

UNIVERSITY OF THE WESTERN CAPE



Monetary Policy Transmission Mechanism in Botswana

How Does the Central Bank Policy Rate Affect
the Economy?

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**MONETARY POLICY TRANSMISSION MECHANISM IN BOTSWANA: How Does the
Central Bank Rate Affect the Economy?**

KEYWORDS

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ABSTRACT

MONETARY POLICY TRANSMISSION MECHANISM IN BOTSWANA: How Does the Central Bank Rate Affect the Economy?

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The transmission mechanism of monetary policy has generated a substantial amount of interest in economic research in many countries, with most studies focusing on how a change in monetary policy stance, usually defined as an exogenous shock in a short-term interest rate, affects the economy at a national level, with changes in output, inflation and exchange rates being the key variables under investigation. This study adopts a similar analysis, with the general objective of examining the effectiveness of monetary policy in Botswana. Specifically, this study aims at finding out how the central bank rate affects inflation in Botswana and the duration of its effects on economic variables in Botswana. The study adopts the recursive VAR methodology, using quarterly data from 1995 quarter one to 2009 quarter four. The results show that monetary policy is most effective via the interest rate channel in Botswana, followed by the credit channel and then the exchange rate channel. In addition, the results reflect that the economy reacts to monetary policy actions with a one period lag, with the effect lasting for seven quarters.

January 2012.

DECLARATION

I declare that *Monetary Policy Transmission Mechanism in Botswana: How does the central Bank Policy Rate Affect the Economy?* is my own work, that it has not been submitted before any degree or examination in any other university, and that all the sources I have used or quoted have been indicated and acknowledged as complete references.

Tebogo Munyengwa

January 2012

Signed:.....



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Time series data: Excel spreadsheets with the time series data used for the analysis in this thesis can be obtained from the Author or from the Department of Economics at the University of the Western Cape.



Chapter 1

1. Introduction

The transmission mechanism of monetary policy has generated a substantial amount of interest in economic research in many countries, with most studies focusing on how a change in the monetary policy stance, usually defined as an exogenous shock in a short-term interest rate, affects the economy at a national level, with changes in output, inflation and exchange rates being the key variables under investigation (e.g., Chuku (2009:112), Hung and Pfau (2008:1), Cheng (2006:1), and Amasakara (2006:1), among others). The main issue relating to the discussion of the monetary policy transmission mechanism is the potential of policy interest rates to influence output and inflation. The transmission mechanism of monetary policy refers to the process in which the policy rate affects other economic variables and ultimately output and inflation (Taylor, 1995:4).

Substantial evidence has emerged from studies in other countries which contribute to the understanding and correct assessment of what monetary policy can do to an economy. This facilitates policy-making and formulation of alternative macro-economic policy frameworks (Chuku 2009:113). For example, Ganey *et al* (2003:29) investigated the transmission mechanism in the Euro area. They found that for most Euro-area countries, responses of inflation were consistent with the economic theory that increases in interest rates dampened inflation. Bhuiyan (2008:14) also confirmed the findings using data from Canada. He found that interest rate changes are transmitted through both the interest rate and the exchange rate channels. Moreover, Bhuiyan (2008:14) finds that the impulse response of a monetary aggregate (M1) does not follow that of the overnight rate.

More evidence exists from other African countries, for example, Smal and De Jager (2001:15) analysed the transmission mechanism in South Africa. They concluded that interest rates affect the real economy with a long time lag. They also found that changes in the real economy affect inflationary pressures through the adjustment of the output gap. In addition, Cheng (2006:12) detects that an increase in short-term interest rates tends to be followed by an appreciation in the nominal exchange rate and a decline in inflation in Kenya.

These findings are important in designing, managing and implementing monetary policy. However, very little analytical work has been conducted in Botswana despite the relative importance of the topic. Moreover, the high levels of inflation and the continuous changes in the monetary policy framework suggest that more work is needed to understand how monetary policy affects the

economy, with the prospect of improving the conduct of monetary policy in Botswana.

1.1 Historical Background

Botswana attained monetary independence and set up its own Central Bank in 1976, moving away from the Rand Monetary Area. At that stage, the monetary policy was in the context of administered interest rates, credit controls and exchange controls (Masalila and Phetwe, 2001:3). At the time, the objective of the monetary policy was to support the balance of payments, to maintain a liberal foreign exchange regime, and to avoid sharp shifts in aggregate demand (Hermans, 1996:56). The objective of price stability was not explicitly stated, as it was assumed that achieving these objectives would be a means to attain price stability.

As explained by Hermans (1996:56), monetary policy operations focused mainly on influencing credit demand and savings by the use of interest rates as a policy instrument. Interest rates were reduced in order to lower the cost of borrowing, and thus to stimulate investment. An upward adjustment in interest rates was aimed at reducing credit demand and as a means of promoting savings by providing a higher real rate of return to domestic savers (Hermans, 1996:56). Masalila and Phetwe (2001:4) point out that the cost of credit was low in order to promote investment to boost economic growth, and this resulted in the interest rates being low and negative in real terms for most of the period up to 1993 in Botswana.

As pointed out by Setlhare (2004:386), the evolution of Botswana's monetary policy can be categorised in two major regimes. The first category, from 1976 to 1988, is characterised by financial repression, while the second category, from 1988 to the present, is characterised by financial liberalisation. The country experienced a substantial balance of payments surplus in the first half of the 1980s, as a result of a major diamond mine discovery, and this led to excess liquidity in the market. There was more money in the market than required. The monetary system had financial controls (e.g. exchange controls, credit control, interest rate controls among others) and the interest rates were kept low and negative in real terms in order to encourage aggregate demand (Masalila and Phetwe, 2001:4).

The failure of the repressive financial policies began in 1989. The problem of excess liquidity remained unsolved as there were no other monetary policy instruments available at the time to sterilize excess liquidity. The market for loan-able funds remained small and comprised only two commercial banks. This adversely affected the conduct of monetary policy (Setlhare 2004:387).

Therefore, there was a need to improve the conduct of monetary policy towards achieving the national objectives of diversification and sustainable growth.

As outlined in the Bank of Botswana Annual Report (2007:106), the authorities embarked on a financial liberalisation in 1989. Financial liberalisation entailed increasing competition in the banking system, deregulation of interest rates, relaxing and ultimately removing exchange controls, and moving to the use of indirect instruments of monetary policy to sterilize excess liquidity. Furthermore, the Bank of Botswana Annual Report (2007:106) reports that the monetary authorities considered that freeing interest rates would allow their movements to reflect relative scarcity of financial resources, and the market determination of interest rates would be supported by open market operations (OMO) to ensure that the level of interest rates would be consistent with the desired monetary policy stance. The absence of credit and interest rate controls would allow the allocation of credit and its cost to be determined on the basis of market appraisal leading to a more efficient use of financial resources.

The removal of controls also necessitated the reconstruction of the monetary policy framework, by taking a more indirect approach. That is, the monetary authorities used interest rates indirectly to influence inflationary pressures in the economy. The interest rates innovation affected intermediate targets with an aim to change domestic demand conditions. The commercial bank credit growth rate was the most important intermediate target. Credit growth was considered the main contributor to the growth of private consumption and investment, and was important as it was argued to be directly influenced by monetary policy through changes in interest rates (Mohohlo, 2004:2).

The exchange rate policy also changed. Before 1989, the Rand/Pula exchange rate was managed to control imported inflation from South Africa, and also to ensure competitiveness of exports by maintaining a stable real exchange rate (Setlhare, 2004:387). However, in 2005, the crawling peg exchange rate framework was adopted, which focused more on the competitiveness of exports than on controlling for imported inflation. An introduction of the crawling peg exchange rate regime was preceded by devaluation of the Pula in 2004, which was followed by a further devaluation in 2005. The implementation of the crawling peg exchange rate regime was coupled with a series of devaluations of the Pula which led to inflation to peak above the Central Bank's inflation objective range of 3 – 6 percent (Mohohlo, 2008:2).

The inflation objective range, according to the Bank of Botswana Annual Report (2007:107), was introduced in 2002. The monetary policy framework entailed announcing an inflation objective to be achieved over the ensuing year. The inflation objective was set based on forecast inflation for trading-partner countries. Specification of the annual inflation objective also took into account a credible inflation path, the desire to influence inflation expectations, as well as a view to the transmission process of the monetary policy to impact on inflation.

In 2006, the monetary authorities abandoned the annual inflation objective and introduced a three-year medium-term inflation objective of 3–6 percent, which considered a more reasonable horizon over which policy could impact on price developments without unduly jeopardising output growth (Bank of Botswana Annual Report, 2007:107). The Annual Report (2007:107) further states that growth of credit to the private sector, which was used as the intermediate target, was also abandoned considering it was influenced by other factors such as structural changes in the financial sector, greater competition resulting from the introduction of new loan products, the general increase in incomes and the substantial loan amounts associated with substantial investments. This resulted in the introduction of the inflation forecast which was associated with and/or encompassing both demand-side and supply-side factors (Mohohlo, 2008:2).

Thereafter, the monetary policy proceeded to pursue the objective of price stability by aiming to achieve low and sustainable levels of inflation. To achieve this goal, the Central Bank used interest rates and OMO with the aim to influence the demand conditions which would then affect inflation in the economy. This goal contributes to the broader national objective of sustainable economic growth (Mohohlo, 2008:2). The attainment of price stability leads to international competitiveness, which is critical in promoting export products. Productive investment by both local entrepreneurs and foreign investors can be encouraged by low and stable inflation, which in turn encourages financial savings and reduces uncertainty in investment decisions.

In conducting monetary policy, the monetary policy authorities considered that policy changes affect inflation with a lag. Therefore, the Bank introduced a rolling medium-term inflation objective in 2006, which is set at 3 – 6 percent. The purpose of the medium-term objective is to anchor long-term inflation expectations (Mohohlo, 2009:3).

1.3 The Problem Statement or Research Problem

The theoretical IS-LM model explains that the monetary policy is transmitted by changes in the interest rate (Meltzer, 1995:51). According to Meltzer (1995:51), contractionary monetary policy leads to an increase in interest rates, which increases the cost of borrowing, reduces investment and consumption and translates to reduced aggregate demand and, ultimately, the bringing down of inflation. However the case of Botswana reflects a contradictory experience, where tight monetary policy does not decrease inflation. For example, annual inflation in Botswana increased alongside an increase in the Bank Rate, exceeding the Central Bank's inflation objective of 3 – 6 percent. Inflation rose from 6.5 percent in the first quarter of 2005 to 13.7 at the end of the fourth quarter of 2008. While the Bank Rate, which is the short-term policy rate, increased by 25 basis points to 14.5 in the first quarter of 2005, and continued to increase to a peak of 15.5 percent in mid-2008, thereafter, it declined to 15

percent at the end of 2008 (Botswana Financial Statistics, 2008:5). The decline was caused as a response to the world recession, but at this level, the monetary policy still remained tight. Nonetheless, the policy rate increased alongside the inflation rate for three years and yet, by the end of the third year inflation was still significantly above the inflation objective. Hence, inferences can readily be made about the ineffective monetary policy in Botswana. This motivates the main research question: How effective is monetary policy in Botswana?

1.4 Objective of the Study

The general objective of this study is to examine the effectiveness of the monetary policy on inflation in Botswana, as well as to investigate and compare the effectiveness of different transmission channels in Botswana.

This study specifically aims at answering the following questions:

- How does an increase in the Central Bank rate affect the inflation rate in Botswana?
- What is the duration of the effects of the policy rate on economic variables in Botswana, i.e., how long does it take other economic variables (such as money supply, the exchange rate, credit, the real GDP and market interest rates) to stabilise after the monetary policy shock to the economy?

1.5 Rationale

Mishkin (1995:4) argues that monetary policy is a very effective tool in attaining stabilisation, and to be successful in conducting monetary policy, the monetary authorities must have an accurate assessment of the timing and effect of their policies on the economy, as these could have unwanted consequences. He argues that the conduct of monetary policy requires an understanding of the mechanisms by which the monetary policy affects the economy, because the monetary policy does not always produce the desired results, probably due to unanticipated shocks or even policy errors.

However, relatively little empirical work has been done in Botswana despite the fact that it is relevant for the conduct of monetary policy. Kganetsano (2007:244) and Mmopelwa (2004:36) were the first to estimate the VAR models to explain the monetary policy effectiveness in Botswana. They did not explore different channels in which the monetary policy is argued to affect the economy. This current study estimates the baseline model and three other VAR models to explore different channels of transmission mechanism of monetary policy in Botswana, thus adding to the limited existing body of literature in Botswana.

1.6 Organisation of the study

This study is organised into five chapters. Chapter one introduces the study. It provides insight into the historical monetary developments in Botswana and how the conduct of monetary policy was affected. It further explains the research problem and justifies why the study is worth undertaking.

Chapter two focuses on literature related to the study. Relevant literature will provide insights into ways in which a monetary policy can affect the economy, such as the interest rate channel, the credit channel, the exchange rate channel and the asset price channel. It also gives a preview and critical analysis of the studies conducted in Botswana.

Chapter three discusses the methodology suitable to be adopted in this study. The VAR model is considered more suitable in view of its advantages and disadvantages. The chapter also explains and presents the data and the VAR model for Botswana, respectively.

Chapter four presents the diagnostic results of the data, as well as the empirical analysis and results. It presents four different VAR models to explain how monetary policy affects the economy in Botswana.

Chapter five concludes the study and advocates the plausible channel of monetary policy transmission mechanism in Botswana.

Chapter 2

2. Literature Review

2.1 Introduction

This chapter reviews literature on the effect of a monetary policy change in the economy. Different studies on the transmission mechanism of monetary policy were reviewed, and Bernanke and Blinder (1992:901), Taylor (1995:2), Mishkin (1995:4), Meltzer (1995:51), Smal and De Jager (2001:6), Mies and Tapia (2003:2), and Lopez (2008:67) among others, share a common theoretical explanation on how the economy responds to changes in monetary policy. The basic assumption as stated by Mohohlo (2009:19) is that “an increase in the policy interest rate results in an increase in other market interest rates and adjustment of the exchange rate, to the extent it is flexible. These developments change the real monetary conditions and, consequently, the desire for borrowing, which affects aggregate demand. The response of firms to lower demand determines the margin of the output gap and inflation”. This study assumes that this basic assumption holds.

The theoretical literature offers different explanations on how monetary policy affects the economy. This provides insight into the relationships between economic variables, challenges faced and possible solutions when determining these relationships. In this chapter, section 2.2 deals with the theoretical consideration relating to the study. A brief overview is given of the seminal IS-LM contribution by Hicks (1937), and the various channels through which monetary policy is transmitted. Section 2.3 provides a review of channels of monetary policy transmission mechanism. This provides insight into the mechanisms of the effects of monetary policy.

2.2 Theoretical Foundation

The main interest of this research is to find out the effectiveness of the policy interest rate in affecting inflation. The term effectiveness is associated with the magnitude and direction of the impact of the policy interest rate on inflation, as well as the duration of the effect of the short-run interest rates in the economy (Mies and Tapia, 2003:2). In this context, the monetary policy will be effective if inflation responds to changes in the short-run interest rate in the direction predicted by economic theory, as will be discussed below.

