channel is related to the financial accelerator phenomenon, that is, changes in interest rate affect the net worth of a firm through its cash-flow and the value of collateral. Higher interest rates thus lead to lower net worth and higher external finance premium.

financial market imperfections, a firm's cost of credit, whether from banks or any other external source, rises when the strength of its balance sheet deteriorates. A direct effect of monetary policy on the firm's balance sheet comes about when an increase in interest rates works to increase the payments that the firm must make to service its floating rate debt, reducing net cash flows and weakening the borrower's financial position. An indirect effect arises too, when the same increase in interest rates works to reduce the capitalised value of the firm's long term assets.

According to Bernanke and Gertler (1995), the indirect effect of tight monetary policy on net cash flows and collateral values comes about through deterioration in a consumer's expenditure. They argued that a firm's revenues will decline while its various fixed or quasi-fixed costs do not adjust in the short run. Therefore, this financing gap will erode the firm's net worth and credit-worthiness over time. Lower net worth means that lenders in effect have less collateral for their loans, and so losses from adverse selection are higher. A decline in net worth, which raises the adverse selection problem, thus leads to a decreased lending to finance investment spending. Lower net worth of business firms also increases the moral hazard problem because it means that owners have a lower equity stake in their firms, giving them more incentive to engage in risky investment projects. Since taking on riskier investment projects makes it more likely that lenders will not be paid back, a decrease in business firms' net worth leads to a decrease in lending and hence in investment spending. They argued that this mechanism may explain why the impact of the credit channel on spending, particularly on inventory and investment spending, may persist well beyond the period of the initial monetary tightening.

$$M \downarrow \Rightarrow p_e \downarrow \Rightarrow adverseselection \uparrow \Rightarrow moralhazard \uparrow \Rightarrow lending \downarrow \Rightarrow I \downarrow \Rightarrow Y \downarrow$$

The above schematic diagram can be explained as follows. A contractionary monetary policy, which causes a fall in equity prices (pe), reduces the net worth of firms and leads to a fall in investment spending and aggregate demand because of the increase in adverse selection and moral hazard problems.

The balance-sheet channel as explained above also provides the transmission through the cash flow channel. This is a contractionary monetary policy that raises interest rates and also causes deterioration in a firm's balance sheets because it reduces cash flow. This leads to the following additional schematics for the balance-sheet channel:

$$M \downarrow \Rightarrow i \uparrow \Rightarrow cashflow \downarrow \Rightarrow adverseselection \uparrow \Rightarrow moralhazard \uparrow \Rightarrow lending \downarrow \Rightarrow I \downarrow \Rightarrow Y \downarrow$$

3.1.4 OTHER ASSET CHANNEL

Movements in interest rates also affect asset prices such as equity and property prices. An increase in interest rates depresses asset prices and the consequent reduction in wealth of households pulls down their consumption. There are two prominent channels that involve asset prices, namely, Tobin's (1969) q theory of investment, as well as wealth effects on consumption (Meltzer, 1995)[24]. Tobin's q theory provides a mechanism through which monetary policy affects the economy through its effects on the valuation of equities (Mishkin, 1995). Tobin (1969) defined q as the market value of firms divided by the replacement cost of capital. If this q is high, the market price of firms is high relative to the replacement cost of capital. This means that investing in new plant and equipment capital will be cheaper relative to the market value of firms (Meltzer, 1995). Therefore, companies can issue equity cheaply and get a higher price for it than the cost of the plant and equipment in the firm they are buying. Thus investment spending will rise because firms can buy a lot of new investment goods with only a small issue of equity. Tobin's q theory is described schematically below:

$$M \downarrow \Rightarrow p_e \downarrow \Rightarrow q \downarrow \Rightarrow I \downarrow \Rightarrow Y \downarrow$$

Contractionary monetary policy leads to a rise in interest rates which lowers equity prices ($P_e, \downarrow$). This in turn will lead to a lower q ($q \downarrow$), and thus to lower investment spending ($I \downarrow$), eventually lowering output.

An alternative channel for monetary transmission through equity prices occurs through wealth effects on consumption. In Modigliani (1971), consumption spending is determined by the lifetime resources of consumers, which are made up of human capital, real capital and financial wealth. Common stocks constitute a major component of financial wealth in this theory. As such, when stock prices fall, the value of financial wealth decreases, and the total lifetime resources of consumers and consumption should fall[25], eventually lowering output.

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[24] In contributing to the monetary policy debate Meltzer (1995) emphasised that asset price transmission effects extend beyond those operating through interest rates, exchange rates and equity prices. In his study of the Japanese experience in the 1980s and 1990s, monetary policy had an important impact on the economy through its effect on land and property values. According to Meltzer (1995), Tobin's q theory can also apply equally to structures and residential housing.

[25] Thus a contractionary monetary policy which leads to a fall in stock prices will reduce household expenditure on durable goods. In turn, revenue and earnings of retail companies will fall and stock prices will be pushed downwards. This shows that interest rates have an influence on stock prices (Mishkin, 2003).

$$M \downarrow \Rightarrow p_e \downarrow \Rightarrow wealth \downarrow \Rightarrow consumption \downarrow \Rightarrow Y \downarrow$$

3.2 EMPIRICAL EVIDENCE ON MONETARY TRANSMISSION

This section reviews the empirical literature on the credit and exchange rate channels. Several research papers on the different channels of monetary transmission mechanism have been published since the early 1980s (see a survey by Ireland, 2005 and Mishkin, 1995). For instance, with regard to the exchange rate channel, Obstfeld and Rogoff (1995) developed an analytical open-economy model in which the exchange rate channel operates together with the interest rate channel. Other studies that support the exchange rate channel include Cushman and Zha (1997), Kyungho and Masao (2001), Kim and Roubini (2000), and Beirne and Bijsterbosch (2009), to mention a few.

With regard to the credit channel, the majority of contributions to the empirical analysis are concerned with US data. These include studies of bank lending based on individual banks' data (the most widely cited is Kashyap and Stein (1994; 1995; 2000)[26]). Although bank lending is an important source of external finance for firms, it is not the sole one, therefore some of the empirical literature on credit frictions has concentrated on identifying the importance of credit in general (Kashyap *et al.*, 1993, Bernanke *et al.,* 1996, Oliner and Rudebush, 1996, Berkelman, 2006, and Ciccarelli *et al.* (2009)). While most of the literature on the credit channel focuses on spending by business firms, Bernanke and Gertler (1995) suggested that the credit channel should apply equally as well to consumer spending. These studies find evidence that the credit and exchange rate channels play an important role in the transmission of monetary policy.

3.2.1 EVIDENCE OF THE BANK LENDING CHANNEL

There is sufficient evidence on the empirical relationship between monetary policy, bank loans and economic activity (Kashyap and Stein, 1995, 2000, Kishan and Opiela, 2000, and Alfaro *et al.* (2004) among others). The general conclusion in most of these studies is that tight monetary policy leads to a drop in bank credit, which has a further negative impact on economic activity. The bank lending view (loan supply rather than loan demand analysis) is strongly motivated by the observation that a number of borrowers are dependent on banks for their source of external finance[27].

[26] The credit channel is empirically confirmed for the United States by Kashyap and Stein (2000), who find that the impact of monetary expansion on bank lending is stronger for banks with less liquid balance sheets.

[27] Kashyap and Stein (1994), using data from Quarterly Financial Report for US manufacturing firms show that in 1991, small firms were dependent on banks for 82.9% of their external finance. For medium sized firms, the share of bank debt was also very high, at 77%. This evidence suggests that the behaviour of banks may be important for the transmission of monetary policy.

Bernanke and Blinder (1992) used a VAR model based on US data to show that bank loans decline following a contractionary monetary policy shock and argue that this provides evidence for the existence of the bank lending channel. Thus a fall in bank lending following a tightening of monetary policy may indicate that the banks have tightened their credit policies. They argued that if GDP declines prior to or parallel with the fall in lending, this is an indication that this development may also reflect a fall in the demand for loans. Holtmoller (2002:12) has also provided evidence on the empirical relevance of the bank lending channel in Germany during the period 1985 to 1998, using an SVAR model.

Kashyap and Stein (2000) examined the way bank lending responds to changes in monetary policy with a quarterly data set that includes observations of every insured US commercial bank from 1976 to 1993. Their emphasis was on whether lending by small banks, banks with relatively small capital reserves, or banks with a small portfolio of liquid assets declines more than lending by other banks after a monetary-policy tightening. They found significant links between the size of a bank's lending contraction and the bank's balance sheet liquidity position as measured by the ratio of securities to total assets. They concluded that the impact of monetary expansion on bank lending is stronger for banks with less liquid balance sheets. They argued that their result is conservative compared to Kashyap and Stein (1995), who showed that small banks' lending falls by substantially more than large banks' lending after a federal funds rate shock.

Kashyap and Stein (2000) further argued that a general problem in connection with empirical studies of the credit channel is how to distinguish between the supply and demand effects of a change in bank lending. For instance, reduced bank lending following an increase in interest rates may be attributable to a decrease in the supply of loans in accordance with a credit channel, as well as lower demand for loans owing to higher interest rates. In addition, the demand for loans may also fall if economic activity has slowed down or is expected to slow down. According to these authors what bank lending channel proponents need to demonstrate is that the fall in the quantity of lending was caused by a fall in loan supply rather than by a fall in loan demand. More details about this phenomenon can be found in Kashyap *et al.* (1993)[28] and Bernanke *et al.* (1996).

Also in support of the bank lending channel, Safaei and Cameron (2003:272-276) have found an immediate impact of monetary policy on the Canadian bank credit within an SVAR framework.

[28] Kashyap *et al.* (1993) assume that a change in the demand for credit affects all kinds of external finance, that is, indirect borrowing from banks (loans) and direct borrowing on capital markets (commercial papers) in the same way while supply side effects should only reduce the supply of loans. Therefore, they interpret a decrease in the loan-paper ratio as a decrease in loan supply.

Their result shows that credit shock appears to have much of its impact on real output in the short run of eight quarters, leaving no significant impact in the long run. The price variable shows stickiness in the short run of four to six quarters, although it rises gradually in the long run. They used seasonally adjusted quarterly time series for Canada from 1956 to 1997 and included the following variables in logarithms: real GDP, consumer price index, monetary base, nominal short term policy rate (in fractional form), narrow money stock, measures of bank credit: bank credit to persons, bank credit to businesses and total bank credit. Their result shows that bank credit to persons affects real output in the short run, whereas bank credit to businesses does not.

Alfaro *et al.* (2004) have analysed whether the bank lending channel played any role as a transmission mechanism for monetary policy in the Chilean economy during the period 1990 to 2002 and, if so, whether this transmission mechanism played any significant macroeconomic role. They followed a two-step approach. First, they used a panel of bank data to identify shifts in the loan supply curve in response to changes in monetary policy. Second, they constructed a variable that is a proxy of how the bank lending channel exacerbates the monetary policy shock, thus having an independent and significant impact on aggregate spending. This variable is the low/high quality ratio, which captures the availability of bank credit to households and small medium enterprise versus large enterprises. Finally, they embedded the low/high quality ratio within a vector autoregressive system (VAR) to test whether the bank lending channel exacerbates the effect of a monetary policy shock over macroeconomic activity. They concluded that the bank lending channel operates as a MTM mechanism in Chile and has a significant impact on macroeconomic activity.

Cappiello *et al.* (2010) used country-based ordinary least squares (OLS) regressions for European Central Bank (ECB) member states and found that in the Euro area, changes in the supply of credit both in terms of volume and in terms of credit standards applied on loans to enterprises have significant effects on real economic activity. They argue that this highlighted the importance of monitoring credit developments and underpins the reasoning behind giving monetary and credit analysis a prominent role in the monetary policy strategy of the ECB. This study used Euro area quarterly data for each ECB member state for the period 1999:q1 to 2008:q1. The data that was used includes nominal and real GDP (at constant prices), GDP deflator, broad money supply (M3) less currency (which constitutes all bank deposits and therefore should influence the ability of banks to grant loans), loan data (which refers to outstanding loans to non-financial corporations), interest rates on bank deposits and credit standards data.

3.2.2 EVIDENCE OF THE BROAD CREDIT CHANNEL

Romer and Romer (1990) assessed the credit channel in the US during various periods of monetary tightening in the presence of credit market imperfections. Their study splits the credit channel into two broad views: the money view, similar to the balance sheet channel, which emphasises the role of banks' liabilities and no banks' assets in monetary policy transmission; and the lending channel, which focuses on the role played by banks' assets as well as that played by asymmetry information. Using ordinary least squares (OLS) and Instrumental Variables techniques, they estimated the St. Louis equations and found little evidence of a bank lending channel. They concluded that the balance sheet view seems to play a more significant role than the bank lending channel.

Kashyap *et al.* (1993) examined how a monetary-policy change affects the composition of corporate debt and showed that in the case where the proportion of bank loans falls following a tightening of monetary policy this may indicate that the banks have tightened their credit policies. In the case where the proportion of bank loans does not decline when total debt is reduced, it is more likely to indicate a general fall in the demand for loans. They argued that this could reflect that all lenders (i.e. not only banks) have tightened their credit policies.

Bernanke and Gertler (1995) estimated monthly data for the sample period January 1965 to December 1993 to test the credit channel in the US using a VAR model. The variables included are real GDP, GDP deflator, commodity price index and federal funds rate. Real GDP and GDP deflator are used as broad measures of economic activity and prices, and the commodity prices index is intended to control for oil shocks and other supply side factors influencing output and inflation. The result supported the credit channel and suggested that the credit channel should apply equally as well to consumer spending. They emphasised that declines in bank lending induced by a monetary contraction should cause a decline in durables and housing purchases by consumers who do not have access to other sources of credit. Similarly, increases in interest rates cause deterioration in household balance sheets and their cash flow is also adversely affected.

The broad credit view is also supported by Australian data in Berkelmans (2005). He used a seven variable SVAR model to examine the endogenous relationships between broad credit and other key macroeconomic variables. His model was estimated for the period that starts with the float of the Australian dollar in 1983:q4 to 2003:q4, and includes two variables for the external sector (commodity prices and US GDP), and five for the domestic sector (GDP, inflation rate, credit, cash rate and trade-weighted exchange rate). The model implies that a shock to the interest rate, increasing it by twenty five basis points, resulted in the level of credit being almost half of a

percentage point lower after four quarters. The result shows that if monetary policy subsequently reacts in a manner consistent with its past behaviour, credit continues to decline for about four years.

