ANALYSIS OF THE IMPACT OF MONETARY POLICY ON ECONOMIC GROWTH IN NAMIBIA

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Abstract

This study sought to examine the impact of the monetary policy on Namibia's economic growth within Common Monetary Area. The main objective was to empirically estimate the impact of changes in monetary policy on economic growth in Namibia. This was done by regressing the changes in the repo rate with Gross Domestic Product growth rates, inflation rate and real exchange rate as independent variables. The sample consisted of 64 observations spanning from 2000Q1 to 2016Q4, using secondary data obtained from the Bank of Namibia and the Namibia Statistics Agency. To estimate the impact of the monetary policy, the Ordinary Least Square and Vector Auto Regression methods were used. The study notes that, firstly, the correlation coefficient statistics under the descriptive statistics show a negative correlation between repo rates, growth in GDP and the inflation rate. In addition, changes in the policy rate help to explain the rate of inflation in the long run as shown by the Granger causality test. Secondly, results from simple regressions indicate that an increase in the repo rate and average inflation by 1 percent points per quarter on average, reduce the growth rate. By the same token, VAR impulse response from the economic growth and inflation rate revealed that these variables decline in response to monetary policy shock. The GDP response to monetary policy shows that the impact lasts beyond the fifth quarter before growth recovers to initial levels, and inflation lasts less than a year before it settles at initial levels. Furthermore, an increase in monetary policy causes the appreciation of real exchange rate in Namibia. This suggests that a degree of diversion from the anchor country's monetary policy, enables policy makers in anchor countries such as Namibia to have an independent influence towards a favourable economic growth discretionally. The study confirmed that policy-makers are still able to stimulate the economy to a certain degree using the monetary policy instrument without disturbing the peg.

Table of Content

Table of Tables

Tables of Figures

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Last but not the least, to my valuable family, thank you for your sacrifices and unwavering support throughout my studies.

Dedication

I dedicate this thesis to my parents especially my father for his unconditional love, guidance, support and for making me understand the importance of education.

Declaration

I, Grace Kashima, hereby declare that this study is a true reflection of my own research, and that this work or part thereof has not been submitted for a degree in any other institution of higher education.

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Acronyms

ADF: Augmented Dickey-Fuller

BON: Bank of Namibia

CMA: Common Monetary Area

CPI: Consumer Price Index

CPIX: CPI excluding interest rate on mortgage bonds

CRDF: Co-integrating Regression Dickey-Fuller

D-W: Durbin-Watson

ECM: Error-Correction Model

E-G: Engle-Granger

GDP: Gross Domestic Price

GRETL: Gnu Regression, Econometrics and Time-series Library

HIES: Household Income and Expenditure Survey

CPI: Consumer Price Index

M2: Broad Money supply

NEPRU: Namibia Economic Research Unit

NID: Normally Independently Distributed

NPC: National Planning Commission

NSA: Namibia Statistic Agency

ODC: Other Depository Corporation

OLS: Ordinary Least Squares

PAM: Partial Adjustment Model

PP: Phillips-Peron

RSA: Republic of South Africa

SARB: South African Reserve Bank

SBDW: Sargan-Barghava Durbin Watson

VAR: Vector autoregression

UN: United Nations

UNTAG: United Nations Transitional Assistant Group

CHAPTER ONE

1 INTRODUCTION

1.1 Orientation of the proposed study

Namibia attained independence in 1990 and introduced its own currency in 1993. After independence, Namibia opted to remain under the framework of Common Monetary Area (CMA). Within the CMA, South Africa continued to have a decisive influence on the exchange rate and monetary policy framework. The currency is pegged 1:1 to the South African Rand. It is eminent that, under a fixed exchange rate arrangement, Namibia cannot operate a monetary policy that is independent from South Africa, as this will eventually disturb the fixed peg through the workings of the capital account. Thus, a study is necessary to assess the impact of monetary policy on economic growth within Namibia.

The impact of South Africa Reserve Bank (SARB) on the CMA members' economies was evaluated by Ikhide and Uanguta (2010) using VAR, which indicated that lending rates, level of prices and money supply respond instantaneously to changes in the repo rate by the South African Reserve Bank. As a result of this arrangement, Namibia faced challenges with developing economic activities that could entice economic growth. For instance, Sherbourne and Stork (2004) argue that investments in cash and government bonds do not contribute to higher growth and employment in Namibia. In addition, Sherbourne and Stork (2004) claim that due to the Namibian interest rate which cannot deviate much from other members of the Common Monetary Area (CMA), excess funds for commercial banks cannot lead to lower interest rates.