According to Meltzer (1995:51), the IS-LM model introduced by Hicks (1937) is a strong pillar to explain how monetary policy is transmitted in the economy.

For this reason, it is important to discuss the model in this section to provide a theoretical framework of how monetary policy affects the economy.

2.2.1 The IS-LM Model

Mankiw (2002:267) explains the IS-LM model as an interaction of the IS curve and the LM curve. The interaction represents the simultaneous equilibrium in the goods markets and in the money market for given values of government spending, taxes, money supply and the price level (Mankiw, 2002:277). The IS curve reflects the equilibrium in the goods markets and the LM shows the equilibrium in the money market. The interaction of the IS curve and the LM curve shows the combination of the level of the interest rate and the output that satisfy the equilibrium in both markets.

The IS-LM model relates money and interest rates to economic output by combining the elements of the Keynesian cross and those of the theory of liquidity preference (Mankiw, 2002:267). In this instance, the Keynesian cross shows how consumer and government spending determine the economy's output (Mankiw, 2002:267). For example, output levels are determined by the response of investment to changes in interest rates in that high interest rates reduce investment which in turn results in lower output levels (Mankiw, 2002:267).

The liquidity preference on the other hand explains how interest rates affect the supply and demand for money (Mankiw, 2002:271). Mankiw (2002:273) argues that money supply is not determined by interest rates, rather that higher interest rates make the cost of holding money more expensive and hence reduce the demand for money.

Meltzer (1995:51) also holds the same view as Mankiw (2002:277) that the IS-LM model relates money and interest rates to aggregate income. He explains that the IS-LM model suggests that the transmission of monetary policy occurs through changes in the interest rates. Indeed, Meltzer (1995:51) explains that monetary contractions lead to an increase in interest rates, which results in an increase in the cost of borrowing. This, in turn, will lead to a reduction in investment and consumption of capital goods and consumer durables, resulting in a decline in aggregate spending or aggregate demand (Meltzer, 1995:51).

2.3 Channels of Monetary Policy Transmission Mechanism.

Mishkin (1995:2), Meltzer (1995:2), Mias and Tapia (2003:4), among others, have used macroeconomic theories to categorise the mechanisms through which

monetary policy can affect the economy. They indicate that monetary policy can affect the economy via the interest rate channel, the credit channel, the exchange rate channel and the asset prices channel. These channels explain, theoretically, how monetary policy affects aggregate demand and inflation. The relevance and importance of these channels are different in various countries due to the level of development of the financial markets, the structure of the economy and the particular macroeconomic environment of the country (Dabla-Norris and Floerkemeier, 2006:5).

2.3.1 The Interest Rate Channel

In explaining the interest rate channel, Mishkin (1995:4) indicates that in order to control inflation, monetary policy is transmitted through real interest rates. He points out that a tight monetary policy will lead to an increase in real interest rates. Rising real interest rates will increase the cost of capital. This, in turn, will decrease the level of investment and consumption spending. Consequently, aggregate demand and inflation will decline.

Mies and Tapia (2003:4) argue along similar lines about the interest rate channel. They explain that a tight monetary policy will increase nominal interest rates. Then, the increasing nominal interest rates will translate to rising real interest rates due to stickiness or imperfection in adjustment mechanisms in the economy. They also indicate that the cost of capital will then increase, resulting in a decrease in the level of investment and consumption, which in turn will reduce output, with inflation declining as a result.

Kganetsano (2007:67) points out another route in which an increase in real interest rate can affect the economy. He explains that a high real interest rate encourages savings. This implies that consumers will prefer to save their money rather than spend it, which will result in low aggregate demand, and ultimately in a decrease in inflation.

Empirically, the operation of this interest rate channel was established in both developed and developing countries. For example, studies by Bhuiyan (2008:14) in Canada and Smal and De Jager (2001:7) in South Africa found similar results in which monetary policy influences other market interest rates. They also found that output and inflation decreased as the cost of borrowing rose.

However, Hung and Pfau (2008:8) investigated the transmission mechanism of the monetary policy in Vietnam. They found that this channel was not active in a country where interest rates were not liberalised. They argue that the interest rates in such a setup are independent of what happens in the money market. In this context, high interest rates have no effect on economic activity and inflation.

Since Botswana experienced financial liberalisation in the late 1980's, it can be expected that this channel should be active.

2.3.2 The Exchange Rate Channel

The concept of interest rate parity explains the relationship between interest rates and exchange rates in two different countries (Redeckaite and Sokolovska, 2004:2). According to Redeckaite and Sokolovska (2004:2) the concept of interest rate parity assumes that “the spread in yields of two countries should be compensated for by the currencies’ movements so that no excess returns are possible”. That is, the domestic rate of return on bonds must equal the rate of return on foreign bonds plus the expected rate of depreciation or appreciation of the exchange rate. Therefore, adjustment to the exchange rate will be via the interest rate parity condition.

Taylor (1995:15) explains that interest rate parity is a necessary condition for the exchange rate channel to operate. The author argues that capital will flow to a country with higher returns until the expected returns are equalised between countries, if the interest rate parity does not hold. For example, Mishkin (1995:5) points out that a monetary policy tightening will lead to an increase in other market interest rates and the domestic financial assets will be more attractive than foreign currency denominated assets. This will lead to domestic capital inflow which will exert upward pressures on the domestic currency. The domestic currency will appreciate as a result, owing to the interest rate parity condition (Mishkin, 1995:5). This will result in relatively more expensive exports, which should decline relative to imports. Consequently, output will decrease together with inflation.

Goeltom (2008:315) asserts that the relative strength in the exchange rate channel depends on the type of exchange rate regime a country adopts. He explains that the exchange rate channel will be stronger in a country with a flexible exchange rate regime rather than in one with a fixed or

managed exchange rate regime, because under a fixed exchange rate regime, movements in the exchange rate are limited and, as such, will produce little effect on inflation and output and with a longer time lag (Goeltom, 2008:315).

The findings by Al-Mashat and Billmeier (2007:29) support Goeltom (2008:315). They investigated the monetary policy effectiveness in Egypt, by using the fixed exchange rate and the flexible exchange rate systems. Their results show that effects of the monetary policy when using a fixed exchange rate were much smaller than under a flexible exchange rate regime, although the monetary policies are similar. Therefore, since Botswana is using a crawling peg exchange rate arrangement, one would expect monetary policy to be less effective through this channel.

2.3.3 The Asset Prices Channel

One of the weaknesses of the IS-LM model is that it considers interest rates as the only asset prices; i.e., the price of money (Mishkin 1995:5). Kganetsano (2004:71) points out that an attempt to improve on this weakness leads to consideration of other assets prices like the equity prices. He indicates that the monetarist view emphasises two routes by which the monetary policy can affect the economy through asset prices. These are the Tobin q route and the effects on wealth route.

The Tobin q theory describes how the monetary policy affects the economy through equity prices. The Tobin q theory focuses on how firms make investment decisions in the stock market (Dornbusch and Fisher, 1994:341). Dornbusch *et al* (2001: 334) defines the q-ratio as a ratio of the market value of firms to the replacement cost of capital, pointing out that a higher q-ratio means that the market value of a firm is higher than its replacement cost of capital. That is, new plant and equipment will be cheaper than the market value of business firms. As such, firms will respond by issuing equity to buy more investment goods and investment spending will rise. In response to rising investment, output will increase, exerting upward pressures on inflation.

In an effort to explain the process of how the monetary policy affects the economy through equity prices, Mishkin (1995:6) argues that a monetary policy tightening reduces money supply in order to affect equity prices. For example, a contractionary monetary policy reduces money supply

which will reduce money holdings of the public. The public will channel their income towards the stock market, with the purpose to generate more money. This will reduce the demand for equities and lower their prices. Lower equity prices will lead to a lower q-ratio, leading to reduced investment and hence lower levels of output and aggregate demand.

The other way in which a monetary policy is transmitted via equity prices is through the wealth effects on consumption. Mishkin (1995:6) points out that consumption depends on the resources of consumers, among which is financial wealth. He adds that common stocks are the largest constituents of financial wealth, and a contractionary monetary policy will decrease stock prices, thereby reducing the value of financial wealth. Consequently, the resources of consumers will fall, which will lead to a decrease in consumption.

Mies and Tapia (2003:7) arrive at a similar conclusion, that rising policy interest rates will have a negative effect on stock prices. They argue that the wealth effect is distributed between consumption and investment decisions. They explain that as stock prices decline, the demand for equities will also fall, leading to a decrease in equity prices. This will result in the market capitalization of firms declining, resulting in the firm balance sheets deteriorating. The firms will lose their credit worthiness and investment will be reduced, resulting in low output and inflation.

Evidence of this channel has been established mainly in countries where the financial markets are well developed. As explained by Al-Mashat and Billmeier (2007:31), the assessment of this channel will need a good measure of asset prices. Therefore, due to the lack of good quality data and a less developed financial system in Botswana, this channel will not be analysed.

2.3.4 The Credit Channel

Smal and De Jager (2001:9) indicate that “asymmetric information and costly enforcement of contracts create agency problems in financial markets”. Mishkin (1995:7) points out that owing to the agency problems, an attempt to explain the monetary policy transmission gave rise to the bank lending channel and the bank balance sheet channel. These two are collectively known as the credit channel, and they are put

forward to help in explaining how a monetary policy shock can influence inflation (Bernanke and Gertler, 1995:34).

2.3.4.1 The Balance Sheet Channel

The balance sheet channel is based on the assumption that the interest rate charged to a borrower depends on the borrower's financial position (Bernanke and Gertler, 1995:35). That is, a borrower will be charged less interest rate premium if s/he has more liquid assets and profitable security to use as collateral. A change in the borrower's financial position affects the quality of the borrower's balance sheet. This is assumed to have an effect on the borrower's investment and spending decision (Bernanke and Gertler, 1995:35). For example, high interest rates reduce the prices of financial assets which will weaken the value of the borrower's collateral. This in turn, will lower the financial position of the borrower which will mean higher interest rate premium should be charged, which increases the costs of borrowing. Higher costs of borrowing will discourage investment, and thus aggregate demand and inflation will decline (Bernanke and Gertler, 1995:35).

Bernanke and Gertler (1995:36) indicate that a monetary policy innovation can affect the balance sheet directly and indirectly. They argue that in the event a borrower has existing debt, a contractionary monetary policy will directly increase interest expenses. This will lower the net cash flows of the borrower, thus reducing the borrower's spending patterns. Aggregate demand will decline leading to low inflation.

Indirectly, a contractionary monetary policy makes it expensive for consumers to purchase goods on credit. This happens because an increase in the policy rate is transmitted to other market interest rates, which will also increase the cost of loan-able funds. As a result, the incentive to invest is reduced, curtailing the levels of investment. Output growth will decline, dampening inflation (Bernanke and Gertler, 1995:35).

2.3.4.2 The Bank lending channel

Goeltom (2008:325) reflects that banks are major players in transmitting monetary policy effects in this channel. This is

because monetary policy effectiveness depends on the ability of the central bank to influence the loan supply by banks. Changes in the supply of bank loans will in turn affect economic activity.

Brooks (2007:3) concurs with Goeltom (2008:325) that the bank lending channel operates by influencing the loan supply by banks. They point out that this is done through a contractionary monetary policy which results in a decline in bank reserves and, ultimately, bank deposits. Since the ability of the banks to increase the deposits is constrained by the reserve requirements, the deposits will decline. Goeltom (2008:326) further explains that if the deposits are not replaced by any funds which are not affected by the reserve requirements, the loans will decline. This will adversely affect economic activity and inflation will also decrease.

In addition, Goeltom (2008:325) explains that with a contractionary monetary policy, real money balances fall due to sticky prices, leading to a rise in both short-term and long-term rates. Consequently, the demand for loans and investment will decline due to increased interest rates with a dampening effect on both output growth and inflation.

Empirical evidence from Hung and Pfau (2008:12) and Al-Mashat and Billmeier (2007:32) suggest that domestic credit should be used to analyse the credit channel. They base this on the assumption that the policy rate will affect the credit that banks supply to influence aggregate demand and inflation. Al-Mashat and Billmeier (2007:32) found that domestic credit expanded significantly following the ease of a monetary policy, while output and inflation increased.

In the case of Vietnam, Hung and Pfau (2008:12) conclude that credit does not affect output and inflation. However, they argue that the weak response of output and inflation to credit is because credit has been used to control liquidity and thus does not reflect the true level of demand in the economy. In Botswana, since credit developments can reflect the demand conditions in the economy, one would expect output and inflation to respond to changes in credit.

2.4 Challenges When Estimating the Monetary Policy Transmission Mechanism

A number of challenges face researchers when they estimate the transmission mechanism of monetary policy. Mies and Tapia (2003:12) identify one of the challenges as the unstable relationships among economic variables, which may be a consequence of various world recessions (such as the 2008 financial crisis) or domestic structural breaks, which could affect the process of the monetary policy transmission mechanism or even lead to a misinterpretation of the monetary policy effectiveness in any country. They suggest the use of dummy variables to address the problem of structural breaks which helps to avoid misleading reactionary functions.

The other challenge faced by researchers, especially in less developed countries, is the unavailability of, or poor quality of data (Hung and Pfau, 2008:8). For example, Hung and Pfau (2008:8) investigated the monetary policy transmission mechanism in Vietnam, but failed to analyse the asset prices channel on account of the underdeveloped nature of financial markets, hence low data quality. Moreover, Taylor (1995:12) points out that data quality changes due to changes in technology and regulation over years. He argues this will introduce inconsistencies which could lead to misinterpretation of the monetary policy transmission. For example, Taylor (1995:12) points out the unreliability of money supply and credit (M1 and the M2) which have shifted in terms of definition and measurement due to the changes in technology and regulation over the years.

2.5 Evidence from Botswana

Kganetsano (2007:126) estimated the channels of the monetary policy by using two different approaches, the narrative approach and the econometric construct approach where he adopted VAR models and a small structural model for a developing country. He estimated the monetary policy transmission mechanism by using two VAR models, the basic VAR model and the extended VAR model.

The basic VAR model includes output, inflation, money supply and the policy rate in this order. In the basic VAR model, output was found to respond to increases in the interest rates after two quarters. It decreased as predicted by economic theory and reached its minimum point after four quarters, thereafter it increased to reach its maximum after six quarters. Kganetsano (2007:160) found that inflation increased as a result of an increase in policy interest rates reaching its maximum after six quarters. He observes that this response of inflation to interest rates contradicts economic theory and presents a phenomenon known as

the price puzzle. He explains that a price puzzle is a situation where inflation increases as a response to increasing interest rates rather than to decreasing interest rates as predicted by economic theory.

The second VAR model is the extended VAR model, which includes output, inflation and private sector credit, as well as the policy rate. In this model, he replaced money supply with private sector credit to represent the Botswana monetary policy framework. He found that an increase in interest rates resulted in a decline in inflation for three quarters, which began to increase thereafter (Kganetsano, 2007:164), while domestic credit on the other hand increased, and remained above steady state for about 11 months. He argues that the continued increase in credit resulted in the short-lived effect of interest rates on inflation. In addition, a policy interest rate shock resulted in an increase in real income, and started to decline after three quarters to reach its minimum after six quarters. Kganetsano (2007:170) argues that the contradicting movements by credit following the policy interest rate shock could be explained by more than just consumers and firms borrowing more to sustain consumption and investment at the pre-policy-shock levels. He concludes that more factors affecting credit than policy-related shocks in the economy are likely.