Ciccarelli *et al.* (2009) used a VAR model with data from the confidential Bank Lending Survey for the Euro area and the Senior Loan Officer Opinion Survey for the US and found that monetary policy contraction tightens bank loan supply for business, mortgage and consumer loans. Their analysis was confined to the 12 Euro area countries (Austria, Belgium, France, Finland, Germany, Greece, Ireland, Italy, Luxembourg, Netherlands, Portugal and Spain) and covered the period from 2002:q1 to 2008:q4. The main objective of this paper was to test the credit channel, where the main identification problem was to separate the effect of monetary policy on loan supply versus demand. According to their analysis the tightening of bank loan supply reduces real GDP both directly and indirectly through reducing loan demand. This showed that the credit channel works through both the bank lending and the balance sheet channel.

3.2.3 EVIDENCE OF THE EXCHANGE RATE CHANNEL

Cushman and Zha (1997:434) applied an SVAR model using Canada as a case study to test the hypothesis that under a flexible exchange rate the effect of monetary policy shocks on the small open economy revolves around the interest rate and exchange rate. They argued that the dynamic responses to the identified monetary policy shock are consistent with standard theory[29] and support the exchange rate as a transmission mechanism. Their data run monthly from 1974 to 1993. The Canadian variables include the Canadian dollar, seasonally adjusted monetary aggregate (M1), three-month Treasury bill rate, consumer price index, seasonally adjusted industrial production, exports to the US, and imports from the US. The foreign (US) variables are seasonally adjusted US industrial production, consumer price index, federal funds rate, and world total exports commodity price index in US dollars. All the variables are in logarithm form except for interest rates which are in decimal percentages.

Kim and Roubini (2000) extended the SVAR approach of Sims and Zha (1995) to an open economy to identify monetary policy under flexible exchange rates. Monthly data was used in this study and the estimation period was 1974:7-1992. All variables were used in logarithm form except for the interest rates. Complete seasonal dummies were used in all estimations and six lags were assumed. The data vector included short-term interest rate, monetary aggregate, consumer price index,

[29] In the short run, an unanticipated fall in the money supply is expected to increase the nominal interest rate (the liquidity or interest rate effect) and appreciate the value of domestic currency (the exchange rate effect).

industrial production, world price of oil in terms of the US dollar, Federal funds rate of the US, and exchange rate expressed as units of foreign currency for one unit of US dollars. The identification scheme appeared to successfully identify monetary policy shocks. Hence, it solved the empirical puzzles about the effects of monetary policy shocks. In all six countries (G7 excluding the US), the effect of a monetary contraction (an increase of the domestic interest rate) led to an appreciation of the domestic exchange rate relative to the US dollar. Such impact appreciation was statistically significant in all cases.

Kyungho and Masao (2001) studied the effects of shocks to US monetary policy on exchange rates using a vector error correction model (VECM) and vector autoregression (VAR) model. They found evidence of overshooting behaviour of exchange rates with all methods. They also found the price puzzle with levels VAR and VECM with short-run restrictions, but they did not find the price puzzle with VECM with long-run restrictions. They estimated their model using seven variables which included the federal funds rate, the non-borrowed reserve ratio, output in the US, the price level in the US, output in Japan, the interest rate in Japan, and the real exchange rate. They selected five lags for the structural VECM, and six lags for the levels VAR. Their conclusion is that a contractionary monetary policy shock leads to an appreciation in the US dollar immediately after the shock. This effect peaks after four months and persists for five years. Thereafter, they observed evidence of the overshooting behaviour of the real exchange rate.

Beirne and Bijsterbosch (2009) studied the extent to which fluctuations in the nominal exchange rate affects inflation (exchange rate pass-through (ERPT)). Their paper examined the degree of ERPT to domestic prices in nine central and eastern European Union (EU) Member States. The paper used a cointegrated VAR model with five variables (the nominal effective exchange rate, consumer prices, producer prices, oil prices and industrial production). They also used impulse responses derived from the vector error correction model (VECM). Their findings indicated a stronger link between nominal variables, and thus a higher ERPT to domestic consumer prices, in particular where some form of fixed exchange rate regime was in place. For countries with flexible exchange rate regimes aiming at Euro adoption, a high degree of exchange rate pass-through indicates that nominal exchange rate appreciations are likely to lower inflationary pressures.

3.2.4 EVIDENCE FROM SOUTH AFRICAN STUDIES

In South Africa a limited number of empirical studies have been published to date regarding monetary transmission channels (Bhundia, 2002; Sichei, 2005; Ludi and Ground, 2006; Aron and Muellbauer, 2006 etc.). None of the studies in South Africa compare the credit and the exchange

rate channels. In relation to the choice of monetary policy in South Africa, most studies, for instance Small and de Jager (2001:5), argued that the repo rate is the most appropriate indicator of changes in the stance of monetary policy given that it has been the chief instrument of monetary policy.

Small and de Jager (2001) applied a macro econometric model to identify MTM focusing on the traditional interest rate channel. The repo rate in this model was increased by 100 basis points from its baseline scenario during the first year of the three-year simulation period in order to illustrate the change and time lag of the response. The results of the simulation model support the notion that there are long time lags between changes in interest rates and the impact on the real economy, and in some instances this impact was only felt after a period of between four to six quarters. Fluctuations in the real economy influence the output gap and as the gap between actual and potential economic activity adjusts inflationary pressures will start to change. However, the effects of the change in real output will only start to affect inflation after a further three to four quarters. Therefore, monetary policy can be expected to have an impact on inflation after a period between twelve to twenty-four months, with the full impact taking at least two years.

Bhundia (2002) analysed the link between rand depreciation and CPIX inflation. He applied a six variable recursive VAR model, comprising six variables in the following order: oil price inflation, output gap, change in the nominal effective exchange rate, import price inflation, producer price inflation, and CPIX inflation. The result showed that exchange rate shocks (depreciation) result in a gradual increase over time in the level of CPIX[30]. A one percent shock to the nominal effective exchange rate results in a gradual increase in the level of the CPIX which is about 0.12 per cent on average for eight quarters, giving a pass-through elasticity of twelve percent.

Sichei (2005) used a dynamic panel data model[31] to investigate the bank lending channel of monetary policy in South Africa using real quarterly data (bank capital and reserves, GDP, repo rate and effective exchange rate). He used a sample of 15 banks out of 38 in existence as at December 2004 and the selection of the estimation period (1999:q1 to 2004:q4) is predicated on the need to test this channel within one single monetary policy regime (repo system and inflation targeting) in South Africa. He found that bank's loan supply reaction to monetary policy is assumed to depend linearly on the bank's balance sheet strength, which can be proxied by asset size, liquidity or

[30] Currency depreciation can affect domestic prices directly by increasing the domestic currency prices of tradables.
[31] The study uses an empirical specification based on Kashyap and Stein (1994).

capitalisation[32]. This assumes a positive relationship between loan supply and bank capital. The principal finding was that the bank-lending channel plays some role in South Africa. The coefficient for the interaction term between repo rate and capitalisation is negative but insignificant in the first quarter and positive and significant after one lag. This indicates a bank lending channel holds in South Africa, as the coefficient associated with the joint effects of the repo rate and capitalisation should be negative.

Ludi and Ground (2006) estimated a four variable VAR and the Johansen (1988) procedure to examine the bank-lending channel in South Africa. The pass-through effects of a change in the repo rate on bank deposits and loans and output were tested using a VECM model, and in this manner they tested and evaluated the validity and effectiveness of monetary policy in South Africa. Quarterly data from the first quarter of 1987 (after the implementation of the De Kock report's findings) to the last quarter of 2004 was used. The series used (loans, deposits and GDP) are seasonally adjusted and are converted to natural logarithms except for the repo rate. The resulting estimated coefficients point towards demand-driven rather than supply-driven bank lending, that is, loans in South Africa are governed by consumer demand and not by bank supply. They argued that this result disproved that the bank-lending channel focusing on bank loans has effectively worked as a tool of monetary policy in South Africa.

Aron and Muellbauer (2006:22) estimated the pass-through from exchange rate shocks to CPIX in the VAR model and suggested a cumulative effect on CPIX of around ten percent after four quarters and fifteen percent after seven quarters. Their result showed a significant exchange rate pass-through to consumer price index.

3.3 CONCLUSION

This chapter explored the theoretical and empirical literature regarding the MTM. Firstly, different classifications of MTM were highlighted. To provide a theoretical backing to the empirical literature, the nature of monetary transmission channels were analysed and thereafter the empirical literature regarding the MTM was reviewed. The paper relies on Mishkin's (1995) classification of different channels of transmission mechanism which makes a distinction between the interest rate, exchange rate, other asset price and credit channels. Each mechanism is based on a particular theory of the effect of monetary policy. With the growing internationalisation of economies and the advent of flexible exchange rates, more attention has been paid to monetary policy transmission operating

[32] Bank' real capital and reserves data are used to segregate commercial banks into two groups (group 1 – large banks and group 2 – small banks).

through exchange rate effects and credit channels. A policy-induced increase in the short-term interest rate not only acts immediately to depress spending through the traditional interest rate channel, it also acts, through the other channels, to deepen and extend the initial decline in output and employment.

A number of empirical studies on the transmission channels in the South African economy, particularly using SVAR models and VECM techniques, have been published up to date (Ludi and Ground, 2006, Bhundia, 2002, Aron and Muellbauer, 2006, etc.). There is also large empirical research in developed economies that supports both the exchange rate and credit channels, and this includes, amongst others, Cushman and Zha (1997), Romer and Romer (1990), Kashyap and Stein (2000), Bernanke and Blinder (1992), Berkelmans (2006), Beirne and Bijsterbosch (2009), Ciccarelli *et al.* (2009) and Cappiello *et al.* (2010).

However, past studies reviewed to date do not compare the credit and exchange rate channels against each other in terms of the dominance of their impact on output and inflation, therefore it is not easy to draw policy conclusions on which one of the two channels is the more dominant monetary transmission channel. Hence, a comparative analysis of these channels would be an important contribution of this thesis. South African literature on hand is conclusive with regard to the existence of the interest rate channel, but not enough research has been done in terms of the existence of the credit and exchange rate channels and this has also prompted this thesis in order to add to the sparse research. The SVAR model reviewed in this section, particularly for Australia, would be used on South African data to find whether it would be suitable to analyse the effects of monetary policy, credit and exchange rate shocks in a small open economy such as South Africa. In light of the above discussion the next section presents the SVAR modelling framework used in this thesis.

CHAPTER FOUR:
METHODOLOGY AND ANALYTICAL FRAMEWORK

4.0 INTRODUCTION

This chapter provides an overview of the SVAR modelling framework that is employed in this thesis. Firstly, the variables used for the estimation are described and discussed. Unit root tests are carried out on all the variables. Secondly, an analytical framework representing the South African SVAR model is discussed[33]. Finally, the SVAR model used to examine the empirical relevance of the credit and exchange rate channel is presented. The impulse response functions are used to produce the time path of the dependent variables in the SVAR model to shocks from all the explanatory variables. In addition, variance decomposition as an alternative method to the impulse response functions for examining the effects of shocks to the dependent variables is carried out.

4.1 ESTIMATION PERIOD AND VARIABLES INCLUDED IN THE MODEL

The data covers the period 1994:q4 to 2008:q2, at a quarterly frequency, and involves variables pertaining to real output (GDP), inflation (CPI), real commodity prices, interest rate, real credit, and nominal effective exchange rate of the rand. In the case of monthly data being the only data available, the averages over three month periods were used to create quarterly data in levels. This applies to credit and commodity prices data, Ludi and Ground (2006:10) used a similar technique. The starting period is selected because between 1991 and1994 the apartheid regime fell, and this signalled the end of sanctions and the opening of the economy. During the period of economic sanctions the South African economy was isolated from the international community (Levy, 1999:3). The end date is informed by the fact that the global economic downturn deepened during the latter half of 2008. The world trade contraction in the last quarter of 2008 is seen as worse than suggested by historical relationships linking world trade to either short-term leading indicators or economic growth (OECD, 2009 q1:20). This sample period is thus suitable for the open economy SVAR model specified in section 4.3.

Open economy SVAR models of monetary policy transmission include both the external and domestic sector variables. The role of the external sector is captured by real commodity prices

[33] This thesis follows the monetary policy transmission model of Berkelmans (2005) estimated on Australian data, with two variables for the external sector and five variables for the domestic sector. Berkelmans' (2005) model is estimated in levels, and identified by short-term restrictions only. Other monetary policy transmission studies that estimate SVAR in levels are: Kim and Roubini (2000); Cushman and Zha (1997); Christiano *et al.* (1998); Brischetto and Voss (1999); Dungey and Pagan (2000); and Safaei and Cameron (2003).

(*comp*), and the real US gross domestic product GDP (*USGDP*). The real commodity price index is equal to nominal commodity price index in US dollars deflated by the US consumer price index. The domestic sector is captured by the following five variables: real South African GDP (*SAGDP*), consumer price inflation (*infl*), real credit (*credit*), the repo rate (*repo*), and the nominal effective exchange rate of the rand (*neer*). The real credit is derived from nominal credit deflated by the South African consumer price index. The credit variable captures credit extension by all monetary institutions. This includes a consolidation of the balance sheets of institutions within the monetary sector, which are the SARB, the former National Finance Corporation, Corporation for Public Deposits and the so-called "pooled funds" of the former Public Debt Commissioners, Postbank, private banking institutions and mutual building societies. Coin circulation is also included (SARB, June 2009:S18).