Moreover, Tjirongo (1995) pointed out that there was a major external shock on the Namibian economy in 1980 and 1992. Namibia was unable to make use of the monetary policy as an instrument to overcome external shocks. For example, Alweendo (2013) indicated that GDP declined with real GDP growth only averaging around 2 percent. However, the Central Bank was unable to use monetary policy to mitigate the impact of external shocks due to the arrangement within the CMA. Furthermore, the evidence presented by Wang, Masha, Shirono and Harris (2007), indicated that external shocks often have an asymmetric effect on CMA members.

Costs and benefits of CMA arrangements have been considerably covered by Alweendo (2005), Hawkins and Masson (2003), Kalenga (2005), Tavlas (2008) and others. It is noted that Namibia derives increased benefits from the CMA arrangement. According to Wang et al. (2007), economic growth accelerated in CMA countries since the end of apartheid in South Africa in 1994, compared to other African countries. Furthermore, the statistical analysis of the growth rates of gross national income per capita in the CMA countries confirms the convergence in per capita income over the last two decades but also points to varying performance across countries. All the three small countries (Lesotho, Namibia and Swaziland) achieved a higher average annual growth in per capita GNI in 1994-2005 than in 1980-1993 (Wang et al., 2007, pp.15).

In addition, Seleteng (2015) alluded that, if South Africa (SA) pursues price stability objectives, the impact will be transmitted to Lesotho, Namibia and Swaziland (LNS) and their economies will also be affected. According to Seleteng (2015), LNS countries are prevented from exercising discretionary monetary policies within CMA, a framework in practice which Seleteng (2015) referred to as “de facto monetary policy framework”. The empirical evidence by Seleteng (2015) attested that positive shock on the South African repo rate affects lending rates, inflation, and economic growth significantly in all the CMA countries. A high impact of South African repo rate on the LNS countries inflation and economic growth was observed.

Contrary to that, the stance of monetary policy can deviate to a certain degree from that of the anchor currency by using capital controls and prudential requirements imposed on banking and other financial institutions. These powers make it possible for the Bank of Namibia to maintain a Repo rate different from the Repo rate of the South African Reserve Bank (SARB) when required, and allow it the discretion to control the domestic money supply and impact the Namibian economy (BoN, 2008, p. 6). The Repo rate is utilized as the main policy tool to influence local monetary conditions. It is also apparent from Kamati’s (2014) study that there is a difference between the CMA and other monetary unions within the management and control of monetary policy, which allows the monetary policy rate to deviate from the South African monetary policy rate without endangering the currency peg. While all these concerns and questions are important, there is a need to empirically examine whether the Namibian monetary policy has a significant effect on the growth process of Namibia.

1.2 Statement of the problem

Fundamentally, macroeconomists argue that there is a unidirectional causal relationship between interest rates and economic growth. This means that the interest rate is used as the monetary policy instrument to promote price stability and induce economic growth. However, with the current CMA arrangement, Namibia might not optimally achieve its goals, if the monetary policy intervention is to a large extent dictated by the monetary policy stance taken by South Africa. For example, Wang et al. (2007) argue that, “the CMA members have no formal role in the formulation of the monetary and the exchange rate policies that affect their countries”. Despite this claim, CMA members use their monetary policy to influence domestic conditions such as inflation, economic growth and private sector credit. Occasionally, this invokes the question of how effective it is for CMA members to announce changes to their policy rate?

For this reason, this study examined whether changes in repo rate affect the economic growth in Namibia. It takes into consideration the contributions by Hartmann (2004) who contended that as a member of the Common Monetary Area, it is not possible for Namibia to pursue an independent monetary policy. The role played by the monetary policy in promoting economic growth depends greatly on the nature of the economic system and attitudes toward the use of other methods of regulation within the monetary union. Having all these assertions in mind, this study posits that it is vital to assess the extent to which the domestic monetary policies influence the growth process of Namibia under the CMA.

1.3 Objectives of the study

The main objective of this study is to evaluate the impact of monetary policy on economic growth in Namibia over the sample period of 2001Q1 to 2016Q4. In so doing, the study also attempts to understand how the Bank of Namibia (BoN) uses the Repo rate as a monetary policy instrument to influence inflation and economic activities in Namibia.

The following hypotheses were devised for the purpose of this study:

Null Hypothesis H_{0a}: There is no significant effect of interest rate on inflation and economic growth.

Alternative Hypothesis H_{1a}: There is no significant adverse effect of inflation on economic growth.

Null Hypothesis H_{0b}: There is significant adverse effect of interest rate on inflation and economic growth.

Alternative Hypothesis H_{1b}: There is significant adverse effect of inflation on economic growth.

1.4 Significance of the study

The results of the study may assist the government, the Bank of Namibia and policy makers in developing policies and to enter into monetary arrangements best suited for Namibia's economic realities on the ground. In addition, the study will assist in the management of both monetary and fiscal policies to enable better control of the economy.