Moreover, he indicates that his results are generally not statistically significant. He interprets the insignificant results as implying that the responses of other economic variables to a monetary policy shock are invalid. This leads to his conclusion that monetary policy has little or no effect in the economy of Botswana.

By using the narrative approach, Kganetsano (2007:135) argues that a positive innovation in interest rates leads to a decrease in money supply, signifying that the interest rate channel is effective. He further points out that credit decreased initially for the first two months and increased thereafter. In some episodes he indicates that credit did not respond to policy interest rates at all. In view of this behaviour of credit, he concludes that the credit channel is inefficient.

In explaining the behaviour of the exchange rate to rising interest rates, Kganetsano (2007:135) argues that the exchange rate by depreciating posed an exchange rate puzzle. He argues that the puzzle is a result of the anticipated minor influence of the monetary policy on a fixed or managed exchange rate. He further adds that this is coupled with undeveloped financial markets in Botswana which offer few financial instruments to foreign investors who would take advantage of high interest rates.

The last model by Kganetsano (2007:178) was a small structural model for Botswana using data covering the period from 1974 to 2004. He found factors that could impede the effectiveness of monetary policy such as devaluation (which is beyond the control of monetary policy authorities) which reduces domestic supply and results in an increased import bill which is inflationary. This observation could suggest that external factors might explain the price puzzle in the VAR models and the exchange rate puzzle indicated in the narrative approach.

Mmopelwa (2004:47) also estimated the transmission mechanism of the monetary policy in Botswana by using data from 1993 quarter three to 2002 quarter two. The study used a structural VAR model, but did not clearly investigate the different monetary policy transmission channels as depicted by economic theory. The author only used one standard VAR model including like real GDP, the domestic consumer price index, the real domestic interest rate, the real exchange rate (Rand per Pula) monetary aggregates, South African interest rates and the international oil price). Mmopelwa's (2004: 47) results reflect that the impulse response function is not statistically significant either. Following on Kganetsano's (2007:164) explanation, these results reflect that the monetary policy is not effective in Botswana.

Nonetheless, Mmopelwa (2007:47) found that real output did not respond to the monetary policy innovations. This response was also observed by Mokoti (2009:48), and he explains that the response was expected, given the heavy dependence on exports and hence that the total real GDP should be treated as exogenous.

Consistent with Kganetsano's (2007:160) findings, Mmopelwa (2007:47) also established the existence of the price puzzle in the context of Botswana data and explains that the price puzzle could be the result of the supply-side response, with the effect dampened later by a decline in aggregate demand which would subsequently reduce inflation. Against this background, the author argues that the monetary policy in Botswana is effective.

Even though Mokoti (2009:48) was estimating the sacrifice ratio (that is, how much economic growth is forgone while reducing inflation) for Botswana, he presents the results which are consistent with those of Kganetsano (2007:164) and Mmopelwa. Mokoti (2009:48) found that a monetary policy contraction led to an increase in inflation, a price puzzle that has already been observed by the other two authors. He supports Mmopelwa's (2004:47) argument that an

increase in inflation is due to an increase in the production costs in the economy, which are caused by the increase in financing as the real interest rates increase, and therefore, the price puzzle should not be a puzzle but an expected response from inflation.

2.6 Conclusion

The aim of this chapter was to provide insight into the discussion on the ways in which the effects of a monetary policy are transmitted in the economy. The review of economic theory indicates that a monetary policy affects inflation via different channels, including the interest rate channel, the credit channel, the asset prices channel and the exchange rate channel. Basically, in all channels, the policy interest rates affect inflation indirectly through the demand for investment and consumption and their impact on aggregate demand. By means of the changes in these demand conditions, inflation will respond to changes in the policy interest rates.

Overwhelming evidence points to statistically insignificant results from the impulse responses, which suggest that there could be a problem with Botswana data. In addition, the price puzzle emerges in all the reviewed studies in Botswana, even though there is no consensus on the cause of the puzzle.

These arguments result in inconclusive inferences about the effectiveness of the monetary policy in Botswana. For example, the insignificant impulses are interpreted to indicate that the monetary policy is not effective, but some economic variables respond according to theoretical predictions, implying that the monetary policy in Botswana has an effect on the real economy.

Evidence from Botswana is limited as there is no study which adopted the econometric constructs which clearly explain the different transmission channels of the monetary policy in Botswana as they appear in theoretical literature. As this section reveals, the monetary policy transmission mechanism differs in different countries due to factors which are country specific and pose challenges in analysing the monetary policy transmission, such as among others the lack of good quality data, structural breaks in the economy and underdeveloped financial markets. This is a gap that this thesis attempts to fill.

The next chapter proposes the relevant methodology adopted for this study.

Chapter 3

3. Methodology and Data

3.1 Introduction

This section presents a thorough discussion of the methodology employed in the study. The aim is to justify the study's adoption of the VAR analysis as opposed to the other economic models, by providing the advantages and disadvantages of the VAR approach.

Time series models (VARs included), linear regression models or the multi-equation (structural) models are the econometric techniques most often used to investigate the effectiveness of a monetary policy (Kalinasuskas, 2009:145). According to Bernanke and Mihov (1998:869), the structural models and the VAR approach are the most commonly used methods to analyse the effectiveness and the transmission of the monetary policy.

Amarasekara (2006:5) notes that VARs were pioneered by Sims (1980) to estimate how a monetary policy is transmitted in the economy. He explains that VARs are a system of simultaneous equations which are suitable for describing a data-generating process of a set of time series variables. In addition, Bernanke and Gertler (1995:30) define a VAR model as "a system of ordinary least squares regressions in which each of a set of variables is regressed on lagged values of both itself and other variables in the set".

In other words, VARs treat all variables as endogenous and are therefore particularly useful to identify the impact of policy actions on target variables. It is also useful in that all lagged variables are included in the analysis, making it suitable for impulse studies. Moreover, few constraints are imposed on the models. However, the strengths of VARs are also their weakness in that the effects of omitted variables will be in the residuals. It may contribute to the difficulty of giving an economic interpretation to the results, due to the lack of 'structure' (economic theory). Nonetheless, the next section more fully discusses the characteristics of a VAR.

3.2 The Structural Model versus the VAR Approach

VAR models have received most attention because of their flexibility and suitability with regard to data restriction such as poor quality of data (Bernanke and Mihov, 1998:870). The structural models, on the other hand, are faced with a number of challenges, especially pertaining to problems associated with developing countries. For example, developing countries are faced with problems like underdeveloped markets, lack of data with meaningful links or

clear distinction between the endogenous and exogenous variables (Bernanke and Mihov, 1998:870).

Tsangarides (2010:3) and Peng and Yang (2008:478) also support the use of VARs over structural models to investigate the monetary policy transmission. They point out that the presence of structural breaks will complicate the use of structural models, as these run the risk of ignoring those structural breaks. As explained by Mies and Tapia (2003:12), these structural breaks can appear in the form of economic recession or drastic changes in economic policies. The use of structural models will lead to possibly misleading results, especially in a country like Botswana where a series of structural breaks have occurred.

Moreover, VAR models have the advantage of being able to embody the interaction between the conduct of the monetary policy and the economy (Amarasekara, 2006:5). They are posited to be suitable for use in a small or modest set of time series variables, which might reflect the sole interest of the monetary authorities about the way monetary policy influences the economy. For example, unlike structural models, VARs can clearly distinguish the simultaneous effects of an increase in the short-term interest rate and changes in other economic variables (like output, inflation, exchange rates, etc.) in a small and modest set of time series data (Tsangarides, 2010:3).

Kalinasuska (2009:145) states that structural models are designed according to economic theory where the elimination restriction is applied. The elimination restriction drops economic variables which do not conform to economic theory, irrespective of whether they are statistically significant or not. He argues that this elimination restriction is the major disadvantage of structural models, because dropping the variables based on theoretical explanations compromises the accuracy of estimates. Consequently, VAR models have a greater advantage over structural models as all variables are endogenous and will not be dropped when the relationship between variables is explained.

As indicated by Del-Negro and Schorfheide (2007:3), VAR models stand a better chance to avoid the misspecification problem than structural models. They point out that the structural models have a potential of imposing invalid restrictions on variables which they seek to explain in complying with economic theory which might be invalid in that specific country, unlike VARs which are “estimated with a well-calibrated shrinkage methods”.

Like other economic models, VAR models also have short-comings. For example, VAR models are criticised for not offering information about the

underlying structure of the economy but rather for concentrating on the inter-relationships of economic variables (Cimadomo, 2002:5). However, Amarasekara (2006:5) indicates that this should not be a problem since VARs are applied to analyse the relationships between variables and not to explain the structure of the economy.

Moreover, as Cimadomo (2002:5) observes, VARs have been criticised to be one-sector specific when determining the shocks which affect the economy, rather than considering the shocks that affect the whole economy. He explains that the heterogeneity problem is primarily caused by considering different sectors to determine economic shocks, because vectors of policy shocks vary across sectors (Cimadomo, 2002:5). Therefore, one can conclude that being one-sector specific reduces the heterogeneity problem.

In summary, VARs have been argued to be more advantageous to adopt as they provide a useful tool for analysing the effects of a monetary policy, especially in conditions where there are data problems, macroeconomic instability, and significant structural changes. For this reason, VARs are considered to be appropriate in analysing the monetary policy transmission mechanism in developing countries, of which Botswana is no exception.

3.3 Types of VARs

Stock and Watson (2001:101) describe three types of VAR models as the reduced form VAR, the recursive VAR and the structural VAR. They explain that the reduced form VAR “expresses each variable as a linear function of its own past, the past values of all other variables being considered and a serially uncorrelated error term”. A recursive VAR model also presents “a variable in terms of its lagged values and lagged values of other variables in the system, but it imposes restrictions so that the error term in each regression equation is not correlated with the error term in the past equation within the system”. In this respect, Amasekara (2006:5) points out that the restrictions are imposed by using arbitrary mechanical methods. For example, in a recursive system, variables can be ordered in the model starting with the most endogenous. The structural VAR model, on the other hand, imposes restrictions based on economic theory to identify the simultaneous links between variables. As noted by Tangarides (2010:36), recursive VARs impose restrictions to avoid having a contemporaneous effect between the variables concerned, while structural VARs relax this restriction but impose restrictions according to economic theory.

The structural VAR model uses economic theory to identify the relationships between variables, although Frohn (1992:2) perceives this as a downfall of the structural VARs, because variables that monetary authorities may consider important may be excluded in this model as advocated by the elimination restriction. As such, the model would have imposed the wrong restrictions to represent the reality of the economy, which puts structural models at a high risk of producing irrelevant results.

In the view of Morsink and Bayoumi (1999:5) the definition of a standard VAR implies that errors are correlated by nature. Therefore, they point out, the recursive VARs are important to use as they focus on isolating the errors by using statistical techniques to avoid having a contemporaneous effect among variables. They further indicate that restrictions in a recursive VAR can be imposed following the developments of the economy in reality, rather than by merely basing them on economic theory which may not hold for a particular country. For these reasons, it is tempting to use the recursive VAR in order to analyse the monetary policy transmission mechanism in an economy where most economic theories will not hold due to the undeveloped status of the economy. Botswana is such an economy, where the financial market is small and underdeveloped with few financial assets which would make some economic theories invalid (Kganetsano 2007:166). Therefore, the recursive VAR is viewed as an appropriate approach to adopt in analysing the monetary policy transmission mechanism in Botswana.

3.4 Theoretical Specification of the Recursive VAR Model

In a case where a VAR model involves two variables; Y_t the non-policy variable and X_t the policy variable, Enders (2004:264) suggests that a VAR model can be specified as the following primitive system;

$$Y_t = b_{10} - b_{12}X_t + \gamma_{11}Y_{t-1} + \gamma_{12}X_{t-1} + \varepsilon_{1t} \tag{1}$$

$$X_t = b_{20} - b_{21}Y_t + \gamma_{21}Y_{t-1} + \gamma_{22}X_{t-1} + \varepsilon_{2t}$$

where b_{10} and b_{20} are the intercept coefficients, and b_{12} , b_{21} and γ 's are the autoregressor coefficients (Enders 2004:217). This system can be represented in matrix form as follows:

$$\begin{pmatrix} 1 & b_{12} \\ b_{21} & 1 \end{pmatrix} \begin{pmatrix} Y_t \\ X_t \end{pmatrix} = \begin{pmatrix} b_{10} \\ b_{20} \end{pmatrix} + \begin{pmatrix} \gamma_{11} & \gamma_{12} \\ \gamma_{21} & \gamma_{22} \end{pmatrix} \begin{pmatrix} Y_{t-1} \\ X_{t-1} \end{pmatrix} + \begin{pmatrix} \varepsilon_{1t} \\ \varepsilon_{2t} \end{pmatrix} \quad (2)$$

The model makes three assumptions: (1) both Y_t and X_t are stationary; (2) errors ε_{1t} and ε_{2t} are white noise disturbances with standard deviation δ_y and δ_x , respectively; (3) errors ε_{1t} and ε_{2t} are uncorrelated white noise disturbances.

Enders (2004:264) points out that this kind of system has a feedback because Y_t and X_t are permitted to influence one another. For example, $-b_{12}$ is the contemporaneous effect of a unit change of X_t on Y_t , and γ_{12} is the effect of a unit change in X_{t-1} on Y_t . The error terms ε_{1t} and ε_{2t} are the innovations (shocks) on Y_t and X_t respectively. Enders (2004:264) further points out that ε_{2t} has an indirect contemporaneous effect on Y_t , if $-b_{12}$ is not equal to zero and ε_{1t} has an indirect effect on X_t if $-b_{12}$ is not equal to zero. This results in the error term ε_{1t} to be correlated with X_t , and Y_t to be correlated with the error term ε_{2t} . This violates the estimation technique assumption which requires that the regressors should be uncorrelated.

One way to eliminate the feedback in this VAR system is to convert the system to a recursive VAR model by imposing restrictions (Enders, 2004:271). Tsangarides (2010:10) indicates that “the recursive ordering assumes that the first variable responds only to its own shock, the second variable reacts to the first variable plus a shock to the second variable and if the system has more than two variables, then the last variable reacts to all shocks without delay, but disturbance to the last variables have no contemporaneous effect on other variables”. To achieve the recursive ordering requires that one of the feedback coefficients b_{21} should be silenced or forced to equal zero (Enders, 2004:271). Therefore, $b_{21} = 0$ will result in a system taking the following form:

$$Y_t = b_{10} - b_{12}X_t + \gamma_{11}Y_{t-1} + \gamma_{12}X_{t-1} + \varepsilon_{1t} \quad (3)$$

$$X_t = b_{20} + \gamma_{21}Y_{t-1} + \gamma_{22}X_{t-1} + \varepsilon_{2t}$$

where the relationship between the pure shocks ε_t and the regression residuals e_t will be given by

$$\begin{aligned} e_{1t} &= \varepsilon_{1t} - b_{12}\varepsilon_{2t} \\ e_{2t} &= \varepsilon_{2t} \end{aligned} \tag{4}$$

where e_{1t} and e_{2t} are the regression residuals from the Y_t equation and the X_t equation respectively.