The measure of economic activity in South Africa is real GDP, at seasonally adjusted annualised rates, at constant year 2000 prices, and the measure of inflation is the total CPI inflation which covered all the metropolitan areas (index 2000=100) and was the most commonly cited measure of inflation before the introduction of the new headline CPI measure, introduced in February 2009. The exchange rate is defined as the nominal effective exchange rate of the rand. This is a weighted average exchange rate of the rand calculated against fifteen currencies (SARB, June 2009:S103). The weights of the five major currencies are: Euro (3482), US dollar (1488), Chinese yuan (1249), British pound (1071), and Japanese yen (1012) (SARB, June 2009:S103). All the domestic variables are downloaded from the SARB and Statistics South Africa website. Real US GDP is measured by the US Department of Commerce, at seasonally adjusted annualised rates at constant 2000 prices. The nominal commodity price index in US dollars was downloaded from the Reuters/Jefferies-CRB Index website. Table 1 provides the data sources. All the series are transformed into a percentage growth rate, except the interest rate, which is already in fractional form.

Table 1: Description of data

Data Series	Description	Source	Frequency Transformation
GDP South Africa	Constant 2000 prices, saar	SARB, KBP6006D	Quarterly
GDP USA	Constant 2000 prices, saar	IMF IFS, IFS:I11164___ZFQ	Quarterly
Commodity price Index	Continuous Commodity Index (CCI)	Reuters/ Jefferies-CRB Index (online)	Monthly to quarterly
Credit	Total domestic credit extension	SARB, KBP1368M	Monthly to quarterly
Nominal effective Exchange rate	15 trading partners average for the period	SARB, KBP5376Q	Quarterly
Repo rate	1986q1 – 1998q2 Bank rate 1998q2 – 2008q4 Repo rate	On request from SARB SARB, KBP1419W	Quarterly
Inflation	CPI index- 2000=100 metropolitan areas	STATSA Stats SA - P0141.1	Quarterly

Note: 1. saar means seasonally adjusted at annualised rates
2. The monthly data have been converted to quarterly series using three months average.

SVAR models in MTM studies have captured commodity prices in a number of different ways. For instance, Kim and Roubini (2000) include world oil prices while others such as Zha (1997) and Berkelmans (2005) include aggregate commodity price index in dollar prices. In Berkelmans (2005), commodity prices are included because they are believed to contain information about the world business cycle and are likely to be particularly relevant to a commodity-exporting country. The inclusion of commodity prices in other studies (such as Zha, 1997) has been found to help resolve the price puzzle – whereby the price level increases in response to a contractionary monetary policy shock in VAR models. According to Christiano *et al.* (1999), commodity prices are also thought to control for policy makers' expectations of future inflation, which is seen as the missing factor responsible for the price puzzle.

In addition to commodity prices, several studies have included global economic activity (GDP) as an important driver of domestic activity in SVAR models. The US GDP is included in this study following Small and de Jager (2000) which shows that it has a strong relationship with South Africa's economic activity. The inclusion of domestic GDP to represent domestic activity is standard in economic theory. Domestic inflation is included in the model rather than the price level as in Berkelmans (2005). According to Berkelmans (2005) the inflation rate is taken to be a consistent variable to interact with real variables and a nominal interest rate. The use of the monetary policy interest rate is standard in macroeconomic models. As such the repo rate series is used although it became only available since 1998; otherwise the bank rate is used as in Ludi and Ground (2006). Zha (1997:440) suggests that the inclusion of the exchange rate helps to resolve the

price puzzle, however, in this thesis the exchange rate is used mainly to test the exchange rate channel.

4.2 UNIT ROOT TESTS

It is important to first investigate the time-series characteristics of the data since it has implications for the choice of the econometric methodology. When using time series data it is often assumed that the data is non-stationary, and that a stationary cointegration relationship(s) needs to be found in order to avoid the problem of spurious regression. When the individual time series in the VAR process are all stationary, the system as a whole will be stationary, for each of the equations in the system is merely a linear combination of stationary variables. However, in case one or more of the series are non-stationary, stationarity of the system requires suitable transformation of the nonstationary series. To ensure stationarity, therefore, the SVAR model has been estimated with series that are transformed into a percentage growth rate. A stationary[34] series can be described as having a constant mean, constant variance, and constant autocovariances for each lag (Brooks, 2002:367).

There are several methods of testing for unit root and the thesis employs four distinct unit root tests, starting with the Augmented Dickey Fuller (ADF) and Phillips-Perron (PP) test, to test whether a series is stationary or not (Dickey and Fuller, 1979) and (Phillips and Perron, 1988). In addition, because the ADF and PP tests may suffer from low power and poor size, the thesis also utilises the results from a test proposed by Kwiatkowski, Phillips, Schmidt, and Shin (KPSS) (1992) for testing the null hypothesis that the variable in question is stationary. The KPSS test gets around the problem of the null hypothesis of a unit root associated with the ADF and PP tests because of its null hypothesis and thus acts as a confirmatory test[35]. Other studies suggest the Ng and Perron (2001) statistic, which is a modification of the standard ADF statistic, because it also has better size and power properties relative to the conventional ADF and PP unit root tests (Rapach and Weber, 2004:412).

The choice of lag length for the ADF for this study is based on the Schwarz information criterion (SIC) and for the KPSS and PP tests, the tests were run using a Bartlett kernel (the bandwidth selected by the Newey and West (1994) method). For the Ng and Perron (2001) test, the lag was set as suggested by spectral generalised least squares (GLS)-detrended autoregressive (AR) based on

[34] There are several methods of testing for stationarity, for instance, visual plots of data, the autocorrelation function, and unit root test, among others. For detailed analysis on the subject of unit roots see Maddala and Kim (1999:45-145).
[35] The ideal result if a series is I(0), is that an ADF test should reject the non-stationarity null hypothesis, whereas the KPSS test should not reject its null or the two should lead to the same conclusion (Brooks, 2002:389).

Schwarz's information criterion (SIC). To check if the series in levels are stationary after being transformed into percentage growth rate, that is, they have only one unit root, one has to repeat the same tests for the first differences of such variables. If the percentage growth rate data is non-stationary and cointegrated, a vector error correction (VECM) analysis rather than an SVAR analysis would be performed, otherwise an SVAR analysis would be performed.

4.3 ANALYTICAL APPROACH

The thesis follows an open economy SVAR representation put forward by Berkelmans (2005) for Australia. Berkelmans' (2005) model is estimated in the first difference of the variables but the impulse responses are in log levels. Other studies have avoided estimating their models in log levels in order to mitigate the potential problem of spurious relationships. This thesis will not deviate from this norm of estimating the model with stationary variables. The primary focus in this thesis is on the short run relationship between the variables, hence the contemporaneous restrictions implemented are for the short run only. Berkelmans (2005) implements open economy techniques which have been established in other studies such as Cushman and Zha (1997), Kim and Roubini (2000) and Dungey and Pagan (2000) to mention a few. These studies introduce foreign variables such as GDP, and commodity prices and in some instances foreign interest rate to account for the external sector.

Although these models are not originally designed for the South African economy and are not based explicitly on an accepted macroeconomic model, there are a number of reasons why they might be recommended for South Africa. Open economy SVAR models appear to do reasonably well across the countries in which they have been applied, which suggests that they are robust and merit consideration for this fact alone. Another benefit of using this model's design is that one can systematically compare the results obtained with other SVAR studies. The Berkelmans (2005) model is applied to Australian data, a small, open commodity-driven country like South Africa. Applying these types of modelling techniques for South Africa and using a similar specification as in Berkelmans (2005) would provide further evidence on the suitability of these models in the examination of monetary policy issues (such as monetary transmission channels).

The choice to follow Berkelmans' (2005) model is also based mainly on the fact that his results reflect the accepted monetary transmission mechanism described in the theoretical framework as discussed in Chapter Three. The results of Berkelmans' (2005) model are similar to Kim and Roubini (2000) and Cushman and Zha (1997), which show that an SVAR approach appears to be successful in explaining all the puzzles that plagued the recent literature on the effects of monetary

policy in closed and open economies using VAR models. Four puzzles have been observed in VAR models: the liquidity, price, exchange rate and forward discount bias puzzles (Kim and Roubini, 2000). Berkelmans (2005) also adopts techniques introduced by Cushman and Zha (1997) and Dungey and Pagan (2000) that impose certain restriction on the structure of the SVAR model, such that international variables are treated as block exogenous. Detailed contemporaneous restrictions employed are presented below in Equation 1.

$$BX_t \equiv \begin{bmatrix} 1 & & & & & & \\ b_{21} & 1 & & & & & \\ b_{31} & b_{32} & 1 & b_{34} & b_{35} & & \\ b_{41} & & b_{43} & 1 & & & \\ b_{51} & b_{52} & b_{53} & b_{54} & 1 & b_{56} & \\ b_{61} & & & & b_{65} & 1 & b_{67} \\ b_{71} & b_{72} & b_{73} & b_{74} & b_{75} & b_{76} & 1 \end{bmatrix} \begin{bmatrix} comp \\ usgdp \\ sagdp \\ infl \\ credit \\ repo \\ neer \end{bmatrix} \quad (1)$$

Note: Restrictions placed on contemporaneous relationships among variables follows specification by Berkelmans (2005).

It is important to first explain the salient features of the above identification strategy used in this thesis. The (non-zero) coefficients b_{ij} in the above matrix indicate that variable j affects variable i instantaneously (for example, b_{21} is the instantaneous impact of commodity prices on US GDP). The coefficients on the main diagonal are normalised to one, while the blank entries indicate that those entries in the matrix are constrained to be zero. The assumptions embodied in the matrix exactly identify the system as shown by Berkelmans (2005). A similar identification strategy is used in Kim and Roubini (2000:567) who base their identification strategy upon a macro economic model based upon optimising agents which was also developed by Sims and Zha (1995).

The structural representation above is composed of several blocks. The first block (Rows 1 and 2) measures the external pressures on the domestic economy using commodity price index and US GDP as a proxy for global activity. Kim and Roubini (2000:568) used the oil price instead of broad commodity prices and their argument was that it controls for current systematic responses to (negative) supply shocks and inflationary pressure. However, this thesis uses a broader measure of the commodity price index instead of the oil price. The main assumption placed in this block is that all foreign variables affect all domestic variables contemporaneously with only two exceptions. The first exception prevents an immediate effect of US GDP on the South African monetary policy

(repo rate). This assumption reflects informational lags faced by policy-makers as argued in Kim and Roubini (2000). The second exception prevents an immediate effect of US GDP on inflation, since the domestic inflationary consequences of world economic activity would normally be thought to be transmitted indirectly through domestic activity. The domestic variables are not expected to affect international variables, reflecting the relatively small size of South Africa's economy.

The second block (Rows 3 and 4) comprises the domestic goods market equilibrium and inflation behaviour. Output might respond contemporaneously to inflation because nominal income, and so spending, may be fixed in the short term (as in Brischetto and Voss, 1999; Dungey and Pagan, 2000). The contemporaneous response of output to credit follows a study by Safaei and Cameron (2003) and reflects a quick pass-through of credit to aggregate demand[36]. According to Safaei and Cameron (2003:269) the inclusion of credit is motivated by the vast literature on financial market imperfections that underlines the importance of credit constraints in determining the level of economic activity and output. Global activity is expected to affect domestic activity contemporaneously. Row 4 reflects price behaviour and can be thought of as the aggregate supply function as argued by Safaei and Cameron (2003). Thus innovations in aggregate demand are allowed to affect inflation in a way consistent with the Phillips curve concept. The rationale behind the inclusion of commodity prices in this block follows Berkelmans (2005).

Two equations describing the monetary sector block are rows 5 and 6. Following the discussion in Sims and Zha (2005:438), monetary policy does not respond contemporaneously to output and prices simply due to time lags; output and prices data are available at least on a quarterly basis but the interest rate data is available on shorter frequency. Monetary policy is expected to respond contemporaneously to the variables that are available contemporaneously such as commodity prices, monetary aggregates including credit, and the exchange rate. In contrast, the policy rate in Safaei and Cameron (2003) is assumed to respond to price and money, but not contemporaneously to output and credit. Row 5 shows that credit demand depends contemporaneously on real income (output), inflation and the repo rate. The contemporaneous interaction of credit with the interest rate and inflation is justified by the perception that borrowers and potential borrowers will respond quickly to the real cost of credit.

[36] Given the cost of borrowing, credit will typically be spent as soon as the funds are obtained immediately adding to aggregate demand Safaei and Cameron (2003).

The final row is the exchange rate block[37] which is treated as dependent on all innovations of the model. This reflects the fact that the exchange rate as a financial variable reacts quickly to all information. Mussa (1982:95) maintained that the exchange rate is influenced by the real factors that determine relative prices of different national outputs and the monetary factors that determine absolute prices. A similar specification is also followed in Zha (1997).

4.4 EMPIRICAL APPROACH: SVAR MODELS

4.4.1 VECTOR AUTOREGRESSION (VAR)

This section provides a relatively non-technical review of SVAR model. Lütkepohl (2004:159) defines SVAR and VAR models as dynamic systems of equations in which the current level of each variable in the system depends on past movements in that variable and in other variables in the system. VAR models in economics were made popular by Sims (1980). SVARs have particularly been used to document the effects of money on output (Sims and Zha, 2005), the relative importance of supply and demand shocks on business cycles (Blanchard and Quah, 1989), identification of MTM, and the effects of fiscal policy (Blanchard and Perotti, 2002), among many other applications[38]. A critical element in the specification of these models is the determination of the lag length.

The lag order of the SVAR is determined by different lag selection criteria in an unrestricted VAR. Most VAR models are estimated using symmetric lags (the same lag length is used for all variables in all equations of the model). The lag length is frequently selected using an explicit statistical criterion such as the final prediction error (FPE), Hannan-Quinn information criterion (HQ), Akaike's information criterion (AIC) or SIC. Symmetric lag VAR model is easily estimated, since the specification of all equations of the model is the same. However, there is no compelling reason from economic theory that lag lengths should be the same for all variables in all equations. In fact, Hsaio (1981:88) suggests estimating VARs in which the lag length on each variable in each equation could differ.

Before specifying an SVAR model it is important to look at the VAR model for the reason that an SVAR is an extension of the VAR model. A VAR model can estimate a dynamic simultaneous

[37] The exchange rate serves two purposes: firstly allowing the monetary authorities to take into account the effects of their currencies on their inflation rates; secondly controlling for the components of interest rate movements that are systematic responses to a depreciation of the domestic currency, which in the model is more likely to identify the interest rate innovations that are true exogenous contractions Zha (1997).