1.5 Limitation of the study

The study period ranges from 2001 to 2016 due to limited availability of data on growth in GDP which was only available from 2001. However, the sample size of 64 was sufficient for the study.

CHAPTER TWO

2 LITERATURE REVIEW

2.1 Introduction

The aim of this chapter is to present the various theories and empirical studies on monetary policy. It highlights brief discussions on different theories and empirical studies which are very important to this study and can be used to determine the methodology. The chapter is divided into three parts, namely: (i) Monetary Policy framework in Namibia, (ii) theoretical framework and (iii) empirical literature review.

2.2 Monetary Policy framework in Namibia

The study aims to investigate the effect of changes in monetary policy instrument (interest rate) on economic growth. This section will enhance the understanding how Namibia uses the policy instrument to start the monetary policy transmission mechanism. The channels through which monetary policy changes affect the level of economic aggregates vary from one country to the other. Premised on this background, a brief monetary policy transmission mechanism in Namibia is reviewed to understand the mechanisms through which the monetary policy impacts real economic activity and inflation in Namibia.

Monetary policy has been broadly described as the action of the central bank to influence short-term interest rates, supply of money and credit to achieve macroeconomic stability and produce a conducive environment for sustainable growth. Commonly many central banks use the bank rate as the policy instrument to achieve these goals (Adelina-Geaninam, 2011). In Namibia, the central bank adjusts the bank rate, which is the rate at which it lends money to various commercial banks in Namibia. This rate also refers to the repurchase rate that is repo rate in short. It refers to the inter-bank rate, which is the rate at which commercial banks borrow from one another. This is done through what is known as open market operations.

Namibia's monetary policy framework is underpinned by the exchange rate system which is linked to the South African Rand, and the country's bank rate is kept close to that of South Africa's. Therefore, for any changes that the Bank of Namibia wishes to impose in addition to domestic and international economic conditions, the bank should consider the repo rate decisions taken by the South African Reserve Bank (Bank of Namibia, 2008).

Scholarly empirical evidence indicates that there are costs and benefits with regards to the pegged exchange rate arrangements. So far, the most debated cost is the foregoing of the use of the nominal exchange rate as an instrument of macroeconomic adjustment. In addition, is the increased exposure of the domestic economy to shocks from the anchor country and the inability to mitigate the impact of the other external shocks (Bank of Namibia,2008). However, it must be noted that Namibia was faced with a major decision to remain under CMA after independence. While not undermining the stability and confidence in the economic and domestic financial system, the new government of Namibia's concern was counterbalancing the dependence of the economy on South Africa and this motivated Namibia to join the CMA. Henceforth, Namibia's monetary policy remains submissive to the fixed peg and maintains it to ensure price stability, which is achieved by importing stable inflation from the anchor country. See Figure 2.1 on page 9 for the transmission mechanism.