Therefore, in this system, it can be interpreted that X_t has a contemporaneous effect on Y_t , but Y_t affects X_t with a one period lag. That is, both ε_{1t} and ε_{2t} shocks affect the contemporaneous value of Y_t , but only ε_{2t} shock affects the contemporaneous value of X_t .

3.5 Impulse Responses and Variance Decomposition

Amarasekara (2006:6) points out that the results of a VAR are analysed by using the impulse responses as they can map out different pathways of various shocks contained in a VAR system. The impulse responses are achieved by expressing variables in the model in terms of the shocks (Kganetsano, 2007:156). The impulse response function can be used to show how variables (Y_t and X_t) respond to various shocks. However, Enders (2004:277) indicates that even though impulse responses are estimated using coefficients which are estimated imprecisely, they are constructed with confidence intervals which control parameter uncertainty inherent in the model (Enders, 2004:277). This implies that the impulse response function is a reliable estimator. Against these reasons, this study will analyse the recursive VAR by using the impulse response function as argued by Amarasekara (2006:6).

Variance decomposition on the other hand helps to explain the importance of each shock in the system (Enders, 2004:278). For example, it was discussed in the previous subsection that inflation can be influenced by its own shock and by shocks from other variables. Therefore, variance decomposition determines by how much each shock contributes to variation in the inflation.

3.6 Time Series Characteristics of the Data

3.6.1 Unit Root Test

Gujarati (2004:797) defines a time series data set as “a set of observations on the values that a variable takes at different times”. He further explains that such a series is problematic to researchers because its mean and variance tend to vary over time. A time series data set is stationary on a given variable if its variance and mean are constant over time. In contrast, Gujarati (2004:797) points out that a non-stationary time series variable has a variance that increases infinitely and has a time dependent mean. Time series data are generally assumed to be stationary, but due to structural breaks in the economy over the years, the series may become non-stationary. A non-stationary time series data set may lead to spurious regression (Gujarati, 2004:797). For example, non-stationary variables which are not related will appear to be moving together with the passage of time showing that they are related. A stationary series has a positive variance and has a tendency to return to its mean value with time. Moreover, Mokoti (2009:34) observes that a shock to a non-stationary times series variable will not die out with time, while a shock to a stationary time series variable will die out rapidly. The following time series model illustrates a non-stationary time series:

$$X_t = \gamma X_{t-1} + e_t$$

According to Gujarati (2003:797), if $\gamma=1$, the model has a unit root problem, that is, a situation of non-stationarity. The suggested solution to this problem of a non-stationary time series variable is to difference the series to make it stationary. He contends that the term non-stationarity, random walk, and unit root can be treated as synonymous.

Using stationary time series data set will produce more reliable results rather than using non-stationary time series data (Mokoti, 2009:34). For example, a VAR model estimated with non-stationary time series data will result in an unstable VAR, which will result in large impulse response standard errors with variance decomposition outcomes that are invalid (Kganetsano 2007:160). Therefore, it is crucial in this study to check all the time series data used for stationarity.

One of the methods to test for stationary is the Augmented Dickey Fuller (ADF) Test (Gujarati, 2003:817). The ADF Test builds on the Dickey-Fuller (DF) Test, which involves the estimation of the following equation:

$$\Delta X_t = \alpha_0 + \beta_t + \gamma X_{t-1} + e_t \quad (6)$$

The Dickey-Fuller test uses the t-statistic from OLS to test the null hypothesis that the γ coefficient is equal to zero. This equation can be transformed into Augmented Dickey-Fuller Test (ADF) by introducing additional lags to obtain:

$$\Delta X_t = \alpha_0 + \beta_t + \gamma X_{t-1} + \sum \phi_t \Delta X_{t-1} + e_t \quad (7)$$

Therefore, we adopt the ADF test because it is appropriate as the VAR model will include more than one-lagged variable. The ADF equation assumes that variable X is stationary if γ is negative and significantly different from zero.

This test can be conducted in E-views, where the ADF Test statistics are evaluated against the t-ratios or against the Mackinnon critical values. The decision rule is made against the null hypothesis that the series has a unit root over against the alternative hypothesis that the series has no unit root. (Mokoti, 2009:36). The decision will be to reject the null hypothesis if the ADF Test statistic exceeds the critical value at the 5 percent significance level.

3.6.2 Lag Length Determination

According to Enders (2004:69), models using lagged variables lose observations. He explains that additional lags increase the coefficients estimated which are associated with a loss of degrees of freedom, where the degrees of freedom mean the total number of observations less the number of independent restrictions put on them (Gujarati 2003:77). He points out that this will affect the performance of the model. Therefore, the aim of selecting a lag length is to identify the best-fitting model.

Moreover, Lada and Wojcik (2007:3) indicate that five available tests can be used to determine the most appropriate lags in a VAR model. These are Swartz Information Criterion (SC), the Akaike Information Criterion (AIC), Sequential Modified LR test statistic (LR), Final Prediction Error (FPE) and Hannan-Quinn (HQ) Information Criterion. The authors argue that concentrating only on the SC and the AIC may be problematic because the criteria may not agree on the optimal lag length. In addition, they point out that the lag length mostly suggested by these five approaches should be selected as the appropriate lag length for the VAR model. However, if out of the five approaches, one approach selects one lag, two select 4 lags, and the last two select 8 lags, the suggested lags to be included will be from a minimum of one lag to a maximum of 8 lags. Therefore, a model will be run with all 8 different lags and the one with the smallest values of the SC or AIC will be the best model to fit the data (Enders, 2004:69). Gujarati (2003:536) indicates that the SC and the AIC are the most preferred because they impose a penalty if a large number of regressors are included to make the model perform better. These two approaches use the following formulas:

$$AIC = \ln|\Sigma| + \frac{2pk^2}{T-p} \quad \text{and} \quad SIC = \ln|\Sigma| + \frac{pk^2 \ln(T-p)}{T-p} \quad (10)$$

where

Σ is the residual variance-covariance matrix

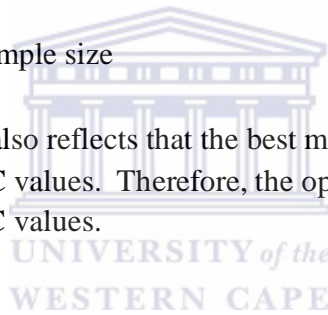
k is the number of variables

p is the lag length

pk^2 is the number of parameters

T is the sample size

Enders (2004:69) also reflects that the best model will be the one with the smallest AIC or SC values. Therefore, the optimal lag length will result in the smallest SC or AIC values.



3.6.3 Diagnostic Tests

Non-stationary variables and inappropriate lag length can affect the stability of the model, and a non-stable VAR will result in wrong results. Therefore, a VAR model should be tested for stability. Also, since time series data will be used, the error terms are tested for serial correlation as the presence of serial correlation could lead to misinterpretation of the results (Gujarati, 2003:442). Serial correlation is when the error terms of the time series model are correlated (Gujarati, 2003:443). It has been argued that the most commonly used tests for serial correlation are the Lagrange Multiplier test (LM) and the Durbin-Watson test (Mokoti, 2009:40). In testing for serial correlation in a model with lagged variables, the LM test is preferred over the Durbin-Watson test, because the Durbin-Watson test does not factor in the relationship between the regressors and the lagged disturbances (Mokoti, 2009:40).

3.7 Variable Selection in a VAR

When constructing a VAR model, most researchers are faced with a dilemma of which variables to select (Amaresakara, 2006:7). For example, Christiano, Eichenbaum and Evans (1996:18) indicated that they could not use all the variables they viewed as important in their VAR model as this would result in an estimation of too many parameters which they were unable to control. This happens because, as explained by Stock and Watson (2001:12), “the number of estimated parameters increases as the square of the number of variables”. The authors also warn that including too few variables could lead to a problem of omitted variables. Stock and Watson (2001:12) also indicate that small VARs of two or three variables are often unstable and create poor prediction of the future.

Traditionally, researches included an indicator of aggregate economic activity, an indicator of inflation and a monetary policy variable at a minimum. Some researchers include other variables that may represent policy objectives or provide useful information about these objectives, or still other variables which could be of interest to the monetary authorities (Amaresakara (2006:7).

As noted by Bhuiyan (2008:1), the policy interest rate should represent the stance of the monetary policy rather than the money supply shocks or market interest rates. He posits that since the policy interest rate is under the sole control of the central banks, it will not be influenced by other shocks in the economy. Therefore, movements in the policy interest rate will reflect a change in the monetary policy stance.

3.8 Should the Variables be Differenced or Not?

Amarasekara (2006:21) observes that two schools of thought have emerged whether the variables used in a VAR should be stationary or not. The first one argues against differencing the variables in a VAR model even if they are not stationary. The view is that differencing results in a loss of important information and that the standard asymptotic tests are still valid irrespective of whether VARs are estimated using variables in their level form while they are non-stationary, as level specifications arguably produce reliable results whether co-integration exists or not.

The second school of thought insists on the variables in a VAR mimicking the true data-generating process. For his part, Enders (2004:358) advocates for using variables which are differenced, if there are no co-integrating relationships between variables. This is because a VAR model estimated in levels with variables that are not stationary and not co-integrated, results in poor estimates. Specifically, estimating a model in levels while the model is not co-integrated

will lead to impulse responses that are inconsistent estimates of the true responses. However, he accepts that a VAR model estimated by using differenced variables produces results where the impulse response settles at zero, meaning that the estimated responses are consistent and valid.

Marcet (2004:3), indicates that pre-testing the variable is initially done to determine whether the variable is stationary or not so that an appropriate integration of variables are used. In opposing Enders (2004:358), he explains that if variables are stationary after the first difference, then the VAR model should be estimated by using differenced variables rather than at levels. He indicates that estimating the VAR model using differenced variables will eliminate all the contradictions and complications caused by a series which is not-stationary. For example, as noted by Marcet (2004:4), non-stationary time series are considered likely to produce spurious regression, because non-stationary time series data does not stay in a compact set.

Therefore, when estimating the monetary policy transmission in Botswana, this study will pre-test the variables to be used so that an appropriate determination can be made of the integration of variables. Variables which are stationary after the first difference will be included in their first difference in a VAR model. This is to avoid problems associated with non-stationary time series such as producing spurious results.

3.9 VAR Model for Botswana

This section specifies a standard VAR model for Botswana. The variables used in the model are explained, as well as a brief justification of why they are considered, together with the expected response of the variables to a monetary policy shock. The variables selected include all the variables that are commonly used in estimating VAR models as pointed out by Amaresakara (2006:7). These variables are indicators of aggregate economic activity, inflation and a monetary policy variable. In addition, the study considers the exchange rate to reflect trade openness, the South African inflation to reflect external influence, and the dummy variables to capture the structural breaks in the economy. All the variables except for the monetary policy rate have been converted into logarithms so that they can be interpreted as percentages. The study uses quarterly data from 1995 quarter one to 2009 quarter four. The data were sourced from Bank of Botswana publications, in particular, different issues of Botswana Financial Statistics and the Bank of Botswana Annual Report.

An indicator of aggregate economic activity, the real GDP (real GDP) is considered because it is assumed that increasing economic activity will have an

upward pressure on inflation. For example, in Botswana around 80 percent of the real GDP is attributed to the mining sector, and the funds from the diamond sales are injected back into the economy through Government recurrent and development expenditures, resulting in an increasing domestic aggregate demand. Therefore, the relationship between the interest rates and the real GDP will shed light on whether domestic demand is responsive to the monetary policy actions as assumed earlier in the literature review section. Consequently, high interest rates are expected to decrease the real GDP, and a declining real GDP is expected to dampen inflation as proposed by the IS-LM model in the discussion of the literature.

An indicator of inflation used is the headline consumer price index (botscpi). It is derived as a weighted average of prices of a basket of goods and services. An increase in the policy rate is expected to lead to a decline in inflation. The monetary policy rate used is the bank rate (bovr) under the control of the Bank of Botswana. Following on the arguments by Bhuiyan (2008:1) discussed earlier in the chapter, the bank rate is used to reflect the monetary policy stance.

Since Botswana is a small open economy, the nominal effective exchange rate (neer) is included to reflect the external environment. The nominal effective exchange rate (domestic currency/foreign currency) is pegged to a basket of currencies, and is determined by a weighted average of 5 different currencies: the South African Rand, US Dollar, UK Pound, Japanese Yen, and the Euro, with the South African Rand constituting the highest weight in the basket since Botswana imports a greater deal from the South African economy (Mohohlo, 2008:7). Therefore, as pointed out by Mishkin (1995:5), a positive relationship between the policy interest rate and the exchange rate is expected, as well as a negative relationship between the exchange rate and inflation. However, even though the exchange rate is fixed or managed, a point also supported by Taylor (1995:15) is that the interest rate movements can affect the exchange rate within that flexible band. The movement of the exchange rate within the band has an effect on inflation. For this reason the exchange rate is considered in the model.

The South African headline inflation (sacpi) is included to account for the influence of external factors. It is expected for South African inflation to have a positive influence on domestic inflation, because around 80 percent of the Botswana goods and services are imported from South Africa (Kganetsano, 2007:96).

The money supply (M2) is considered to reflect how financial depth affects inflation. Liquidity in Botswana is mainly influenced by the mining sector. This observation was made by Masalila and Phetwe (2001:7), who maintain that revenues from the sales of the diamonds in Botswana are injected back into the economy through fiscal expansion which leads to demand increasing more rapidly than supply does, hence inflationary pressures are generated. Therefore, as argued by Mankiew (2002:273), high interest rates are expected to reduce the demand for money, hence a negative relationship is expected between money supply and the interest rates, as well as inflation.

Three dummy variables are considered, following on the arguments by Mies and Tapia (2003:12), to reflect the structural breaks in the economy. The impact of the dummy variables will show how the structural breaks affect inflation. The first dummy variable (*dumrec*) is included to capture the recent world financial crises from mid-2008. The second dummy variable (*dumdev*) captures the impact of the May 2005, 12 percent devaluation of the Pula on inflation, when the exchange rate regime was also changed to the current crawling peg. Finally, another dummy (*dumvat*) is intended to capture the effect of the replacement of the sales tax by value added tax (VAT) on inflation in the third quarter of 2002.