[38] A variety of SVAR models have been proposed, advocating short-run restrictions (Berkelmans 2005) or long-run restrictions (Blanchard and Quah, 1989), or combinations of short-run and long-run restrictions (Gali, 1992) on impulse responses that are derived from economic theory.

equation system without putting any prior restrictions on the structure of the relationships, which is not the case with an SVAR model. The VAR system can enable the estimation of a reduced form of correctly specified equations whose actual economic structure may be unknown because it does not have any structural restrictions.

Consider the following reduced-form representation of the VAR system, ignoring constant terms:

$$X_t = \sum_{s=1}^{m} A_s X_{t-s} + \varepsilon_t \qquad (2)$$

Where X_t is a 7 x 1 column vector of variables under consideration, A_s are respectively, 7 x 7 matrices of coefficients, m is the lag length and ε_t is the 7 x 1 innovation vector which is uncorrelated with all the past X_s. The VAR analysis is a useful tool to test for and examine linkages between variables. However, the fact that there are so many coefficients raises problems regarding interpretation[39]. The VAR estimates do not allow one to determine the period of time that it takes shocks to work through the system. Thus, the VAR model is normally extended with block exogeneity, impulse responses and variance decompositions functions in order to alleviate some of these problems.

4.4.2 STRUCTURAL VECTOR AUTOREGRESSION (SVAR)

The main critique of VAR models centres on the fact that the model fits the data at the expense of theoretical consistency, both from a short and long run perspective. In contrast, SVAR models explicitly provide an economic or informational rationale behind the restrictions necessary to identify monetary and other shocks (Zha, 1997). The following equations briefly outline the SVAR methodology. For a more detailed exposition, the reader is referred to Lütkepohl (2004:159-194). Consider the following reduced-form representation of the system as described in Berkelmans (2005):

$$X_t = C(L)\, X_t + \varepsilon_t \qquad (3)$$

$$E(\varepsilon_t\, \varepsilon_t') = \Omega$$

$$E(\varepsilon_t\, \varepsilon_{t+s}') = 0, \forall s \neq 0$$

[39] Of particular concern here is that the signs' coefficients of some of the lagged variables may change across lags. Together with the interconnectivity of the equations, this could make it difficult to see how a given change in a variable would impact on the future values of the variables in the VAR system (Brooks, 2002:338).

where X_t is a vector of variables under consideration, C is a polynomial function of order p and L is the lag operator. Now consider a square matrix T such that $(T^{-1})(T^{-1})' = \Omega$, so $T\Omega T' = I$, the identity matrix. Define $T = AB$, where A is diagonal and B's diagonal contains only ones. The matrix A has the same lead diagonal as T, but zeros elsewhere, while B is formed by dividing each row of T by the lead diagonal element of that row. Multiplying Equation (3) by B gives the structural VAR representation:

$$BX_t = BC(L)\,X_t + u_t \tag{4}$$

where the matrix B is the contemporaneous relationships between the variables and $B\varepsilon_t = u_t$. The covariance matrix of the errors from Equation (4) is given by:

$$E(u_t\, u_t') = E(\boldsymbol{B}\,\varepsilon_t\, \varepsilon_t'\, \boldsymbol{B}') = (A^{-1})(A^{-1})' = D \tag{5}$$

Note that because A is diagonal, so too is D. Therefore, u_t can be interpreted as a vector of structural shocks, defined as a shock to a particular variable that is orthogonal to other shocks in the economy. In the reduced form, that is Equation (3), the disturbances, ε_t, could be the result of structural shocks to other variables. For example, unexpected changes to the exchange rate could be caused by contemporaneous disturbances to the interest rate. The matrix B filters the reduced form shocks so that the structural shocks can be identified.

The matrix B can be solved for by first running the VAR represented in Equation (3) to obtain an estimate of Ω. From this estimate, B and A can be calculated from the equation $((AB)^{-1})((AB)^{-1})' = (T^{-1})(T^{-1})' = \Omega$ if sufficient restrictions are imposed on these two matrices. Suppose that there are k variables in the system, so there are k^2 degrees of freedom in A and B. Because Ω is a symmetric matrix, there are only $(k^2+k)/2$ unknowns, so at least $(k^2-k)/2$ restrictions need to be imposed. These restrictions typically, but not always, take the form of restricting B's off-diagonal elements to be equal to zero, and as such constitute restrictions on the contemporaneous affect of one variable on another. For the system of seven variables and thus seven equations, the estimated variance-covariance matrix of reduced form residuals has $7(7 + 1)/2 = (28)$ unique elements. Hence, just identification of the parameters in the matrix B would require exactly 21 restrictions on the off-diagonal elements of the matrix.

Some studies choose a Choleski decomposition of Ω, resulting in a temporal ordering of the variables. This is referred to as a recursive VAR in Sims (1980). An alternative, followed in this thesis, is to allow a more elaborate set of restrictions guided by economic theory and this is referred to as an SVAR. The aim of this modelling process is to say what effect changes in one variable have on the other variables. This requires identifying the structural form of the model wherein each element in the error term is contemporaneously uncorrelated with the others (thus one must orthogonalise the error term).

4.4.3 IMPULSE RESPONSE ANALYSIS

The impulse response analysis describes how innovations (shocks) to one variable affect another variable after a given period of time. Sims' (1980) Cholesky decomposition is one method to identify the impulse-response functions in a VAR[40]. This option imposes an ordering of the variables in the VAR and attributes all of the effect of any common component to the variable that comes first in the VAR system. In this case the responses can change dramatically if the ordering of the variables is changed. Another method is the residual one standard deviation which sets the impulses to one standard deviation of the residuals. This option ignores the correlations in the VAR residuals. Another method is the Generalized Impulses which constructs an orthogonal set of innovations that does not depend on the VAR ordering (Pesaran and Shin, 1998).

However, the aim of an SVAR is to apply economic theory to better obtain structural innovations from the residuals. It is necessary to observe the structural impulse response functions for each independent shock to analyse the estimated models better. Structural Decomposition uses the orthogonal transformation estimated from the structural factorisation matrices. This approach is not available unless one has estimated the structural factorisation matrices as explained in E-Views 6 (2007: 357). First one must estimate the structural factorisation matrices in E-Views 6 in order to use the structural options in impulse responses and variance decompositions. Throughout the discussion the results focuses on the point estimates, as these provide the most meaningful guide to the behaviour of the model (Suzuki, 2004:5).

The impulse responses can be constructed for shocks to any of the variables in the model. Several SVAR studies often analyse the response of the economy to monetary shocks, and so impulse responses to interest rate, exchange rate and credit shock allow a useful comparison with previous studies and a check on the properties of the model. In the context of this thesis, the impulse

40 As noted by Aziakpono (2006:8), the impulse responses are commonly estimated using the generalised impulse response proposed by Koop, Pesaran and Potter (1996) and Pesaran and Shin (1998), and the Cholesky decomposition proposed by Sims (1980).

response function answers questions with regard to response of inflation and output to a structural one standard error unit shock in the interest rate, exchange rate and credit variables. Ninety per cent confidence bands are estimated in E-Views 6 for the standard errors of the impulse responses, which is common in the literature. The responses are plotted for a time horizon of up to 36 quarters (9 years) for all cases. The sign, magnitude and persistence of responses of inflation and output to shocks in exchange rate and credit are captured.

4.4.4 FORECAST ERROR VARIANCE DECOMPOSITION ANALYSIS

The Variance Decomposition analysis can also be utilised to analyse the linkages between the variables. Unlike the impulse response, which traces the effects of a shock to one endogenous variable on other variables in the SVAR framework, variance decomposition splits the variations in a variable into component shocks in the SVAR. By so doing this analysis gives information about the relative importance of error/innovation of each variable in explaining other variables included in the SVAR system. Stated differently, variance decompositions show the proportion of the movements in the explained variable that are due to its own innovations against those from other variables.

Empirical literature widely documents that own series innovations tend to explain most of the forecast error variance of the series in the VAR (Brooks, 2003:342). Note that the variance decompositions based on the Cholesky factorisation can change dramatically if the ordering of the variables in the VAR is altered. Factorisation based on structural orthogonalisation is available only if one has estimated the structural factorisation matrices as explained in E-Views 6 (2007: 358 - "Identified SVARs"). The forecast standard errors should be identical to those from the Cholesky factorisation if the SVAR is just identified. For over-identified SVARs, the forecast standard errors may differ in order to maintain the adding up property (E-Views 6, 2007: 358).

CHAPTER FIVE:
ESTIMATION AND EMPIRICAL RESULTS

5.0 INTRODUCTION

This chapter is divided into several sections. Section 5.1 discusses results of the unit root tests. Section 5.2 assesses and reports the SVAR model diagnostic tests, block exogeneity, impulse responses and variance decomposition. The thesis therefore analyses and identifies monetary policy transmission based on the credit and exchange rate channels. This section presents answers to the objectives of the thesis particularly examining the impact of credit and exchange rate channels of monetary policy transmission in the South African economy. This model is also applied to a short sample period which largely covers the inflation targeting period in South Africa.

5.1 UNIT ROOT TESTS

The results of the unit root tests (of the ADF, PP, KPSS and NG and Perron tests) of all the variables in levels are presented in Table 2. The same tests are repeated for the first differences of such variables. All the variables in levels are found to be stationary in particular based on the KPSS and Ng and Perron tests.

Table 2: Unit Root Tests (ADF, PP, KPSS and Ng and Perron test: 1994:q1 to 2008:q2)

		ADF		PP		KPSS		Ng & Perron	
Series	Model	Level	First difference	Level	First difference	Level	First difference	Level	First difference
COMP	Trend	-2.519	-6.344a	-3.099a	-7.397a	0.085a	0.034a	-10.92a	-71.92a
	Constant	-2.052	-6.391a	-2.838c	-7.373a	0.305a	0.070a	-7.261c	-3020a
USGDP	Trend	-6.987a	-14.55a	-7.048a	-38.77a	0.076a	0.181b	-26.86a	-21.76b
	Constant	-3.541b	-14.69a	-6.528a	-39.03a	0.397c	0.181a	-13.58b	0.551
SAGDP	Trend	-5.333a	--5.582a	-2.095	-5.582a	0.111c	0.043a	-36.22a	-268.8a
	Constant	-3.486b	-5.584a	-1.787	-5.584a	0.480c	0.044a	-25.09a	-301.6a
INFL	Trend	-3.292c	-7.757a	-3.292c	-9.285a	0.106a	0.119a	-17.56b	-27.96a
	Constant	-3.412b	-7.784a	-3.412b	-8.887a	0.173a	0.225c	-16.45a	-27.88a
CREDIT	Trend	-2.709c	-6.796a	-2.815b	-8.383a	0.207b	0.099a	-11.61a	-26.867a
	Constant	-2.5257	-6.924 a	-2.636c	-8.375a	0.336a	0.105a	-10.65b	0.436
REPO	Trend	-2.619c	-5.058 a	-2.205	-4.817a	0.092c	0.112b	-13.267	-24.638a
	Constant	-1.816	-5.109a	-1.244	-4.877a	0.722b	0.114a	-6.570c	-24.693a
NEER	Trend	-5.665a	-8.104a	-5.673a	-22.045a	0.087a	0.226a	-25.39a	-26.005a
	Constant	-5.713a	-8.152a	-5.713a	-20.506a	0.091a	0.231a	-25.37a	-27.092a

Where c,b,a denote the rejection of the null hypothesis at 10%, 5% and 1% level, respectively (for the ADF, PP) and failure to reject the null for the KPSS at 10%, 5% and 1% level, respectively.

The optimum lag lengths for each variable have been chosen using the E-views 6 automatic lag selection option and are based on the Schwarz information criterion. It is clear from the Table 2 that the KPSS and Ng and Perron test statistics reject the null hypothesis of a unit root in all of the series in levels - all of the level variables are integrated of order zero, I(0). The results of the ADF and PP tests show that the repo rate may be non-stationary, however, the KPSS and Ng and Perron tests would be the preferred results based on the reasons explained in section 4.2. Thus, this evidence suggests that the level variables are sufficient for modelling the time series in this study. Therefore, the SVAR model is estimated in percentage growth rate of the variables. Having established that most of the data set of the variables may be integrated in the same order, the next section looks at the results of tests for the SVAR lag order.

5.2 SVAR RESULTS

5.2.0 LAG SELECTION

The structure of the SVAR model used in the thesis is based on the fact that South Africa is a small open economy which means that external shocks are an important driver of domestic activity. An important choice to make in SVAR models is the number of variables and variable lags to include. The lag order of this model is determined using a sequence of likelihood ratio (LR) tests for the significance of each lag, final prediction error and information criteria.

The LR test, final prediction error and the Akaike information criterion indicates that the minimal lag order is two (Appendix 1) whereas the Schwarz Information Criterion and Hannan-Quinn information criterion suggests a lag order of one. However, the diagnostic tests based on the period 1994:q1 to 2008:q2 support lag order two rather than lag order one. It is important to do the diagnostic check in the next section to ensure that the final lag selected will give robust results with white noise residuals. Therefore the model with two lags was used for the full sample period.