Therefore, as already assumed that an economy can be represented by the equation (1) above, the recursive VAR model in Botswana will include the following endogenous variables, the Botswana consumer price index, the real GDP, money supply, the Central Bank policy interest rate, the exchange rate, arranged in this order as per the assumptions of the recursive ordering. The vector of endogenous variables Y_t is

$$\begin{pmatrix} Y_t \end{pmatrix} = \begin{pmatrix} botscpi \\ realGDP \\ M2 \\ bobr \\ neer \end{pmatrix}$$

where the exogenous variables to control for external changes which affect inflation in Botswana are

$$\begin{pmatrix} X_t \end{pmatrix} = \begin{pmatrix} sacpi \\ dumvat \\ demdev \\ dumrec \end{pmatrix}$$

As already mentioned earlier, a recursive model using a Cholesky decomposition assumption requires a triangular ordering of an identity matrix, hence the relationship between the reduced-form errors and the innovative shocks are given by:

$$\begin{pmatrix} \varepsilon_t^{botscpi} \\ \varepsilon_t^{realGDP} \\ \varepsilon_t^{m2} \\ \varepsilon_t^{bobr} \\ \varepsilon_t^{neer} \end{pmatrix} = \begin{pmatrix} 1 & 0 & 0 & 0 & 0 \\ b_{21} & 1 & 0 & 0 & 0 \\ b_{31} & b_{32} & 1 & 0 & 0 \\ b_{41} & b_{42} & b_{43} & 1 & 0 \\ b_{51} & b_{52} & b_{53} & b_{54} & 1 \end{pmatrix} \begin{pmatrix} e_t^{botscpi} \\ e_t^{realGDP} \\ e_t^{m2} \\ e_t^{bobr} \\ e_t^{neer} \end{pmatrix}$$

This recursive identification scheme implies that inflation reacts only to its own shock. Real GDP reacts to its own shock and a shock to inflation, while money stock reacts to a shock to inflation, the real GDP, and to its own shock. The policy interest rate, however, reacts to its own shock, a shock to inflation, a shock to real GDP, and shock to money stock. Finally, the flexible band of the crawling peg exchange rate reacts to its own shock and a shock to all these variables included in a VAR (Tsangarides, 2010:10). Moreover, Cheng (2006:12) points out that this standard approach which imposes a recursive VAR structure, assumes that the variables impact each other with a lag. For example, he indicates that output has no immediate effect on inflation, money stock has no immediate effect on real GDP, the monetary policy shock has no immediate effect on money stock, and the nominal effective exchange rate has no immediate effect on the monetary policy.

To examine how the monetary policy interest rate in Botswana affects inflation via specific channels, additional variables are introduced to the standard VAR

model for Botswana. These variables have been selected as guided by the theoretical review and empirical evidence discussed in Chapter 2. Moreover, all the VAR models will include the exogenous variables as in the standard VAR model, for reasons already explained earlier in the section. However, the asset prices channel is not explored due to the lack of readily available data on equity prices. For the same reason, the credit channel is explored using the total commercial bank credit according to specification by Hung and Pfau (2008:7). They used the total credit to represent the lending and the balance sheet channel. The total commercial bank credit used consists of credit to household and credit to private businesses.

To explore the exchange rate channel, the VAR model includes the real GDP, as Mishkin (1995:5) indicates that movements in the exchange rate will have an impact on output. This will affect inflation via the output gap. The model also includes the nominal effective exchange rate, the monetary policy interest rates and inflation. As already discussed, theory predicts that a monetary policy tightening will lead to a nominal exchange rate appreciation, which will result in a decline in domestic growth and ultimately in decreasing inflation.

To explore the credit channel, money supply is replaced with the total commercial bank credit in the standard VAR model. Theory predicts that an increase in a monetary policy interest rate will lead to an increase in the cost of credit (Mies and Tapia, 2003:6). This is expected to reduce consumption and investment, leading to a decline in the total credit, and, ultimately, in output and inflation. Therefore, the variables in this channel are inflation, the real GDP, the total commercial bank credit and the policy interest rate.

The interest rate channel assumes that a positive innovation to the monetary policy will increase other market rates, which will add to an increased cost of borrowing, leading to a decline in investment and consumption demand due to high credit costs, which will ultimately reduce aggregate demand and inflation (Smal and De Jager, 2001:6). Therefore, the standard VAR model excludes the money supply and introduces the real prime rate to explore the interest rate channel in Botswana. Therefore, the variables included in this channel will be inflation, the real GDP, the real prime rate, money supply and the policy interest rate.

3.10 Conclusion

The aim of this chapter was to identify and establish the relevant methodology for this study. This chapter identified the recursive VAR as a suitable

methodology for Botswana due to the underdevelopment status of the economy. The relevant standard VAR model for Botswana includes the variables: the Botswana consumer price index (inflation), the real GDP, money supply (M2), the Bank of Botswana bank rate (policy interest rate), and the nominal effective exchange rate.

To explore the different channels the recursive VAR model explores the interest rate channel by including endogenous variables such as the Botswana consumer price index, the real GDP, the real prime rate, money supply and the policy interest rate. The credit channel is explored by using inflation, the real GDP, the total commercial bank credit and the policy interest rate, while the exchange rate channel is explored by using inflation, the real GDP, the nominal effective exchange rate and the policy interest rate. The results for these models by using the Botswana data are presented in the following chapter.



Chapter 4

4. Empirical Results: Data Analysis and Estimation Results

4.1 Introduction

This chapter presents empirical results from the model discussed in the previous section. The results include the time series trend of the main variables used in the model, the unit root test for all variables included in the model, the lag length determination, the stability tests, the serial correlation test, the impulse response and finally the variance decomposition. The results are based on tests using the E-views 5 package.

4.2 Time series trend

As the objective of the paper is to find out how the monetary policy change affect the inflation, only a graphical representation of the movements of the bank rate and inflation are presented below to give a better visual understanding of their trends over time and the type of relationship they display.

Figure 1

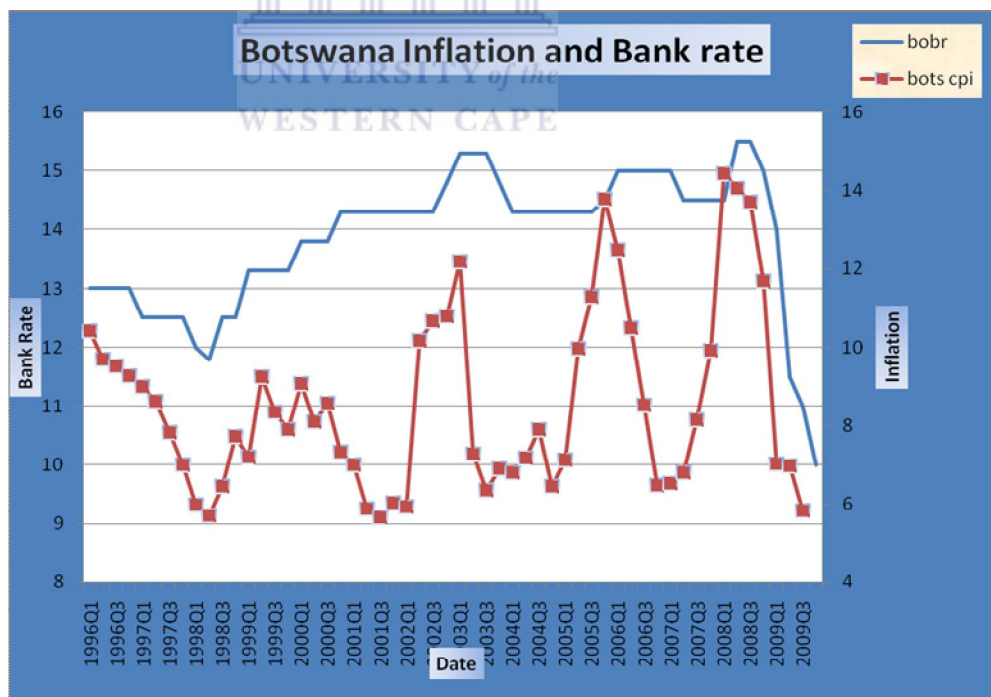


Figure 1 reflects that inflation was declining from 1996Q1 to 1998Q2. Over this period, the monetary policy rate (the bank rate), was easing (declining) as

advocated by Mishkin (1995:4). Moreover, figure 1 illustrates that the monetary policy tightened as inflation increased from 1998Q1 to 1991Q1. From 2008Q1 to 2009Q3, both variables declined drastically reflecting the world recession caused by the financial crisis in the United States.

4.2 Unit root test

All the variables in the model are tested for unit root. The series of the variables tested for unit root are the Botswana consumer price index (lbotscpi), the total real GDP (lrealGDP), money supply (lm2), the real interest rates (rprm), the nominal effective exchange rate (neer) and the policy interest rate (bobr). Table 4.1 presents the results of the unit root test.



Table 4.1: ADF test results

Variable	ADF statistic	t-statistic	Decision	No Trend	Trend
IBots cpi	-2.273331	-3.4875	Non-stationary		Y
ISacpi	-1.885103	-3.4875	Non-stationary		Y
ITotcre			Non-stationary		Y
Bobr	-1.672202	-2.9126	Non-stationary	Y	
lrealGDP	-2.272810	-3.4875	Non-Stationary		Y
Rprm	-2.631055	-2.9155	Non-stationary	Y	
IM2	-1.828416	-3.4875	Non-stationary		Y
1st Difference					
IBots cpi	-5.796144	-3.4889	Stationary		Y
ISacpi	-5.408838	-3.4889	Stationary		Y
ITotcre			Stationary		Y
Bobr	-5.776753	-2.9126	Stationary	Y	
lrealGDP	-9.631678	-3.4889	Stationary		Y
Rprm	-6.116791	-2.9155	Stationary	Y	
IM2	-5.7870	-3.4889	Stationary		Y

Wang *et al* (2005:458) argue that variables displaying a trend should be tested for stationarity, taking into account the trend behaviour. They explain that non-factoring trend behaviour affects the power of the stationarity test, and this will lead to stationary variables to appear to be non-stationary. Therefore, following on the arguments by Wang *et al.* (2005:458), a trend component was included when testing variables which display a trend. In using the ADF test, the null hypothesis tested is that the ‘variable has unit root’. Therefore, the decision rule

is to reject the null hypothesis if the ADF statistic is more negative than the t-statistic. This indicates that the variable will be stationary.

The top part of Table 4.1 represents the results of the ADF test of the variables tested in levels. It presents the ADF statistic and the t-statistic obtained from E-Views. The last two columns provide information on the stationarity status of variables, where 'y' represents yes and that the variable will be tested for stationarity taking into account the trend behaviour. The results show that the ADF statistic is not more negative than the t-statistic for all variables. Therefore, the null hypothesis is not rejected. This implies that all variables are non-stationary in level.

The next step is to re-test the variables after taking their first difference. The results are presented in the bottom part of Table 4.1. The results show that the ADF statistic is more negative than the t-statistic, implying that the null hypothesis is rejected. Therefore, we conclude that the variables are stationary after the first difference.

As discussed in the previous chapter, if the variables are found to be stationary after the first difference, the VAR model will include the differenced variables. This is to avoid confirming spurious relationships among variables which may arise from using non-stationary time series data as argued by Marcet (2004:3)

4.3 Lag length determination

The results of the five tests indicated by Lada and Wojcik (2007:3) to identify the appropriate lag length are presented in the table below. As noted earlier, these five tests are used as a means to determine the appropriate lag lengths. They provide information about the number of lags that could be included in the VAR model. But the decision will be made after considering the Akaike Information Criteria (AIC) and the Swartz Information Criteria (SIC). These are considered because they perform better as they impose a penalty if a large number of regressors are included.

Table 4.2a: Lag Length Selection Criteria

Lag	LR	FPE	AIC	SC	HQ
0	NA	2.98e-13*	-14.65442	-13.70745*	-14.29255*
1	26.55040	4.26e-13	-14.32160	-12.42765	-13.59787
2	37.92934	4.22e-13	-14.39480	-11.55388	-13.30920
3	41.25771*	3.39e-13	-14.74530	-10.95741	-13.29783
4	14.58775	6.55e-13	-14.32598	-9.591109	-12.51664
5	26.99275	7.25e-13	-17.41538*	-8.949112	-12.45975

Note: SC means the Swartzs Information Criterion, AIC means the Akaike Information Criterion, LR means the Sequential Modified LR Test statistic, FPE means the Final Prediction Error and HQ means the Hannan-Quinn Information Criterion

The first column (lag) presents the number of lags, while the remainder of the column presents the values computed by each approach for each lag. However, in the VAR model, the zero lags are invalid as the model by nature includes lags. Moreover, the AIC and the LR do not agree on the number of lags, they suggest five and three lags respectively. Therefore, these approaches do not clearly suggest a lag length to be selected.

As explained earlier, if the results do not clearly suggest the optimal lag length, the next step is to estimate various models with different lags. In this case, 1 lag will be used as the zero lag suggested by the approaches as invalid. Therefore, the five approaches suggest that this VAR model can have a minimum of 1 lag to a maximum of 5 lags. Therefore, five models with different lag lengths from a minimum of 1 lag to a maximum of 5 lags are estimated to compare their AIC and the SIC values. The results of the individual models are presented in Table 4.2b.

Table 4.2b: Lag Length Selection Criteria

Lag	AIC	SIC
1	-14.67470	-12.89846*
2	-14.67577	-11.98755
3	-14.87225*	-11.25555
4	-14.35838	-9.796259
5	-14.48990	-8.964942

Table 4.2b above presents the values of the AIC and the SC from the five VAR models. As explained earlier, the decision rule is to select the model with the smallest SIC or AIC. The results show that a model with one lag length produces the SIC value which is more negative (i.e., the smallest SIC value). Therefore, by using SC decision rule, the optimal lag length selected is one. The AIC approach presents that a model estimated with three lags produces the smallest AIC value (i.e., the AIC value which is more negative). Therefore, under the AIC approach the optimal lag length selected is three. Consequently, since the AIC and the SIC suggest different lags, the best model from each approach is subjected to a diagnostic test to see which one performs better.

4.4 Diagnostic Test

The SC and the AIC selected models are tested for serial correlation. As explained in the previous chapter, the model with serial correlation could lead to spurious results. Therefore, the model which does not have serial correlation is the one which performs better, and is the one which has the optimal lag length. As already pointed out in the previous chapter, the LM test is preferred to check for serial correlation because of its ability to factor in the relationship between the regressors and the lagged disturbances (Mokoti, 2009:40). The results are presented in Table 4.3 below.

Table 4.3: Serial Correlation Test Results Using LM test

Lag	SC MODEL		AIC MODEL	
	LM-Stat	Prob	LM-Stat	Prob
1	56.24652	0.0003	12.50762	0.9820
2	38.91676	0.0376	16.11518	0.9114
3	39.61988	0.0319	15.97285	0.9156

In the LM test the null hypothesis states that there is no serial correlation. The decision rule is to reject the null hypothesis if the probability statistic (represented by prob in Table 4.3) is less than 0.05, concluding that there is serial correlation. This means that at 5 percent significance level, the model has serial correlation.

Table 4.3 presents the results for the LM statistic and the probability statistic for the SIC and AIC models. The results show that for the model suggested by the SC approach, the probability statistic is less than 0.05 for all 3 lags. Therefore,

the null hypothesis is rejected and the conclusion is that the model suggested by the SC approach shows the presence of serial correlation. On the other hand, the model selected by the AIC approach shows probability values greater than 0.05 for all lags. Therefore, the null hypothesis cannot be rejected and it is concluded that the model has no serial correlation. This implies that the model suggested by the AIC approach has no serial correlation at the 5 percent significance level.