5.2.1 THE DIAGNOSTIC TESTS

The Lagrange multiplier test (LM-test) (Appendix 2) is conducted in order to see whether disturbances in the model are serially correlated. When testing for serial correlation the null hypothesis is that there is no serial correlation. If the probability of the LM-statistic is low, one must reject the null and if the probability of the LM statistic is high one fails to reject the null that there is no serial correlation. The LM test results fail to reject the null hypothesis of no serial correlation, as the probabilities of the LM statistics are reasonably high and achieve the desired situation, except for autocorrelation in the model estimated with lag order one which shows autocorrelation in the

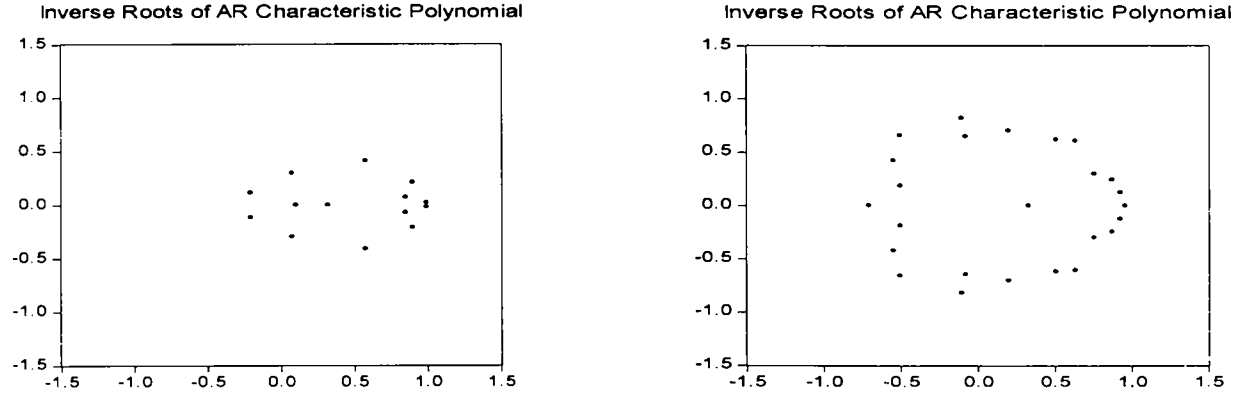
first lag. Since the null hypothesis cannot be rejected for the model with two lags, this test does not provide any hint of model misspecification, as serial correlation is not evident in the residuals.

The next test conducted is the heteroscedasticity test to ascertain whether the error variance is constant. The null hypothesis in this case is that the residuals have a constant variance. Standard estimation techniques become inefficient if the error variance varies. The joint chi-squared test statistic obtained leads to failure to reject the null hypothesis for both models with one and two lags, meaning that the variance of the residuals is constant. Heteroscedasticity in this case is not a problem. The test statistic for heteroscedasticity does not indicate any misspecification for both models with one or two lags (the probability is 0.2429 and 0.5156 for model with one lag and two lags, respectively).

The test for normality of the residuals rejects normality of the residuals at the five percent critical level only for the model with lag order one. For the model with lag order two the Jarque-Bera residual normality test does not reject normality of the residuals, which implies that residuals are normally distributed for this model. For lag order one model the Jarque-Bera residual normality test shows that the residuals are not normally distributed (Appendix 3)).

The stability of the SVAR model is tested to find out whether the model satisfies stability condition. The results in Figure 3 below shows that all the eigenvalues of the model lie inside the unit circle, which shows that the SVAR model (both lag one and lag two) satisfies the stability condition. If the VAR is not stable, certain results (such as impulse response standard errors) are not valid. The lag order of one and two are generally supported by the stability tests.

Figure 3: Inverse Roots of AR Characteristic Polynomial (lag one and lag two respectively)



5.2.2 SVAR ESTIMATES

The estimates of the contemporaneous matrix parameters show that the SVAR model is just-identified as specified according to equation 1 in section 4.3. This result of the contemporaneous matrix parameters is not interpreted as it is the case in several studies of this kind. It is convention in SVAR studies to focus on interrelationships between variables (for instance impulse response functions and variance decomposition), rather than the structural parameter estimates. As argued in Joiner (2002), this is largely because the structural parameter estimates do not reflect the dynamics of the variables in response to shocks.

5.3 IMPULSE RESPONSES

In this section, the impulse response function answers questions with regard to the response of mainly inflation and output to a structural one-standard error unit shock in the interest rate, exchange rate and credit variable. Residual structural one-standard error impulse response (SIR) of the model with two lags forms the basis of this analysis. One additional type of impulse response is carried out to check for consistency, for instance the non-factorised one standard deviation impulse response (NIR)[41] (Appendix 4). The starting point is the discussion of the results of the full data sample, from 1994:q1 to 2008:q2. Figure 4 shows the effect of domestic, structural one-standard deviation, monetary policy shock (repo rate) on domestic GDP, inflation, exchange rate and credit.

5.3.1 MONETARY POLICY SHOCK

The result as represented in Figure 4 shows that a shock to the repo interest rate leads to an immediate depreciation of the exchange rate in the first two quarters followed by an appreciation in the third and sixth quarters. Due to larger error bounds in the first two years the impact of the repo rate on the exchange rate may be less effective. The exchange rate depreciates persistently after the second year, as GDP falls due to the rising repo rate until the twentieth quarter, then the exchange rate moves towards baseline. The observed exchange rate response is largely due to the specification of the model. This exchange rate pattern following a monetary policy tightening may not be inconsistent with theoretical models as the result represents the short run exchange rate response to the repo rate and the quick response of GDP to the repo rate which also impacts the exchange rate. According to this model, in the short run the exchange rate is determined by both domestic and international variables contemporaneously.

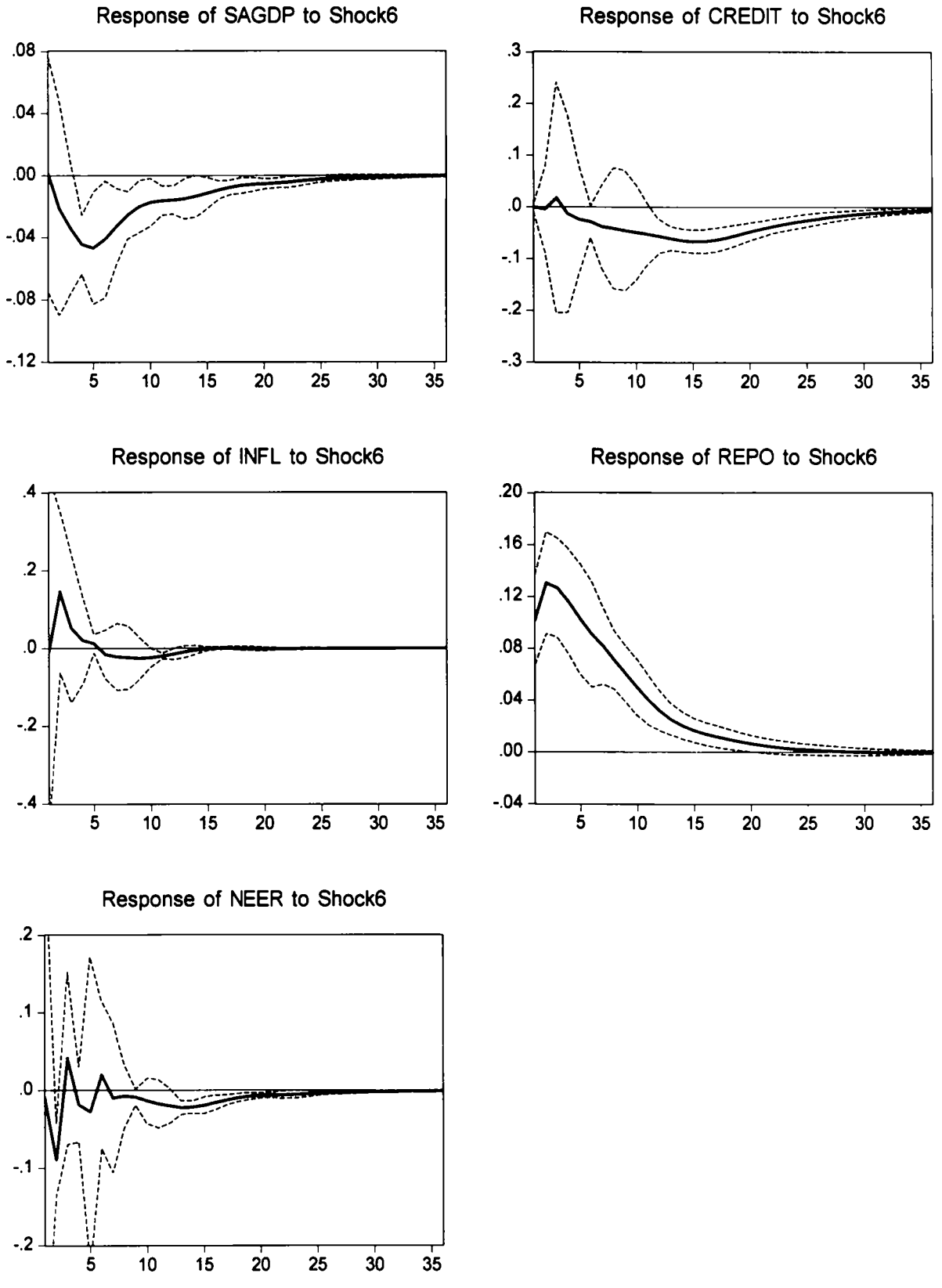
The direct effect of the innovation on the repo rate itself is presented with standard error bounds. The repo rate rises sharply within the first year, reaching the highest point and thereafter starts to

[41] SVAR studies that have used this impulse response include Berkelmans (2005) and others.

move towards baseline, reaching it after twenty-five quarters. This arises because of the interdependence of the variables. Impulse response functions describe the response of the system to an exogenous shock but with the paths of all variables including the shocked variable endogenously determined. It is this endogenous determination that results in the interest rate rising sharply after the initial shock and moving towards baseline thereafter. The rise in the repo interest rate is accompanied by an immediate fall in GDP though it slowly returns towards baseline after the second year. The inflation rate increases in the first year and falls thereafter in the second and third year, reaching a minimum in the second year. It returns towards baseline after the third year. An increase in the interest rate results in a persistent fall in credit, after the first year, which in turn leads to a further fall in domestic GDP.

The responses of domestic credit, output and inflation are more obvious compared to the exchange rate response. Credit falls persistently until it moves towards baseline towards the end of the estimation period. Therefore this result may be showing a stronger support for the interest rate via the credit channel than the exchange rate channel in South Africa during this sample period. It is important to note that the full data sample takes into account the period of exchange rate intervention and the flexible exchange rate period. Hence the exchange rate, like any typical financial variable, is determined by many factors in the short run. The shorter data sample in the subsequent section also supports the credit and exchange rate channel to some extent.

Figure 4: Impulse responses – Monetary policy (repo) innovation



Note: Where shock 6 is the same as impulse responses to repo rate (monetary policy innovation).

Credit responds more strongly than GDP over the estimation period and this is similar to other studies such as Berkelmans (2005) who showed a slower response of GDP to the interest rate shock. Credit is half a per cent below counterfactual level after five quarters. It then continues to fall until it reaches a minimum of about negative 0.08 per cent within four years, and then it begins to move towards baseline. The above result shows a persistent fall in credit. It is interesting to note that while the initial credit response is negligible, credit appears to respond immediately after the first year which is a lagged response. Berkelmans (2005) reported that many studies have found that credit only declines in response to an interest rate rise with a lag.

It is clear from the result that the repo rate has an effect on real output. An unexpected rise in the interest rate tends to be followed by a persistent fall in output for about twenty-six quarters before moving towards baseline. Output falls quickly and reaches a minimum of about 0.45 per cent at the beginning of the second year. The effect on output bottoms out within this year. Other studies have shown that the effect on output bottoms out in approximately six quarters, and output returns to baseline thereafter. Small and de Jager (2001:12) using a large macro-econometric model showed that GDP growth starts to fall after an initial monetary policy adjustment, reaching a maximum decline after five quarters, from this point on, economic activity starts to return smoothly back to baseline. The effect on output is consistent with standard macroeconomic theory which shows that a rising interest rates will reduce output.

The structural response of inflation to the repo rate may capture a positive and negative shock effect. It implies that changes in the repo rate contemporaneously have a positive effect on inflation in the short horizon within the first year as the exchange rate depreciates initially but in subsequent quarters inflation responds negatively, as expected. Inflation falls with some delay and reaches a minimum by approximately eight quarters. Looking at the above figure, the effect on inflation is not permanent as inflation reaches baseline in approximately fifteen quarters. The depreciation of the exchange rate could counter the impact of monetary policy tightening on inflation during the third and fourth years. The lagged response of inflation has been acknowledged in other monetary policy transmission studies.

The results of the full data sample would be compared to the short data sample to reflect the observed behaviour of the South African economy in two different sample periods. Due to different policy regimes experienced and the influence of reforms in the financial sector, the results are different as expected but not contrary to standard theory. The finding so far supports the broad credit and exchange rate view of monetary policy transmission mechanism in South Africa.

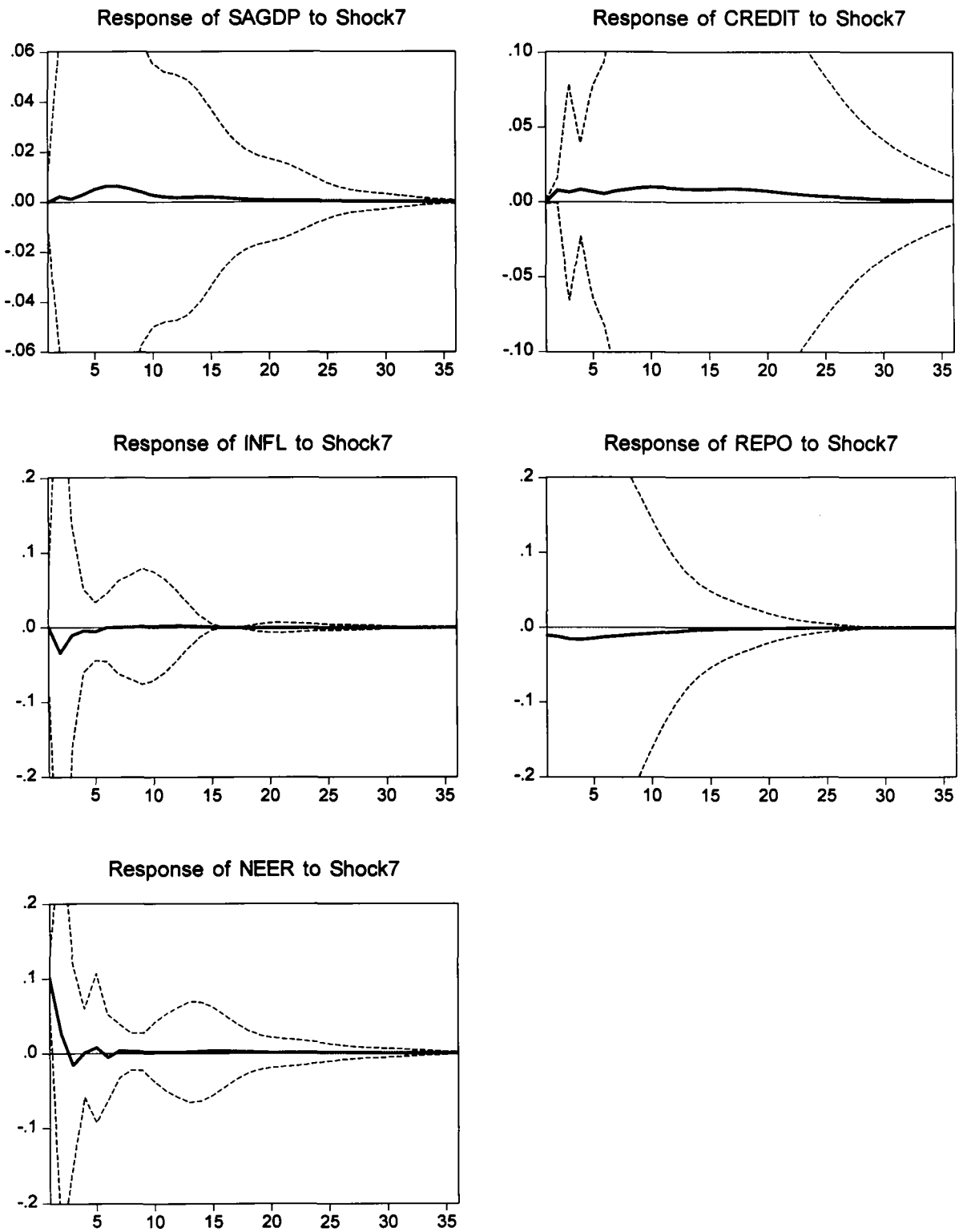
5.3.2 EXCHANGE RATE SHOCK

The response of domestic variables to a nominal effective exchange rate innovation is reported in Figure 5. Given that the result is reported with large error bounds which may imply a less effective exchange rate channel in the short run, only the point estimates are of interest here. In response to an appreciation of one standard deviation, the repo rate decreases and stays below baseline until the twenty-sixth quarter. The fall in the repo rate is consistent with monetary policy systematically moving to offset the fall in inflation due to an appreciation of the currency. In response to the rand appreciation, the monetary authority reduces the repo rate, probably to stabilise falling inflation with maximum impact reached in the second year, and then returns to baseline thereafter.

The identification restrictions used in this model imply that a shock to the exchange rate causes inflation to fall within the first year and returns to baseline thereafter. The inflation responds to exchange rate innovation quickly in the short-run. This could imply that South African goods become expensive and therefore result in a decrease in demand for local goods versus foreign goods which in turn could lead to lower prices. Due to the exchange rate appreciation imported goods could also be cheaper and this would tend to reduce prices. This result clearly supports the exchange rate channel of monetary policy transmission mechanism looking at the point estimates only but the large error bounds may in contrast imply that the exchange rate channel is not as effective in the short run. Looking at this result, especially large error bounds and the impact of the repo rate on exchange rate, one should appreciate the current monetary policy stance of not intervening in the foreign exchange market to influence economic activity.

A shock to the exchange rate causes a rise in output, though small in magnitude, which is persistent but reaches baseline at the end of the period. The maximum impact on output is reached in the second year. A possible explanation of this phenomenon can be offered as follows. The results observed could reflect the effects of the resultant fall in the domestic interest rate and a persistent rise in credit over the whole period. The smaller impact on growth may be due to the negligible exchange rate innovation which may imply that a large appreciation could be good for growth, due to the response of the monetary authority to reduce the interest rate. This is in line with the current monetary policy followed in South Africa in order to control inflation. However, the effect of both the falling repo rate and appreciation of the exchange rate could be contradictory, as appreciating currency may encourage imports and discourage exports. Appendix 5 (NIR) shows large error bounds that are consistent with the SIR. The effect of this shock on inflation seems to stronger than on GDP in the first year, though in the second year the effect on GDP seems relatively stronger.

Figure 5: Impulse responses – Exchange rate (neer) innovation



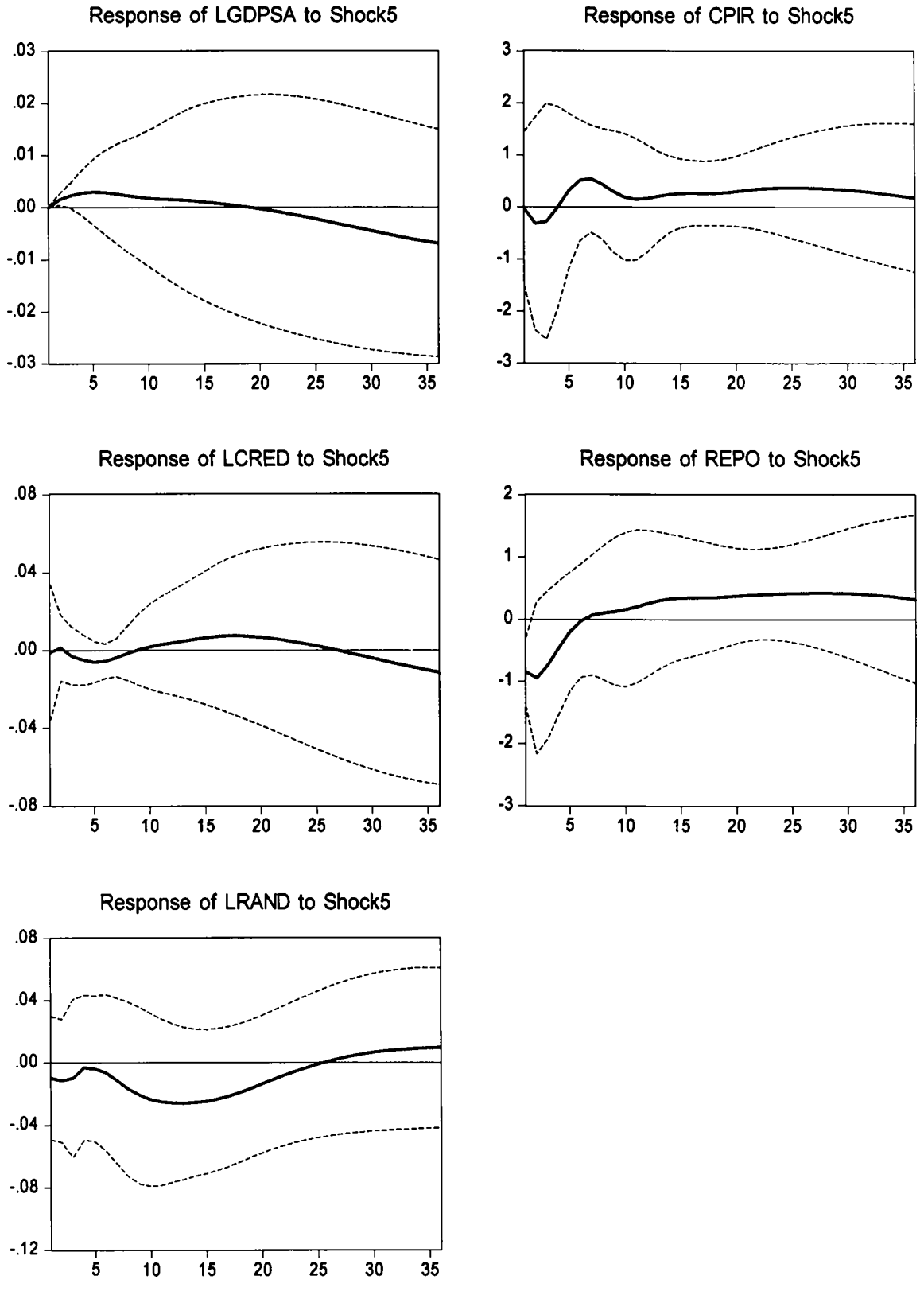
Note: Where shock 7 is the same as impulse responses to exchange rate innovation.

5.3.3 CREDIT INNOVATION

Figure 6 below shows the effect of a structural one-standard-deviation credit shock on domestic real GDP, inflation, the exchange rate and interest rate. In response to the credit shock, the repo rate increases and remains above baseline permanently after an initial decline in the first year. This supports the standard macroeconomic view that credit growth should have a positive relation with the repo rate. In Berkelmans' (2005:17) paper the impulse response for endogenous monetary policy showed that credit shock leads to a sizeable increase in the interest rate. He argued that this does not imply that monetary policy responds directly to credit movements but rather the endogenous changes in monetary policy are the response to all of the variables in the system, including inflation and output.

The effect on output to credit shock is as anticipated: output increases until the fifth year and remains below baseline thereafter – the maximum effect on output is seen during the second year. The result shows that credit has a significant influence on domestic GDP and inflation. Inflation increases sharply in the second year after an initial fall in the first year.. Therefore, credit shock appears to have a stronger impact on inflation than on real output. The effect on inflation is with a lag. The impact of credit on output is stronger within five years years, with negative impact thereafter. The finding, once again, supports the credit view of monetary policy transmission mechanism in South Africa. However, the large standard error bounds may imply that the credit channel is not as effective in the short run as is the exchange rate.

Figure 6: Impulse responses – Credit innovation



Note: Where shock 6 is the same as impulse responses to credit innovation.

It is clear from the result that the repo rate has a relatively stronger effect on real output than inflation within the first two years, but the effect on inflation does not revert to baseline within the chosen nine year period. In contrast to the model with two lags, the result shows that the exchange rate and credit do not also revert to baseline. Though this result may not be inconsistent with the theoretical models, the diagnostic tests performed earlier showed this model is inferior compared to the one estimated with two lags.

5.4 VARIANCE DECOMPOSITION

The variance decompositions for five different forecast horizons (quarters 1, 4, 8, 24 and 36 months) are reported in Table 3. Each column reports for a different domestic variable the proportion of the forecast error that is explained by structural shocks to each of the other explanatory variables.

Within the first two years, exogenous variables (foreign) shocks, shocks to inflation, credit, interest rate, exchange rate and GDP's own shocks are important for GDP forecast errors. As the horizon lengthens, the same pattern continues though the GDP impact becomes smaller. Within the first year 57 per cent of the variance in GDP is explained by its own innovation compared to 30 per cent at the end of the forecast period. At the end of the period, exactly 27 per cent of the variance in real output is explained by exogenous variables while nominal effective exchange rate explains about 2.4 per cent, interest rate explains about 31 per cent, credit is about 4.7 per cent and only 15.4 per cent of output variances is accounted for by inflation shocks. This shows that credit effect on output is stronger than exchange rate at all horizons.

In case of inflation, its own shocks and shocks to the exchange rate, credit, and interest rate variables are responsible for most of the short-term forecast error within two year. Over longer horizons, the same pattern persists. Within the first year 60 per cent of the variance in inflation is explained by its own innovation compared to 54 per cent at the end of the forecast period, credit explains about 5.9 per cent and exchange rate about 3.6 per cent. At the end of the period, about 24.9 per cent of the variance in inflation is explained by exogenous variables while nominal exchange rate explains about 3.24 per cent, nominal interest rate explains about 11.5 per cent, credit is about 5.3 per cent and only one per cent is explained by output. This shows that credit effect on inflation is marginally stronger than exchange rate at all horizons. It is interesting to note the exchange rate and credit effect are stronger on inflation than output.

Table 3: Variance Decomposition

SAGDP Period	S.E.	SAGDP	CREDIT	INFL	REPO	NEER
1	0.467	83.738	0	0	0	0
4	1.226	56.623	5.804	1.398	17.595	1.049
8	1.608	34.039	5.261	14.960	29.536	2.315
24	1.762	30.069	4.657	15.360	30.654	2.431
36	1.763	30.037	4.655	15.376	30.666	2.433
CREDIT:	S.E.	SAGDP	CREDIT	INFL	REPO	NEER
1	0.807	1.772	92.489	0	0	0
4	1.847	3.628	72.893	8.657	0.332	1.840
8	2.393	5.624	53.841	5.597	1.439	1.369
24	2.482	5.293	44.024	7.080	9.729	1.624
36	2.714	5.258	43.563	7.244	10.135	1.637
INFL:	S.E.	SAGDP	CREDIT	INFL	REPO	NEER
1	0.022	0.540	4.027	85.385	0	0
4	0.034	0.448	5.902	60.412	12.314	3.604
8	0.045	0.754	5.433	54.503	11.091	3.251
24	0.049	0.988	5.336	53.987	11.485	3.242
36	0.054	0.989	5.335	53.985	11.487	3.242
REPO:	S.E.	SAGDP	CREDIT	INFL	REPO	NEER
1	0.872	0.520	2.178	37.304	58.746	0
4	2.260	0.479	0.967	38.573	52.187	0.587
8	2.652	1.688	0.942	36.034	49.917	0.956
24	2.774	1.573	0.936	34.699	49.316	1.239
36	2.900	1.573	0.938	34.698	49.314	1.239
NEER:	S.E.	SAGDP	CREDIT	INFL	REPO	NEER
1	0.065	0.492	0.205	17.241	4.4324	71.989
4	0.101	2.327	4.776	11.558	5.1946	45.527
8	0.129	2.392	5.343	12.849	5.1508	43.005
24	0.140	2.564	5.290	13.031	5.5765	42.453
36	0.149	2.565	5.289	13.035	5.5847	42.445

Over short horizons, the forecast errors for credit are mostly explained by shocks to credit, followed by exogenous variables. In the first year 73 per cent of the variance in credit is explained by its own innovation compared to 44 per cent at the end of the forecast period. Domestic GDP explains 3.6 per cent of the credit forecast errors whilst exchange rate, inflation and the repo rate explain about 1.8, 8.7 and 0.3 percent respectively within the first year. As the horizon lengthens, the same pattern continues with the repo rate becoming increasingly important. At the end of the period exogenous variables account for 22 per cent of the variance in credit, the repo rate account for about 10 per

cent, domestic GDP for about 5.3 percent, and inflation for about 7.2 per cent. The exchange rate explains little of the variance in credit at all horizons between one and two per cent. Shocks to the repo rate and exchange rate have almost the same effect on credit within the first year at about 1.4 per cent each, but over longer horizons the repo rate has a much bigger effect at about 10 per cent.