Thus, the model suggested by the AIC approach is superior to the model suggested by the SIC approach. Therefore, the optimal lag length as suggested by the AIC approach is three. This study will thus adopt the model suggested by the AIC which includes a lag length of three.

4.5 Stability test

Since it has already been established that an unstable VAR will lead to invalid impulse response and variance decomposition, the stability test is conducted as the lags included in a VAR model can affect the stability of the model. The stability results of the model are presented in Figure 1.

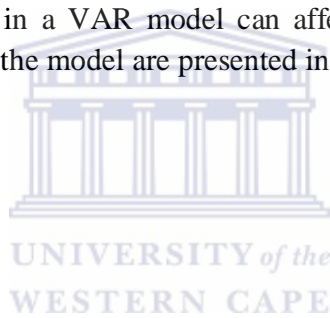


Figure 2: Stability Test Results for a VAR Model

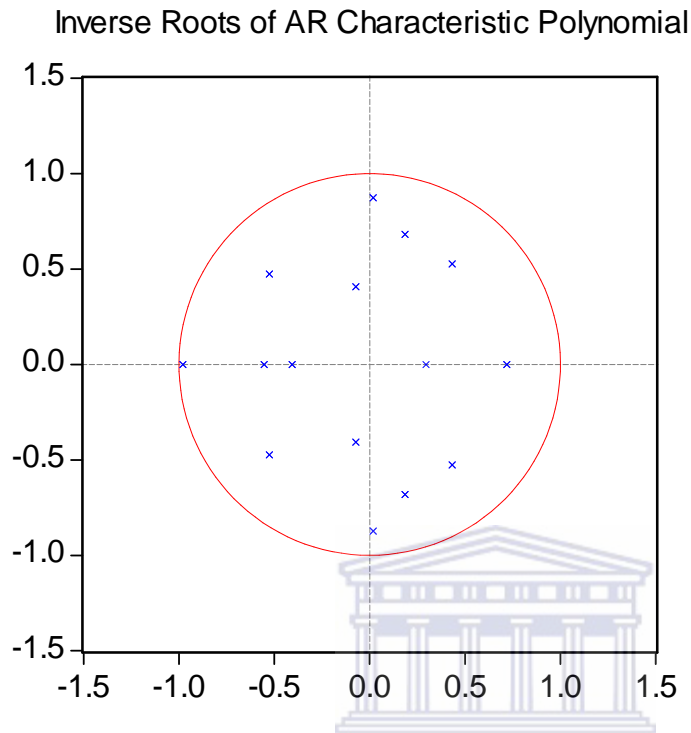


Figure 2 reports the inverse roots of the characteristic AR polynomial. The points within the circle are the AR root values and they present essential information about the stationarity or non-stationarity process. The AR values of a stationary process should be less than one. The circle reflects the unit root circle. Therefore, if the AR values are one, they will lie along the circle implying that there is a unit root. The required condition for a stable VAR is that all roots should lie within the unit root circle.

The model is stable if all the estimated roots in the model lie within the root circle. Figure 2 reflects that the model is stable. This implies that the impulse responses and the variance decomposition results will be valid.

4.6 Estimation results from the standard recursive VAR

The VAR model was estimated over a period of 1995 quarter one to 2009 quarter four, with the endogenous and exogenous variables discussed in the previous section. The lag length used is 3 as established earlier in the section, and the model has no serial correlation and is stable. To assess the effectiveness of the monetary policy, we analyse the impulse response to a monetary policy shock on inflation, the real GDP, money supply, the bank rate and the nominal

effective exchange rate. The purpose is to determine the reaction of these variables, and the length of time it takes for the variables to return to equilibrium (or the zero line). The variance decomposition is used to determine how much variation in inflation is explained by the endogenous variables.

4.6.1 Impulse Response

The impulse response helps to map out the effect of a monetary policy shock on inflation, and on other economic variables such as the nominal effective exchange rate, money supply and output. The impulse response results are presented in the Figure 3 below. The response horizon is given by the horizontal axis. Periods 1 to 20 represent quarters one to 20. The solid lines are the responses of variables to the shock, where the upper and lower dashed lines are the one standard error bands which reflect the statistical significance of the variables. That is, the impulse responses will be statistically significant if the standard errors lie in the same region of the zero line (Kganetsano, 2007:160).

Figure3: Impulse Response Results for a Standard VAR Model

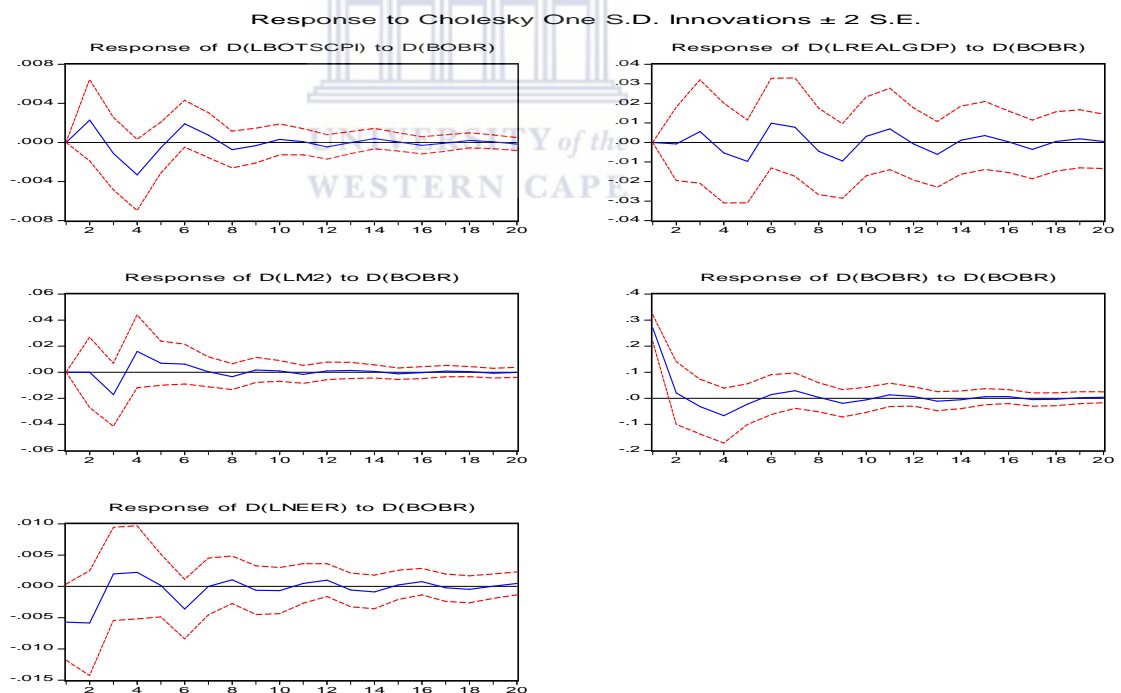


Figure 3 shows five panels of the impulse response graphs indicating how the policy interest rate affects economic variables. These findings in all the five panels are not statistically significant because the error bands do not lie in the

same region of the zero line. That is, the upper band of the error band lies in the upper region of the zero line while the lower band of the error band lies on the lower region of the zero line. Kganetsano (2007:160) interprets this to suggest that a monetary policy has little or no influence in the economy.

Nonetheless, the results show that a one-standard deviation of a monetary policy shock at the beginning of the first quarter causes inflation to increase immediately after the shock until the end of the first quarter. The response of inflation to the monetary policy in the first period reflects a price puzzle. This implies that the response of inflation to a monetary policy shock is not conforming to economic theory. One possible explanation for an immediate increase in inflation after a monetary policy shock is the persistence of inflation from previous high levels (Arnostova and Hurnik, 2004:8). Another explanation could be that immediately after the shock, consumers are still committed to servicing their existing debt and therefore experience an increasing cost of living. After the first quarter they begin to adjust their decision to the new interest rates.

In contrast, Mokoti (2009:48) suggests that this response of inflation to a monetary policy is not a price puzzle, but an appropriate response of inflation to a contractionary monetary policy. His contention is based on the standard theoretical proposition that a contractionary monetary policy leads to an increase in other market interest rates, causing the cost of production to increase, which in turn results in an increase in inflation.

However, inflation decreased from the second quarter reaching a minimum at the end of the third quarter, where it is assumed that the monetary policy shock is at its maximum. But, from the second period to the end of the third period, the response of inflation to the monetary policy shock conforms to theory. That is, inflation declines with an increase in the policy interest rate as high interest rates lead to high costs of borrowing which will result in reduced aggregate demand and inflation. This could mean that inflation responds with a lag as predicted by economic theory. Inflation begins to increase after the fourth quarter but it passes the equilibrium level or the pre-shock value. This could be a result of the interest rates decaying from the system. Also, at low levels of inflation, people demand money, and as a result, aggregate demand will start to increase, thus exerting upward pressure on inflation.

These results are different from Kganetsano (2007:162). He found a price puzzle from the second quarter to the 12th quarter, whereas, this study reflects the price

puzzle occurs only in the first quarter. Thereafter, the results in this paper reflect that inflation responds to the monetary policy from the second quarter as is predicted by economic theory.

Moreover, from the seventh quarter, fluctuations in inflation are relatively small and are found around the zero line. This implies that inflation starts to stabilise from the beginning of the seventh quarter. Overall, the effect of a monetary shock on inflation can be assumed to last for seven quarters.

Money supply does not immediately respond to a monetary policy shock until the end of the first quarter. Thereafter, money supply starts to decrease reaching its minimum by the end of the second quarter. The money supply starts to increase at the end of quarter two until the end of quarter three. According to Mankiw (2002:107), the decline in money supply can be explained by the fact that in this period inflation was also decreasing, therefore the cost of holding money was also decreasing. As a result, the demand for money began to increase until the end of quarter three while inflation was beginning to go up (Mankiw, 2002:107). Money supply begins to stabilise at the beginning of the seventh quarter. The non-responsiveness of money supply in the first quarter could explain the price puzzle. This could mean that a monetary policy shock impacts the economy with a lag. However, the decrease of money supply is expected as higher interest rates will reduce the demand for money.

The response of the nominal effective exchange rate is also unchanged from the beginning of the first quarter when the monetary policy is announced until the end of the first quarter. This supports the view that a monetary policy change affects the economy with a one period lag. Nonetheless, the nominal effective exchange rate begins to appreciate in the second quarter conforming to the predictions of economic theory, although it begins to depreciate from the start of the fourth quarter to the end of the fifth quarter. This behaviour confirms an observation by Bhuiyan (2008:17) that an increase in the policy interest rate will result in an appreciation of the nominal exchange rate, which causes a decline in the prices of imported goods and inflation rate. He further argues that this will lead to an increase in domestic returns, and the domestic currency will depreciate to offset the excessive domestic returns. The exchange rate stabilises in the seventh quarter.

The real GDP also does not show any response to the monetary policy shock in the first quarter, but it shows a small upward movement in the second quarter. This response contradicts the theoretical prediction that the real GDP will fall

when interest rates are increased because of the negative response of investment to high interest rates (Mankiw, 2002:267). However, the real GDP starts to decline from the beginning of the third quarter until the end of the fourth quarter. This reflects the expected response of the real GDP to an increase in the policy interest rate.

The real GDP continues to respond by fluctuations around the zero line. This could be due to other shocks in the economy. Alternatively, since the results are not statistically significant, this could mean that the real GDP does not respond to a monetary policy shock as pointed out by Kganetsano (2007:160). Moreover, Mokoti (2009:48) argues that the response of the real GDP is not surprising because “the Botswana economy is dependent on exports of diamonds and hence the real GDP can be assumed to be an exogenous variable determined by factors outside the influence of Botswana’s monetary policy”.

An overall finding is that three (m2, real GDP and near) out of four variables responded with a one quarter lag, while the other (lbotscpi) responded immediately. Therefore, one can conclude that the monetary policy impacts the economy after one quarter from the period of a shock. Also, the results show that three variables (lbotscpi, m2 and near) not the other (real GDP) start to stabilise in the seventh quarter after a monetary policy shock. Moreover, the real GDP reflects little or no response to the monetary policy and the fluctuations in the real GDP could be explained by other factors in the economy. For these reasons, it can be concluded that the effect of the monetary policy lasts for seven quarters in the economy. Most importantly, most variables (inflation, money supply and the nominal effective exchange rate) respond according to theoretical predictions. The real GDP does not reflect any theoretical explanation. In fact, it is irresponsive to a monetary policy shock. Even though this is the case, the impulse responses are not statistically significant because the standard errors do not lie in the same region. Therefore, it can be concluded that the monetary policy has little or no effect on the economy. This conclusion is buttressed by Kganetsano (2007:160) and Mokoti (2009:48) whose findings also suggest that the impulse responses are statistically insignificant.

4.6.2 Variance Decomposition.

The variance decomposition points to the contribution of other variables to variations in inflation in the VAR system. The results of the variance decomposition are found in Table 4.4.

Table 4.4: **Variance Decomposition of D(lbotscpi)**

Period	S.E	D(lbotscpi)	D(lrealGDP)	D(lm2)	D(bobr)	D(lneer)
1	0.011395	100.0000	0.000000	0.000000	0.000000	0.000000
2	0.011909	91.55627	1.153442	0.409088	3.675909	3.205291
3	0.012040	90.20173	1.150990	0.421801	4.474679	3.750798
4	0.012646	81.89882	3.203752	0.406338	10.93414	3.556950
5	0.012789	81.54445	3.273591	0.481901	10.85833	3.841728

While impulse response functions trace the effects of a monetary policy shock to endogenous variables in the VAR, variance decomposition separates the variation in inflation into components according to the contribution by each shock in a VAR system. As pointed out in the previous section, the variables are converted to logarithms so that they can be interpreted as percentages. For example, when considering Table 4.4, in the first period inflation is only influenced by its own shock, therefore a shock from inflation accounts for 100 percent variation in inflation. However, the variance decomposition analysis shows that variation in the policy interest rate explains more of variation in inflation than other variables. The table also reflects that most variation in inflation is explained by its shock. This implies persistence of the previous levels of inflation.

The results from the impulse response indicate that an increase in the policy interest rate leads to an increase in inflation immediately after the shock in the first quarter. However, the variance decomposition reflects that the policy interest rate shock does not contribute to movements in inflation in the first quarter, but contributes 3.7 percent to the decline in inflation at the beginning of the second quarter. In addition, the impulse response shows that the effect of policy change is in full effect at the beginning of the fourth quarter. At this point the variance decomposition reflects that the contribution of the monetary policy interest rate has increased from 3.7 percent in the second quarter to 10.9 percent in the fourth quarter. This shows that the interest rates play an insignificant role in influencing movements in inflation.

The impulse response indicates that money supply (m2) starts to respond to the policy interest rate in the second quarter and the effect of the monetary policy is in full effect at the beginning of the third quarter. The variance decomposition shows that as money supply (m2) starts to respond to the policy interest rate in the second quarter, it explains 0.41 percent of movements in inflation, which increases slightly to 0.42 percent in the fourth quarter. This means that money supply is not an important component when explaining variation in inflation. This finding is consistent with that of Kganetsano (2007:167).

Following the impulse response function, the real GDP responds to the monetary policy shock from the second quarter and the monetary policy shock is in full effect in the fifth quarter. At these two points, the real GDP shock explains 1.2 percent and 3.3 percent variation in inflation when the real GDP starts to respond to the monetary policy shock, and when the monetary policy shock is perceived to be in full effect, respectively. This result also proves that the contribution of the real GDP shock to variation in inflation is relatively small.

The nominal effective exchange rate also starts to respond to the monetary policy interest rate in the second quarter and the effect of the policy interest rate is in full effect in the second quarter. In both these two instances, the nominal effective exchange rate shock contributes 3.2 percent and 3.8 percent respectively. This indicates that a nominal effective exchange rate shock explains relatively small variation of inflation.

As already explained at the beginning of this section, variance decomposition reflects the relative importance of other variables in explaining movements in inflation. In Botswana, previous levels of inflation are persistent. However, the policy interest rate is relatively important, more than the other variables in the VAR system for explaining movements in inflation. Also, it is interesting to note that even though a nominal effective exchange rate is expected to have a limited effect in explaining variation in inflation because it does not float, it explains more of variation in inflation than contributions from the real GDP and money supply shocks. However, these findings are at variance with the conclusion of Kganetsano (2007:166). He finds that the real GDP shocks are important in explaining variations in inflation. This disagreement could be explained by the fact that impulse responses are statistically insignificant, leading to different inferences.

4.7 Different Channels of Monetary Policy

Different channels are explored by introducing appropriate variables which explain the different ways in which a monetary policy shock can affect inflation. As already explained in chapter three, the asset prices channel is not estimated due to lack of data. Only the interest rate channel, the credit channel and the exchange rate channel will be estimated.

4.7.1 The Interest Rate Channel

Figure 4: Impulse response of the interest rate channel

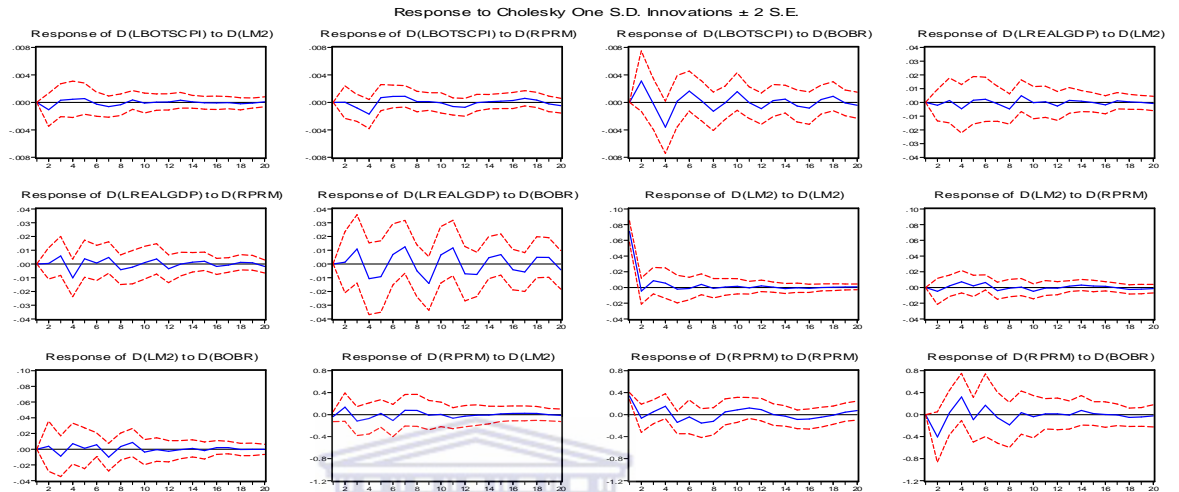


Table 4.5.1: Variance Decomposition of the Interest Rate Channel

Period	S.E.	D(LBOTSCPI)	D(LREALGDP)	D(LM2)	D(RPRM)	D(BOBR)
1	0.010761	100.0000	0.000000	0.000000	0.000000	0.000000
2	0.011415	91.73104	0.004803	0.902026	0.000289	7.361838
3	0.011570	91.09029	0.262317	0.947674	0.493981	7.205742
4	0.012262	81.11235	0.380275	0.974994	2.393425	15.13895
5	0.012501	78.58895	3.104676	1.123513	2.599524	14.58334

Figure 4 shows the results of an estimated interest rate channel in Botswana. These reflect that a monetary policy shock leads to a decline in the real interest rates in the first quarter. The decline in real interest rates after a monetary policy shock is not predicted by economic theory. The response can be explained by a more rapid increase in inflation than in the nominal interest rates. Thereafter, the real interest rates increase as predicted by economic theory in the literature section, reaching a peak at the end of the third quarter.

Figure 4 also shows that inflation responds to a real interest rate shock with a one quarter lag. It declines at the beginning of the second quarter, as the rising

real interest rates increase the cost of borrowing, leading to a decline in aggregate demand. This is the expected behaviour as predicted by economic theory in the literature section.

Furthermore, the real GDP responds to an increase in the real interest rate with a one period lag. The real GDP increased slightly in the second quarter, mainly as a result of rising real interest rates which makes the domestic deposits more attractive, thus increasing savings which are generally utilized to stimulate the economy.

Table 4.5.1 represents the variance decomposition results. The results show that monetary policy has a zero effect on inflation in the first quarter after the policy shock. The policy interest rate contributes more to variation in inflation than other policy variables do. It accounts for a maximum of 15.1 percent in the fourth quarter, while the real prime rate accounts for 2.39 percent, money supply (m2) accounts for 2.97 percent and the real GDP accounts for only 0.38 percent over the same period.

The variables included in this channel contribute relatively little to the variation in inflation. This forms the basis for a conclusion that the monetary policy has little effect in this channel. The relatively minor effect of the monetary policy via this channel could be attributed to the underdevelopment of the financial markets which undermines the effect of interest rate changes.

4.7.2 The Credit Channel

Figure 5: Impulse response of the credit channel

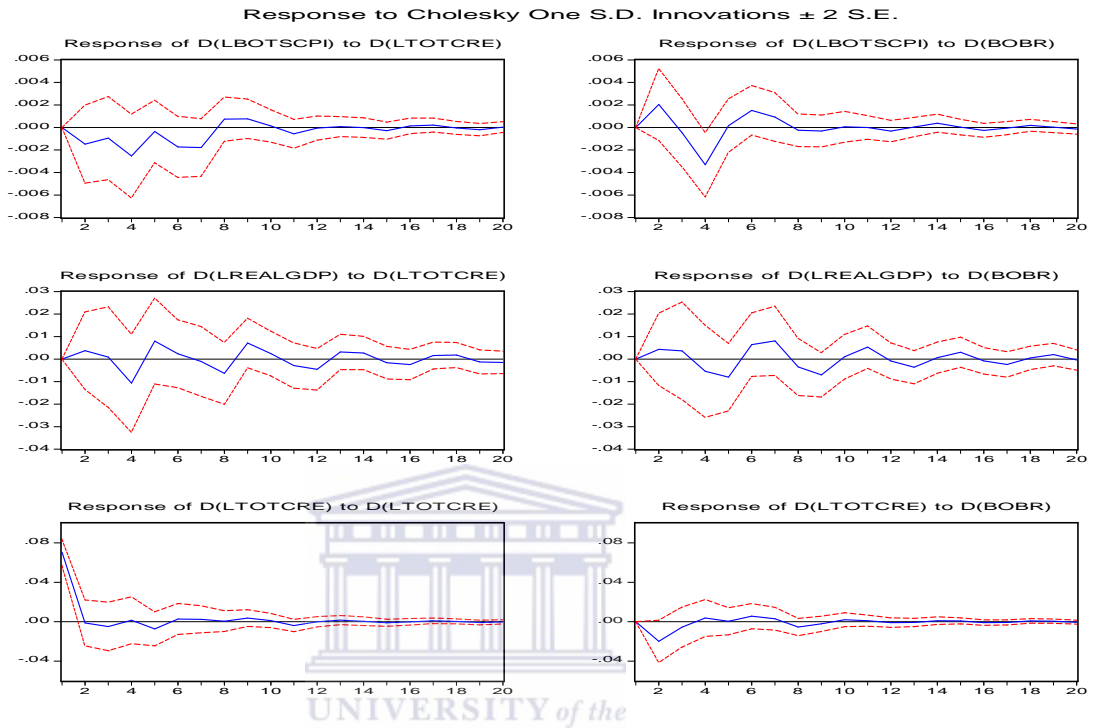


Table 4.5.2: Variance decomposition of the credit channel

Period	S.E.	D(LBOTSCPI)	D(LREALGDP)	D(LTOTCRE)	D(BOBR)
1	0.010853	100.0000	0.000000	0.000000	0.000000
2	0.011198	93.97864	2.025257	0.150922	3.845175
3	0.011304	92.60357	1.995097	0.687453	4.713879
4	0.012402	77.36949	6.340781	3.613227	12.67650
5	0.012640	76.95367	6.343825	4.249860	12.45264

Figure 5 presents the results of the credit channel. The results show that a tight monetary policy shock leads to a decline in credit. This response of credit to a monetary policy shock is predicted by economic theory. A tight monetary policy is expected to increase the cost of borrowing that will lead to consumers demanding less credit. However, the credit begins to rise in the second quarter, and stabilises at the end of the fourth quarter. The rising credit at this point is

argued not to respond to the monetary policy action but could be explained by the provision of grants and low interest rate loan schemes by Government in an effort to diversify the economy (Kganetsano, 2007:148).

Inflation, on the other hand, decreases as credit increases, which is against the prediction of economic theory as rising credit is expected to increase economic activity which will increase aggregate demand and inflation. This could also reflect the involvement of Government in the financial sector which results in the growth of credit not reflecting the true level of aggregate demand in the economy.

The real GDP increases to an increase in credit, reflecting that increasing credit increases economic activity. However, the real GDP starts to decrease from the beginning of the second quarter to the end of the third quarter. This could be explained by other factors in the economy because the mining sector contributes a significant proportion to output in Botswana, resulting in the monetary authorities having only limited influence on the output level.

Table 4.5.2 presents the variance decomposition of the credit channel. The results show that the monetary policy impacts the economy with a lag as inflation accounts for 100 percent of its movement in the first quarter, and continues to dominate in the remainder of the quarters. Again the policy interest rate accounts for more variation in inflation than other variables do. In the fourth quarter when the monetary policy is in full effect, the policy interest rate contributes 12.7 percent to variation in inflation, while the real GDP contributes 6.3 percent to variation in inflation and the total credit accounts for 3.6 percent. This reflects that the monetary policy in this channel has little effect in influencing inflation.

4.7.3 The Exchange Rate Channel.

Figure 6 Impulse response of the exchange rate channel

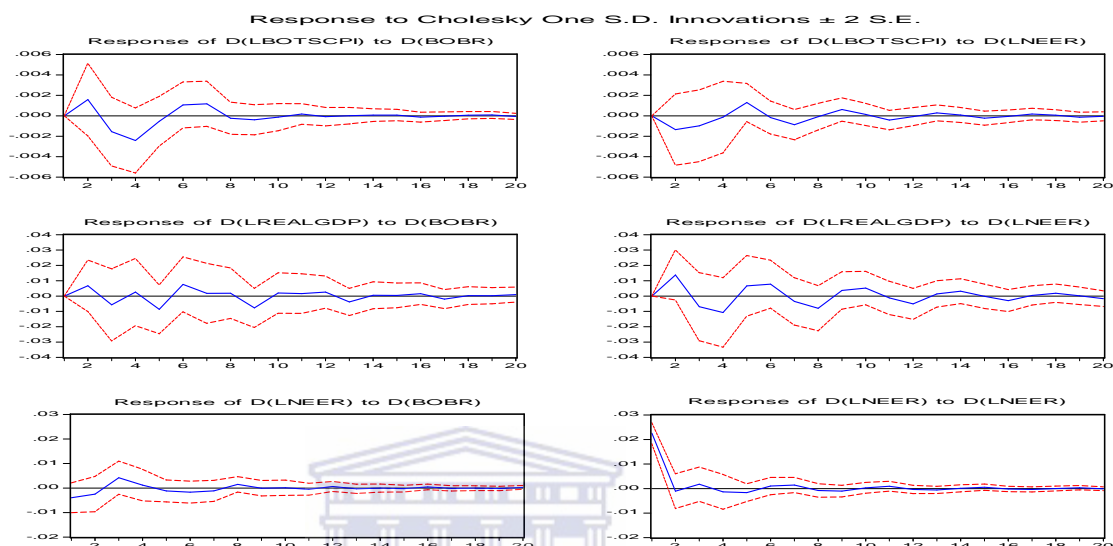


Table 4.5.3: Variance decomposition of the exchange rate channel

Period	S.E.	D(LBOTSCPI)	D(LREALGDP)	D(BOBR)	D(LNEER)
1	0.011303	100.0000	0.000000	0.000000	0.000000
2	0.011774	92.20816	2.559763	3.104314	2.127760
3	0.011961	90.12334	2.580481	4.892160	2.404022
4	0.012316	85.43016	5.421190	6.827450	2.321204
5	0.012433	84.98690	5.322216	6.768490	2.922390

Figure 6 presents the impulse response results of the exchange rate channel. The results show that a tight monetary policy leads to an appreciation in the exchange rate as predicted by economic theory. An appreciation in the exchange rate leads to a decrease in inflation. This happens as the domestic currency appreciates, the prices of imported goods decline, resulting in low inflation. The exchange rate depreciates later in the fourth quarter, following a similar pattern as the response of the exchange rate in the standard model does.

Table 4.5.3 reflects the variance decomposition of the exchange rate channel. According to the results, the monetary policy also affects the economy with a lag in the exchange rate channel. The policy interest rates contribute 6.8 percent of variation in inflation when the monetary policy is in full effect, and the real GDP accounts for 5.42 percent, while the nominal effective exchange rate accounts for only 2.3 percent of the variation. This limited response of inflation to an exchange rate shock can be explained by the managed exchange rate regime the country adopted.

Overall, a monetary policy seems to have an effect on the economy, even though it is limited. The exchange rate channel reflects a very weak response of inflation compared to other channels. Among the three channels, the monetary policy interest rate has a greater effect through the interest rates channel, although the real interest rates seem not to have a greater effect on inflation. Credit responds accordingly to a monetary policy shock, but the response of an increase in credit appears to contradict economic theory. Inflation increases with an increasing credit. However, this is not surprising as in Botswana credit is considered not to fully represent demand conditions in the economy as credit is affected by other macroeconomic policies which are meant to promote economic diversification by providing subsidies in different sectors.

4.8 **Conclusion**

The standard VAR model reflects that all the other variables (output, money supply, and the exchange rate) affecting the demand conditions respond to the monetary policy interest rate with a lag, whereas inflation responds immediately to supply factors. Therefore, since the monetary policy aims at affecting the demand conditions, these results imply that the monetary policy is effective and affects the economy with a one period lag.