In the first quarter 72 percent of the variance in the exchange rate is explained by its own innovation compared to 42 percent at the end of the forecast period. At the end of the period, about 30 percent of the variance in the exchange rate is explained by the exogenous variables while credit explains about 5.3 percent, interest rate explains about 5.6 percent and only 2.6 percent of exchange rate variance is accounted for by domestic output. Inflation plays a big impact over all horizons, explaining about 12 per cent on average. In terms of the impact on the repo rate, inflation has the biggest impact over all horizons, about 36 per cent on average. Within the first year credit has a bigger impact than the exchange rate on the repo rate, however, over the longer horizons the exchange rate has a bigger impact. Domestic GDP has a small impact on the repo rate within the first year which increases slightly over the longer horizons to 1.6 per cent.

The above result in Table 3 are in line with the impulse response analysis and shows that the exchange rate and credit channel are important transmission channels in South Africa over the chosen sample period.

5.5 CONCLUSION

This chapter presents and discusses the estimation and results in order to determine (i) the empirical relevance of the credit and exchange rate channels in South Africa, (ii) the dominance of each channel, in terms of the impact of its shocks and innovations on output and inflation, and (iii) to what sense is the instrument of monetary policy itself a function of the exchange rate and domestic credit pressures. The first part of the chapter presents and discusses descriptive properties of the data. The second part of the chapter addresses the thesis objectives using an SVAR model in an attempt to understand the MTM in South Africa particularly the credit and exchange rate channels using both the impulse responses and variance decomposition analyses.

The result of the impulse response function shows that a shock to the repo interest rate affects both the credit and the exchange rate, though the effect on credit is stronger. The response of GDP to a repo rate shock is immediate as GDP falls and bottoms out within the second year. Inflation shows a lagged response, it is positive initially but in subsequent quarters inflation responds negatively as expected. A shock to the nominal effective exchange rate causes the repo rate to decrease. In

response to an exchange rate appreciation of one standard deviation, inflation falls within the first year and GDP increases. In response to the credit shock, the repo rate increases. Credit has a significant positive influence on both GDP and inflation.

The findings of this thesis support the credit and exchange rate view of monetary policy transmission mechanism in South Africa and show that both channels have a stronger effect on inflation than on GDP. However, the large standard error bounds associated with this analysis may imply that the credit and exchange rate channels are not as effective in the short run. The variance decompositions for five different forecast horizons (quarter 1, 4, 8, 24 and 36 months) are in line with the impulse response analysis and show that the exchange rate and credit channel are important transmission channels in South Africa over the chosen sample period. The next chapter provides a detailed summary of the results and policy recommendations.

CHAPTER SIX:
SUMMARY OF FINDINGS, POLICY RECOMMENDATIONS AND AREAS FOR FUTHER RESEARCH

6.1 SUMMARY OF THE STUDY AND CONCLUSIONS

This thesis is about monetary policy transmission and seeks to examine the impact of credit and exchange rate channels of monetary policy transmission in the South African economy, specifically on output and inflation. South Africa's monetary policy has gone through several changes over the past thirty years. In this respect, there is a need for robust empirical evidence on the effects of these channels on inflation and output. In order to achieve the objectives laid out in Chapter One, the thesis started with an in-depth review of the relevant theoretical and empirical literature about the MTM, especially focusing on the credit and exchange rate channel. The empirical literature has shown the significance of these monetary transmission channels in a number of countries.

The thesis uses an SVAR model to identify monetary transmission in South Africa for the period 1994q4 to 2008q2, which is associated with different monetary policy regimes. This methodology has been tested and found to be appropriate for studies of monetary policy transmission in a number of countries. Although various model designs have often been used in empirical MTM studies, SVAR models are still regarded as the best way to discover what dynamic relations exist between multivariate series (Dungey and Pagan, 2008:1). The emphasis of SVAR models is on data coherency, with the consequence that theoretical ideas appeared in it in only a loose way. It is, however, desirable if SVAR models broadly incorporate the structures that come from the theoretical models. The impulse responses and variance decomposition results show that the repo rate plays a significant role in terms of its impact on inflation and output. Credit and exchange rate are also found to impact inflation and output to some extent.

Based on a theoretical macroeconomic framework, an increase in the repo rate would tend to make rand denominated assets relatively more attractive, and the rand exchange rate will therefore tend to appreciate. However, in reality other external and domestic factors make achievement of exchange rate predictability difficult as experienced by substantial swings in the currency. The impulse responses result shows that the shock to the repo interest rate, increasing it by one standard deviation, leads to an immediate depreciation of the exchange rate in the first two quarters followed by an appreciation in the third and sixth quarters. Due to larger error bounds in the first two years the impact of the repo rate on the exchange rate may be less effective. The exchange rate depreciates persistently after the second year, as GDP falls due to the rising repo rate, until the twentieth quarter then the exchange rate moves towards baseline.

The result suggests that a shock to the interest rate results in credit being almost half of a percentage point lower after four quarters. Credit falls persistently until it moves towards baseline towards the end of the estimation period. It is interesting to note that while the initial credit response is small, credit appears to respond immediately after the first year which is a lagged response. This supports Berkelmans' (2005) report that many studies have found that credit only declines in response to an interest rate rise with a lag. An unexpected rise in the interest rate tends to be followed by a persistent fall in output for about twenty-six quarters before moving towards baseline. Output falls quickly and bottoms out within the second year; this reaction is similar to the one found in Small and de Jager (2001). A change in the repo rate has a positive effect on inflation in the short horizon within the first year as the exchange rate depreciates but in subsequent quarters inflation respond negatively, as expected. Inflation falls and reaches a minimum by approximately eight quarters then moves towards baseline after three years.

This thesis identifies monetary policy within an SVAR model that explicitly accounts for endogenous policy reaction in South Africa. The estimated responses presented in the results are not inconsistent with standard theory, suggesting that this identification procedure is a promising approach for other studies. According to the results in this thesis a contractionary monetary policy shock is, indeed, followed by a fall in domestic output, a decrease in inflation and a fall in credit. As expected, the impact on the exchange rate is limited. Therefore this result may be showing a strong support for the credit channel rather than for the exchange rate of MTM in South Africa during this sample period. It is important to note that the full data sample takes into account both the period of exchange rate intervention and flexible exchange rate. The flexible exchange rate, like other typical financial variables, is determined by many factors in the short run, hence it is difficult to control.

In response to the credit shock (increasing by one standard deviation), the repo rate increases to stabilise inflation and remains above baseline until the tenth quarter after an initial decline in the first quarter. The maximum impact on the repo is in the fifth quarter. The effect on output to credit shock is as anticipated: output increases from the third quarter after an initial fall in the first two quarters, and the maximum effect on output is seen at the end of the first year. After the second year output moves closer to the baseline and it appears there are no permanent effects. Inflation increases sharply in the first year before falling slightly below baseline in the second year but in the third year onwards it is virtually close to baseline. Therefore, credit shock appears to have a quicker impact on inflation within the first year than on real output. However, in the second year output response is positive compared to a negative response of inflation due to rising interest rate.

In response to the exchange rate appreciation of one standard deviation, the monetary authority reduces the repo rate, probably to stabilise falling inflation with maximum impact reached in the second year, and then returns to baseline thereafter. The fall in the repo rate is consistent with monetary policy systematically moving to offset the fall in inflation due to an appreciation of the currency. The identification restrictions used in this model imply that a shock to the exchange rate causes inflation to fall within the first year and returns to baseline thereafter. A shock to the exchange rate causes a rise in output, though small in magnitude, which reaches baseline at the end of the period. This result could reflect the effects of the resultant fall in the domestic interest rate and a persistent rise in credit over the whole period, which tends to increase output.

The response of domestic credit on output and inflation is more obvious compared to the exchange rate response. However, the large standard error bounds may imply that credit and exchange rate channels are not as effective in the short run as it would be expected. The identification restrictions used in the small sample model is also associated with large standard error bounds. Estimates of the impulse responses in this thesis are sensitive to the changes in the lag length and to changes in the sample period as expected. The variance decomposition result is in line with the impulse responses and shows that the exchange rate and credit channels are important transmission channels in South Africa over the chosen sample period. The results seems consistent with: 1) the conventional open economy transmission mechanism discussed in Chapter Three; 2) the stylised facts cited in support of the credit and exchange rate channel that augments the conventional interest rate channel; and 3) lastly, the exchange rate and credit show a stronger effect on inflation than on GDP, looking at the impulse responses and variance decomposition results.

6.2 POLICY RECOMMENDATIONS

Monetary policy strategy followed by the SARB since 1985 in its pursuance of protecting the value of the currency was initially based on monetary targeting (Small and de Jager, 2001:2. However, the relationship between changes in interest rates, money supply and the inflation rate become far more obscure over time. It was against this background that the South African Reserve Bank started to move away from formally targeting the money supply and began with the 'informal inflation targeting' framework (Small and de Jager, 2001:2-3) which formally paved the way for the inflation targeting framework under an environment of flexible exchange rates. This led to the repo rate being the dominant transmission channel of monetary policy employed by the SARB. The results in this thesis do not contradict the current stance of monetary policy in South Africa since the model shows that the repo rate is the dominant monetary transmission channel.

In support of the current monetary stance of the SARB, Aron and Muellbauer (2006) showed that the repo rate has been successful in combating inflation and can also be used to boost economic activity. The results of this thesis support Aron and Muellbauer's (2006) view that the current framework should be left as it is since the interest rate shows a significant impact on inflation and output. The issue of whether the current inflation target range is relevant for South Africa is out of the scope of this study which focuses on the transmission channels. The thesis shows the importance of taking into consideration other transmission channels in South Africa, and that output fluctuations should be taken seriously in the conduct of monetary policy. Mboweni (2006) argued that the SARB takes into consideration output in its policy but this is not emphasised and legislated as it is the case regarding inflation in the inflation targeting framework.

Bernanke and Gertler (1995) argued that the effects of monetary policy are exacerbated by credit effects. The current global credit crunch shows that the credit channel should be taken seriously as credit can impact economies severely. Papers that have formally looked at the credit channel in South Africa include Ludi and Ground (2006) and Sichei (2005). More studies are required in South Africa in order to understand this relationship between credit, inflation and economic activity. With the scope for lowering interest rates virtually exhausted other economies have introduced unconventional policies in response to the recent credit crunch (IMF, 2009). Central banks continue exploring less conventional measures, using both the size and composition of their own balance sheets to support credit intermediation. In South Africa the introduction of the National Credit Act to regulate credit in the economy and the sound financial regulation environment is a step in the right direction as these policies may have helped South Africa to weather the current global economic crisis to some extent.

Emerging economies such as South Africa have also eased monetary conditions in response to the deteriorating economic outlook caused by the credit crunch. However, in many small open economies such as South Africa the task of the central bank is further complicated by the need to sustain external stability in the face of highly fragile financial flows and in other cases balance sheet mismatches. Thus although central banks in most of the emerging economies have lowered interest rates in the face of the global downturn, they have been appropriately cautious in doing so to maintain incentives for capital inflows and to avoid disorderly exchange rate moves. Hence in an open economy the monetary authority actions are complicated by the impact of the exchange rate effects. It has been shown that the exchange rate has a significant impact on inflation and hence

interest rates. However, after reviewing several studies the results of the impact of the exchange rate on output have been found to be inconclusive.

Policy actions by the SARB therefore need to take into consideration exchange rate effects. It is apparent that in periods of a global economic recession, such as the recent case of 2008 and early 2009, the SARB could afford to reduce the interest rate without worrying much about inflation as the global deflation impacts the South African inflation and economic activity. The model employed in this thesis shows that a fall in interest rates is expected to increase inflation. However, in reality recent experiences have shown that the credit crunch leads to a fall in economic activity which reduces prices further. Hence, an expansionary monetary policy could help boost demand while avoiding deflationary scenarios caused by recession. This policy action is not expected to have adverse impacts on the economy. The exchange rate depreciation is also not expected to cause high inflation due to counter effects of lower imported inflation. It would be important to study this phenomenon further in order to understand these tradeoffs and to make good policy decisions.

Important lessons can be drawn from the results of the thesis, especially within the current challenges facing monetary authorities globally. Monetary authorities have gone to great lengths to boost economic activity. A key challenge will be to calibrate the pace at which the extra ordinary monetary stimulus now being provided to boost economic activity is withdrawn. The challenge is that acting too fast to reverse the easing of monetary policy would risk undercutting what could likely be a fragile economic recovery, but acting too slowly could risk inflating new asset price bubbles or eroding credibility. At the current juncture, according to the IMF (2009), the main priority is to avoid reducing monetary stimulus prematurely while developing and articulating coherent exit strategies. Hence, it is essential to understand how MTM works.

6.3 AREAS FOR FURTHER RESEACH

The results of this thesis support the credit and exchange rate view of monetary policy transmission mechanism. However, a more rigorous structural specification of the SVAR approach for South Africa is needed as the theoretical specification was employed in a loose way in the thesis. In addition, other modelling dimensions to be investigated should include different specifications for credit variables, e.g. different categories of credit. The specification of the model to include explicit trade variables which have been identified in other studies such as Zha (1997) could also be explored to compare the performance of different models. This study has been limited in its approach of using stationary data in percentage growth rate and short-term restrictions, which overlooked long run relations between variables.

GLOSSARY OF TERMS

Asymmetric information: The failure of two parties to a transaction to have the same relevant information. Examples are buyers who know less about product quality than sellers, and lenders who know less about likely default than borrowers.

Eclectic approach to monetary policy: Enables the Central Bank to use all available information in conducting policy.

External financial premium: A wedge between the cost of funds raised externally (by issuing equity or debt) and the opportunity cost of funds raised internally (by retaining earnings).

Federal funds rate: The interest rate that banks charge each other for the use of US Federal funds.

Flexible exchange rate: An exchange rate that is determined by market forces in the absence of central bank intervention.

Floating/flexible exchange rate regime: A regime in which a country's exchange rate is allowed to fluctuate freely and be determined without intervention in the exchange market by the government or central bank.

Inflation targeting policy framework: Involves the public announcement of inflation targets, coupled with a credible and accountable commitment on the part of government policy authorities to the achievement of these targets.

Large country: A country that is large enough for its international transactions to affect economic variables abroad, usually for its trade to matter for world prices.

Monetary policy: The use of the money supply and/or the interest rate to influence the level of macroeconomic activity and other policy objectives.

Monetary transmission mechanism: Any of several channels by which a change in the money supply of a country can cause changes in real variables.

Moral hazard: A situation in which one of the parties to an agreement has an incentive after the agreement is made to act in a manner that brings additional benefits to himself or herself at the expense of the other party.

Nominal effective exchange rate: An index of a currency's value relative to a group (or basket) of other currencies, where the currencies in the basket are given weights based on the amount of trade between the countries that use the currencies.

Open market operation: The sale or purchase of government bonds by a central bank, in exchange for domestic currency or central-bank deposits.

Output gap: The difference between actual GDP and potential GDP or potential output.

Repo rate: The interest rate at which the central bank stands ready to make loans to commercial banks.

Small open economy: An economy that is small enough compared to the world markets in which it participates that is (as a good approximation) its policies do not alter world prices or incomes.

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APPENDIX 1: VAR Lag Order Selection Criteria

Endogenous variables: COMP USGDP SAGDP INFL CREDIT REPO NEER
Sample: 1994Q1 2008Q2
Included observations: 54

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-1003.309	NA	42023803	37.41886	37.67669	37.51829
1	-814.3771	321.8842	239528.0	32.23619	34.29884*	33.03167*
2	-749.7622	93.33262*	146920.1*	31.65786*	35.52533	33.14939
3	-706.6893	51.04937	234103.8	31.87738	37.54967	34.06496
4	-654.3277	48.48296	351151.4	31.75288	39.22998	34.63650

* indicates lag order selected by the criterion
LR: sequential modified LR test statistic (each test at 5% level)
FPE: Final prediction error
AIC: Akaike information criterion
SC: Schwarz information criterion
HQ: Hannan-Quinn information criterion

APPENDIX 2: Serial Correlation LM Tests

LM Tests: lag two

Lags	LM-Stat	Prob
1	45.63170	0.6105
2	49.49388	0.4534

Probs from chi-square with 49 df.

LM Tests: lag one

Lags	LM-Stat	Prob
1	85.48373	0.0010

Probs from chi-square with 49 df.

APPENDIX 3: VAR Residual Normality Tests

Normality Tests: lag two

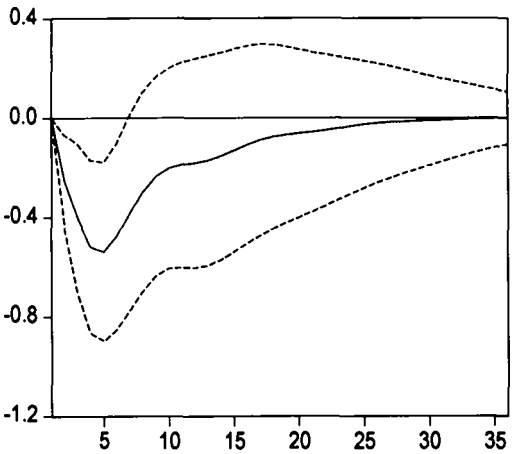
Jarque-Bera	df	Prob.
19.56174	14	0.1446

Normality Test: lag one

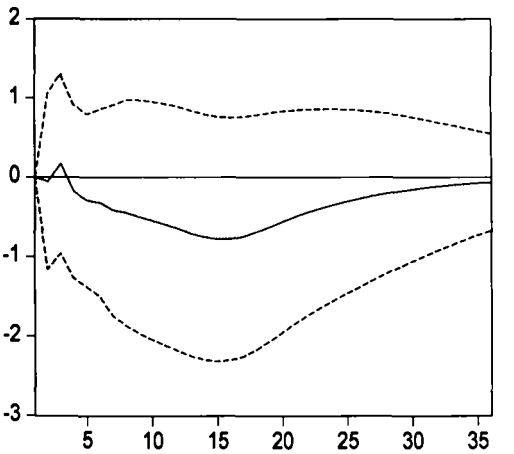
Jarque-Bera	df	Prob.
25.55312	14	0.0295

APPENDIX 4: Impulse Response (Nonfactorised One S.D. Innovations ± 2 S.E)

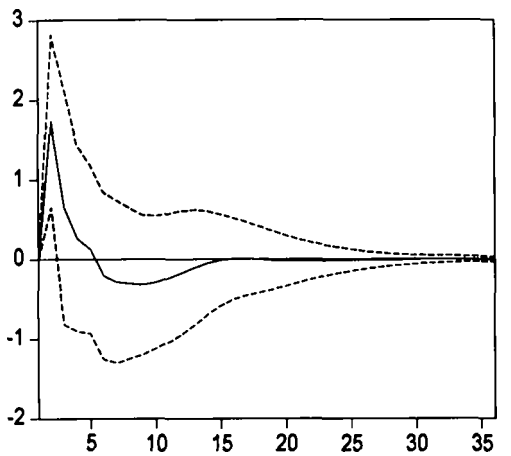
Response of SAGDP to REPO



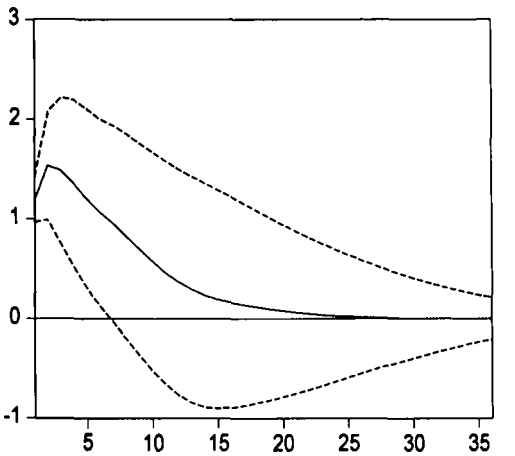
Response of CREDIT to REPO



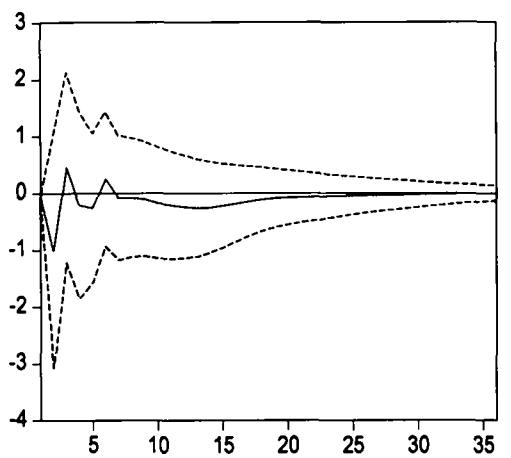
Response of INFL to REPO



Response of REPO to REPO

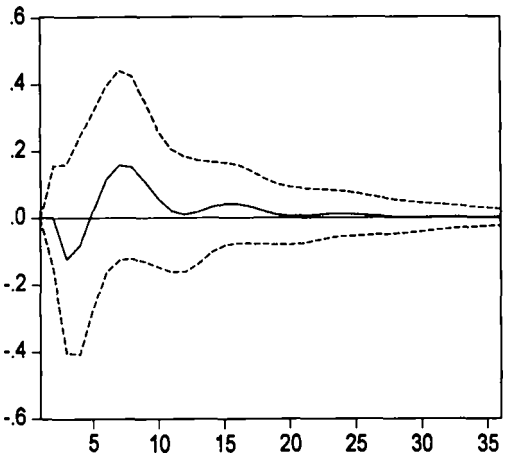


Response of NEER to REPO

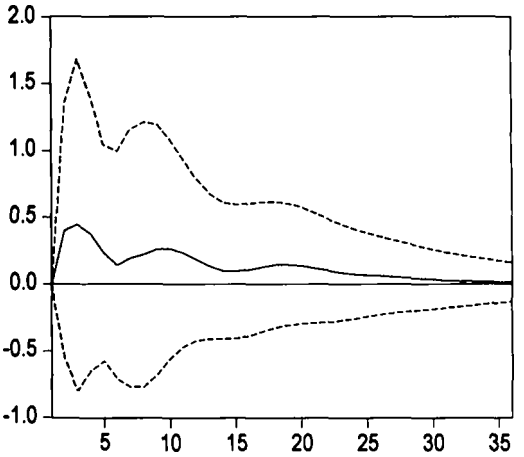


APPENDIX 5: Impulse Response (Nonfactorised One S.D. Innovations ± 2 S.E)

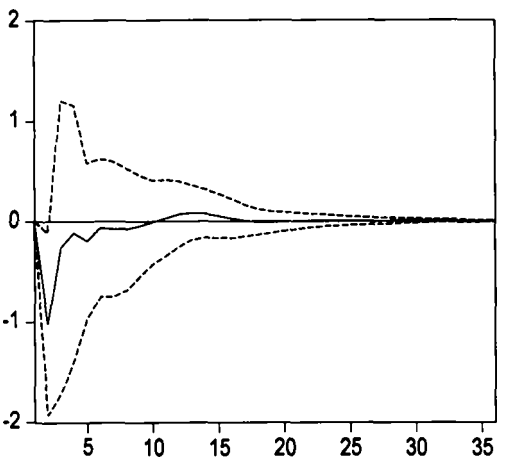
Response of SAGDP to NEER



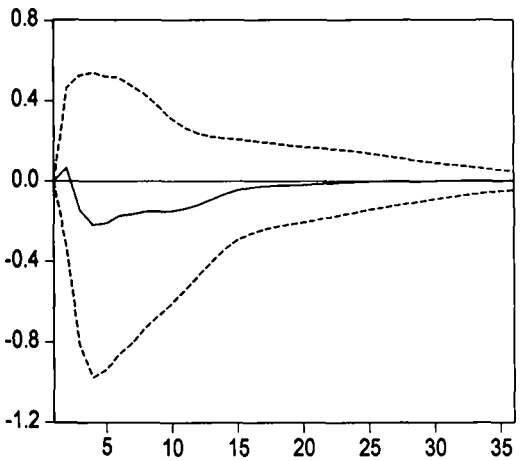
Response of CREDIT to NEER



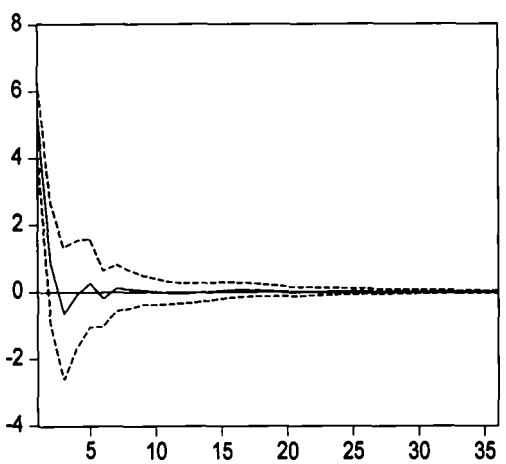
Response of INFL to NEER



Response of REPO to NEER

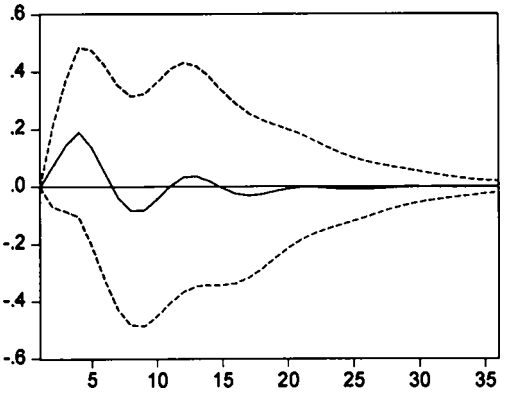


Response of NEER to NEER

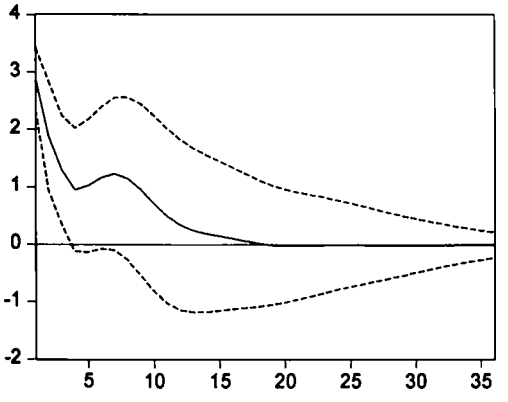


APPENDIX 6: Impulse Response (Nonfactorised One S.D. Innovations ± 2 S.E)

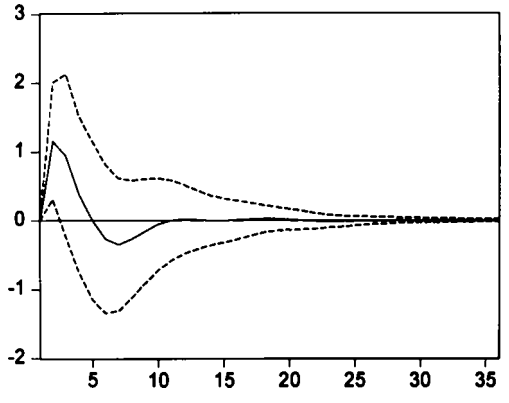
Response of SAGDP to CREDIT



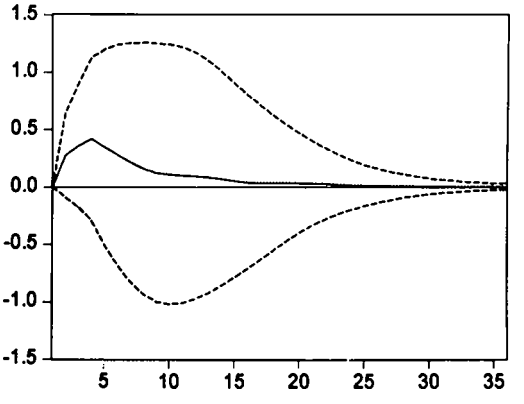
Response of CREDIT to CREDIT



Response of INFL to CREDIT



Response of REPO to CREDIT



Response of NEER to CREDIT