The results from different channels show that the monetary policy is more effective in the interest rate channel, with the policy interest rate being responsible for 15.1 percent variation in inflation. The credit channel follows with the policy interest rate contributing 12.7 percent and the exchange rate channel is the worst where the policy interest rate contributes 6.8 percent.

The next chapter concludes the study, stating the challenges faced in this study and the direction for future research.

Chapter 5

5. Conclusions

This study investigated the monetary policy transmission mechanism in Botswana to assess the effectiveness of the monetary policy in Botswana. This thesis specifically focused on how an increase in the short-term policy rate influences other economic variables. The thesis also sought to establish the time it takes for the monetary policy actions to impact on economic variables and the duration of the effect on the economy in general. For this to be achieved, the study adopted the recursive VAR approach, which is considered to be a better approach to investigate the effects of the monetary policy, because it is suitable for use where data limitations, macroeconomic instability and significant structural breaks occur, characteristics of which can be associated with Botswana.

The Botswana economy experienced a series of structural changes which affected the conduct of the monetary policy. This led to the development and reconstruction of the monetary policy framework, from a direct to an indirect approach, employing more monetary policy instruments. In other words, the Central Bank introduced among others OMO and the rolling medium-term inflation objective of 3 – 6 percent, in a bid to attain price stability.

The section on literature review presented the fundamental theoretical basis for the monetary policy transmission mechanism introduced by Hicks in the 1930s, the IS-LM model, which basically explains the interrelation of the monetary policy and the real economy. It suggests that the monetary policy is transmitted through changing interest rates, which will lead to changing demand conditions, by which inflation will be affected. That is, increasing interest rates through a contractionary monetary policy will lead to an increase in the cost of borrowing. This in turn will reduce investment and consumption, resulting in a decline in aggregate spending, causing output to decline and ultimately to a decrease in inflation.

Theoretically, different ways are suggested for the transmission of a monetary policy in the economy, namely the interest rate channel, the credit channel, the asset price channel and the exchange rate channel. Collectively, all these channels argue that the monetary policy influences inflation by affecting other market interest rates and the exchange rate, which will, in turn, affect the real monetary conditions which influence investment and consumption decisions. In

this way aggregate demand, will be affected and thus will determine the margin of the output gap, following which inflation adjusts.

This study estimated a standard VAR for Botswana, including variables such as inflation, output, money supply, the policy interest rate and the nominally effective exchange rate. These variables were varied to explore the different channels of the monetary policy. In other words, to explore the interest rate channel, the real prime rate was introduced to reflect how other market interest rates respond to the monetary policy, and the exchange rate was dropped from the standard VAR model. In exploring the credit channel, the total commercial banks' credit was introduced and the exchange rate and money supply were dropped from the standard VAR model. Finally, the exchange rate channel reflected inflation, output, the exchange rate and the policy rate. The results were statistically not significant but the study continued to analyse the impact of the policy interest rate on economic variables.

All VAR models estimated in this study included the same dummy variables to capture the structural breaks in the economy. Three dummy variables were included. The first dummy variable was used to capture structural breaks due to the introduction of VAT, the second dummy variable was introduced to capture the structural breaks due to the Pula currency devaluation, and the third dummy variable captured the structural breaks due to the 2008 economic recession.

The data used for analysis were from 1995 quarter one to 2009 quarter four. The data were collected from different publications of the Bank of Botswana. The variables used were tested for stationarity; and were found to be stationary after the first difference. Hence, they were used in their first difference to follow the data-generating process (Marcet 2004: 3). The lags of the models were selected using the AIC approach and the SIC approach, as they were considered to be superior because they impose penalties when many variables are used. All models were found to be stable and they had no serial correlation, implying that the models were of best fit.

All the models estimated reflect a price puzzle in the first quarters. The presence of the price puzzle was also detected by Kganetsano (2007: 162), Mmopelwa (2004:53) and Mokoti (2009:48). However, Mokoti (2009:48) argues that the price puzzle reflects how the economy should react. He points out that prices rise with the cost of production caused by a contractionary monetary policy initiative.

The standard VAR model reflects that all the other variables (output, money supply and the exchange rate) affecting the demand conditions respond to the monetary policy interest rate with a lag, whereas inflation immediately responds to supply factors. Therefore, since a monetary policy aims at affecting the demand conditions, these results show that a monetary policy affects the economy with a one quarter lag.

Nonetheless, the standard VAR model generally shows that from the second quarter, the variables included in the model respond as predicted by economic theory, as some variables were flat indicating that it takes a one period lag for these variables to respond to a monetary policy shock. For example, a contractionary monetary policy leads to a decrease in inflation, an appreciation of the exchange rate and a decline in money supply in the second quarter. These responses last up to the fourth quarter, when the model is assumed to be at full capacity. This limited response implies that the monetary policy has little or limited influence on the economy.

These results are confirmed by the variance decomposition results, which reflect that the maximum contribution to inflation variation by 10.9 percent was the policy interest rate. Money supply contributed the least to variation in inflation, around 0.4 percent, implying that money supply is not important.

All the variables in the standard VAR model except for the real GDP fluctuated around the zero line in the seventh quarter. This means that the monetary policy effect lasts for about seven quarters in the economy. The real GDP does not show any response to a shock in monetary policy, possibly because the majority of the contribution to output comes from the mining sector.

With regard to the different channels, the monetary policy is more effective in the interest rate channel, with the policy interest rate being responsible for 15.1 percent variation in inflation. The credit channel follows with the policy interest rate contributing 12.7 percent and the exchange rate channel is the worst with the policy interest rate contributing 6.8 percent. The exchange rate channel is disadvantaged by the crawling peg exchange rate regime, while the credit channel is disadvantaged by the Government policies aiming at promoting economic diversification.

5.1 Limitation of the Study

This study faced challenges of availability of data, which resulted in one of the transmission mechanism of the monetary policy, the asset prices channel, not

being analysed. In addition, due to the fact that Botswana is still a developing country with undeveloped financial markets, the quality of data used is generally poor, which could explain the insignificant results of the impulse response function.

5.2 Direction for Future Work

As the financial sector in Botswana continues to develop, it would be useful to undertake an analysis of the asset prices channel. In the meantime, this study established that there is a price puzzle in Botswana, which calls for further investigation into the response of the economy to the monetary policy at the sectoral level, which might help to explain the puzzle.



Reference list

Al-Mashat, R. and Billmeier, A., (2007). "The Monetary Policy Transmission in Egypt". *IMF Working Paper, wp/07/285*. Washington DC, USA.

Amarasekara, C., (2006). "The Impact of Monetary Policy on Economic Growth and Inflation in Sri Lanka". Central Bank of Sri Lanka.

Arnostova, K. and Hurnik, J., (2004). "The Monetary Transmission Mechanism in the Czech Republic: Evidence from the VAR Analysis". Czerch National Bank, Czech Republic.

Bank of Botswana, (2007). "Annual Report". [online]. Available: www.bankofbotswana.bw. [2009, May 18].

Bank of Botswana, (2008). "Botswana Financial Statistics". [online]. Available www.bankofbotswana.bw. [2009, May 18].

Bernanke, B.S. and Blinder, A.S., (1992), "The Federal Funds Rate and the Channels of Monetary Transmission". *The American Economic Review*, 82(4).

Bernanke, B.S. and Gertler, M. (1995), "Inside the Black Box: The Credit Channel of Monetary Policy Transmission". *The Journal of Economic Perspective*, 9(4).

Bernanke, B.S. and Mihov, I., (1998), "Measuring Monetary Policy." *Quarterly Journal of Economics*, 113(3).

Bhuiyan. R., (2008). "Monetary Transmission Mechanism in a Small Open Economy: A Bayesian Structural VAR Approach" *Queen's Economics Department. Working paper no. 1183*.

Brooks, P.K., (2007). "Does the Bank Lending Channel of Monetary Transmission Work in Turkey?" *IMF Working Paper, wp/07/272*. Washington DC, USA.

Cheng. K.C., (2006). "A VAR Analysis of Kenya's Monetary Policy Transmission Mechanism: How Does the Central Bank's REPO Rate Affect the Economy? *IMF working paper no. 300*. Washington DC, USA.

Christiano, L.J., Eichenbaum, M. and Evans, C., (1996). "The Effects of Monetary Policy Shocks: Evidence from the Flow of Funds." *The Review of Economics and Statistics*, 78.

Cimadomo, J., (2002). "The Effects Of Systematic Monetary Policy on Sectors: A Factor Model Analysis" Universite Libre de Bruxelles, CP 114-av, F.D. Roosevelt,1050, Bruxelles, Belgium.

Clements, B., Kontolemis, G.Z. and Levy, J., (2001). "Monetary Policy Under EMU: Differences in the Transmission Mechanism?". *IMF Working Paper*, wp/01/102. Washington DC, USA.

Chuku, A.C., (2009). "Measuring the effects of Monetary Policy Innovations in Nigera: A Structural Vector Autoregressive (SVAR) Approach". *African Journal of Accounting, Economics, Finance and Banking Research*, 5(5).

Dabla-Norris, E. and Floerkemeier, H., (2006). "Transmission Mechanism of Monetary Policy in Armenia: Evidence from VAR Analysis" *IMF Working Paper*, wp/06/248. Washington DC, USA.

Del Negro, M. and Schortheide, F., (2007). "Monetary Policy Analysis with Potentially Misspecified Models". NBER Working Paper no 13099. 1050 Massachusetts Avenue Cambridge, MA 02138.

Dornbusch, R. and Fisher, S., (1994). "Macroeconomics". Sixth edition. McGraw-Hill Inc. New York.

Enders, W. (2004). "Applied Econometric Time Series" John Wiley & Sons, Inc. 111 River street, Hoboken, NJ 07030, USA.

Frohn, J., (1999). "Structural Macroeconomic Models Vs Vector Autoregressive Models". University of Bielefeld, Department of Economics, 33501 Bielefeld, Germany.

Ganev, G., Molnar. K. and Prezemyslaw, W., (2002). "Transmission Mechanism of Monetary Policy in Central and Eastern Europe". European Central Bank.

Goeltom, S.M., (2008). "The Transmission Mechanism of Monetary Policy in Indonesia" *BIS working paper no.351*.

Gujarati, N.D., (2003). "Basic Econometrics". McGraw-Hill/Irwin, 1221 Avenue of the Americas, New York, USA.

Hermans, H.C.L., (1996) "The History of the Bank of Botswana", *The Research Bulletin: Special Edition*, 14(2) Research Department, Bank of Botswana.

Hung, L.V. and Pfau, W.D., (2008). " VAR Analysis of the Monetary Transmission Mechanism in Vietnam". [online]. Available: <http://ssrn.com/abstract=1257854>. [2010, August 18].

Kalinauskas, Z. and Cuvak, A., (2009). "Application Of Vector Autoregression Model for Lithuanian Inflation". ISSN 1822-6515, Economics and Management. Vilnius Ciediminas Technical University, Lithuania.

Kganetsano, T.A., (2007). "Transmission of Monetary Policy in Botswana". Loughborough University, Department of Economics, England.

Lada, K. and Wojcik, P., (2007). "Macroeconometrics". [Online]. Available: <http://coin.wne.uw.edu.pl/~lgoczek/pdf/macroeconometrics1.pdf>.

Lopes, F.L., (1998), "The Transmission Mechanism of Monetary Policy in a Stabilising Economy: notes on the case of Brazil", [online]. Available: www.bis.org/publ/plcy03.htm [2009, May 18].

Mankiw, G., (2003). "Macroeconomics". Fifth edition. Worth Publishers. 41 Madison Avenue, New York.

Marcet, A., (2004). "Overdifferencing VAR's is ok" Institute d' Analisi Economica (CSIC), UPF, CREI, and CEPR. Prepared for Seminar at CEMFI. [online]. Available: <http://ftp.cemfi.es/pdf/papers/Seminar/marp.pdf> [2009, May 18].

Masalila, K. S., and Phetwe, M., (2001). "Botswana's Monetary Policy Framework", a Paper prepared for the Conference on Monetary Policy Frameworks in Africa, Pretoria, South Africa

Meltzer, A.H., (1995). "Monetary, Credit and Other Transmission Processes". *Journal of Economic Perspective*, 9.

Mies, V. and Tapia, M., (2003). Monetary Policy Transmission Mechanism In Chile: Has The Effect Of Monetary Policy Changed in Time? Why? [Online]. Available: http://www.cemla.org/org/pdf/redviii/chile_mies_tapia.pdf. [2009, May 10].

Mishkin, F. S., (1995). "Symposium on the Monetary Transmission Mechanism". *Journal of Economic Perspective*, 9(4).

Mmopelwa, B. N., (2003). "The Operation and Transmission Mechanism of Monetary Policy in Botswana: A VAR Approach". University of Stellenbosch, Research department, South Africa.

Mohohlo, L. K., (2006). "Monetary Policy Statement". Bank of Botswana. [Online]. Available: <http://www.bankofbotswana.bw> . [2009, May 10].

- Mohohlo, L. K., (2009) “Monetary Policy Statement”. Bank of Botswana, [Online]. Available: <http://www.bankofbotswana.bw> . [2009, May 10].
- Mokoti, P. T., (2009). “The Short Trade-Off between Prices and Output: The Case of Botswana”. Faculty of Humanities, University of Manchester, England.
- Morsink, J. and Bayoumi, T., (1999). “ A Peek Insight The Black Box: The Monetary Policy Transmission in Japan”. *IMF Working Paper, wp/99/137*. Washington DC, USA.
- Negro, M. D. and Schorfheide, F., (2007). “ Monetary Policy Analysis with Potentially Misppecified Models”. *NBER working paper 13099*. 1050 Massachusetts Avenue Cambridge, MA, 02138.
- Rudebusch, G.D., (1998). “Do measures of Monetary Policy in a VAR Make Sense?: A Reply to Christopher A. Sims”. *International Economic Review* 39(4). A Symposium on Forecasting and Empirical Methods in Macroeconomics and Finance, pp 943-948.
- Saizar, C. and Chalk, N., (2008). “Is Monetary Policy Effective When Credit is Low?”. *IMF Working Paper, wp/08/288*. Washington DC, USA.
- Setlhare, L., (2004). “Bank of Botswana’s Reaction Function: Modeling Botswana’s Monetary Policy Strategy”. *South African Journal of Economics*, 72.
- Smal, M. M. and De Jager, S., (2001). “The Monetary Transmission Mechanism in South Africa”. Occasional Paper No. 16. Reserve Bank of South Africa, South Africa.
- Stock, H.J. and Watson, M.W., (2001). “Vector Auto regressions”. *Journal of Economic Perspective*, 15(4).
- Tsangarides, C., (2010). “Monetary Policy Transmission in Mauritius Using a VAR Analysis”. *IMF Working Paper, wp/10/36*. Washington DC, USA.
- Wang, W., Van Gelder, P.H.A.J.M. and Vrijling, J.K., (2005). “Trend and Stationarity Analysis stream-flow Process of Rivers In Western Europe in the 20th Century”. IWA International Conference on Water Economics, Statistics and Finance. Rethymno Greece. [online]. Available: <http://doi.ewi.tudelft.nl/live/binaries/ec906edd-af0e-4ba1-bcd818e7e7cd73ab/doc/paper161a.pdf>.