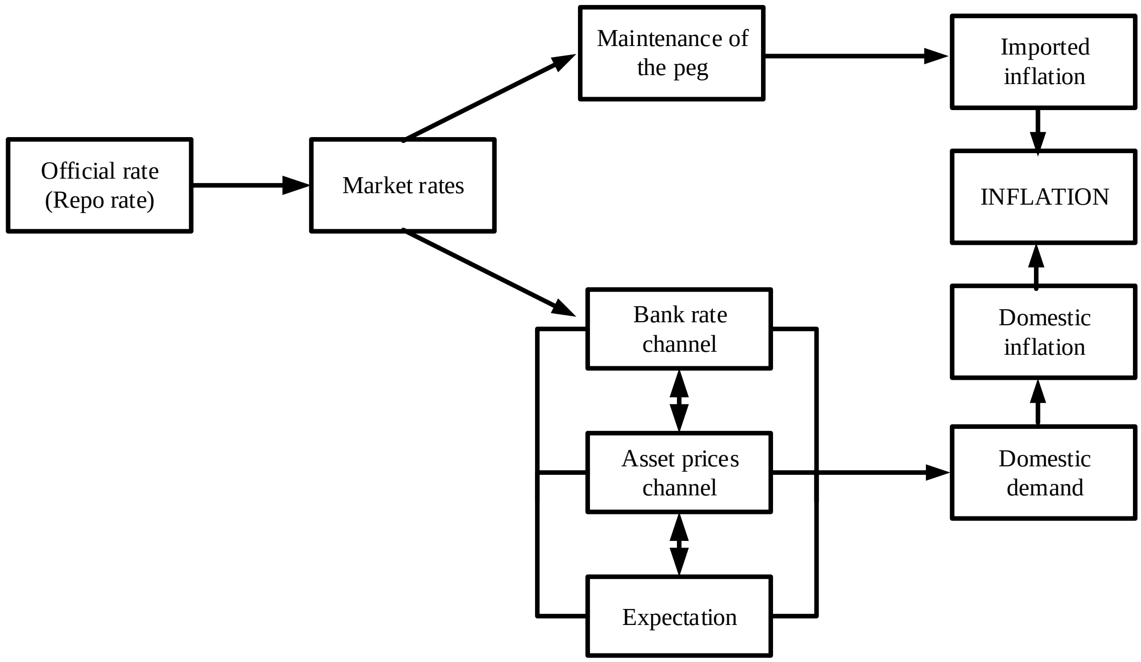

Figure 2.1: *Schematic illustration of the monetary policy transmission mechanism for Namibia. Adapted from "Namibia's Monetary Policy Framework," by Bank of Namibia, 2008, p. 3. Copyright 2008 by Bank of Namibia.*

Ordinarily, when the monetary policy committee changes the repo rate, this action sets of the transmission mechanism from the repo rate to markets prevailing in the domestic economy. Thus, money market rates react in a short-term period to reflect the changes in monetary policy stance. Consequently, other long-term asset prices will adjust to reflect the changes in real rates and expected path in long term real rates. According to BON (2008), commercial banks adjust their lending rates immediately after the official repo rate changes. This in return causes firms and individuals to respond to the change in the commercial bank lending rates by altering their spending and investment decisions. In Namibia's case, BON (2008) observed changes in the borrowing behaviour of individuals in response to interest rate changes to be more pronounced than those of businesses. In addition, changes in household demand patterns eventually filter through to output and domestic inflation. Thus, the repo rate channel is the most important channel in Namibia in terms of influencing the output and inflation rate.

The CMA arrangement is such that it is dominated by South Africa's economy, which as a result is about forty times larger than the Namibian economy. Thus, interest rates and exchange rates are determined by the policies of the SARB. Practically, this means that when interest rates in South Africa change, interest rates in Namibia follow suit. This phenomenon is shown by Figure 2.2, which shows the nominal and prime interest rate for Namibia and South Africa.

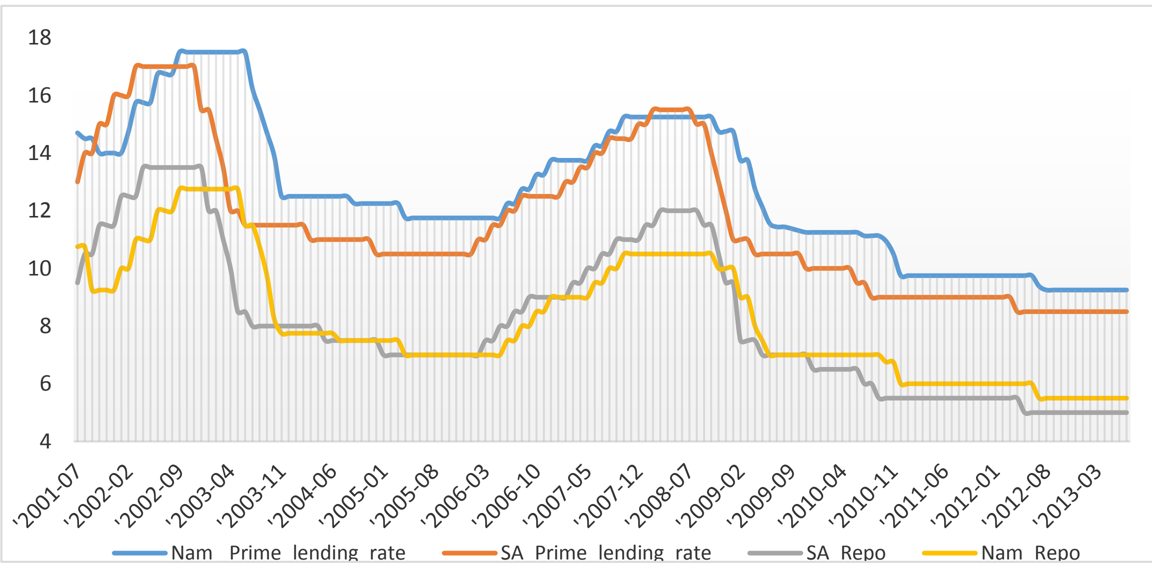

Figure 2.2: *Nominal and prime interest rate for Namibia and South Africa by value 2001-2013 (Bank of Namibia Publications, 2017 & South Africa Reserve Bank publications, 2017).*

The analysis presented in Figure 2.2 allows conclusions to be drawn about Namibia's macroeconomic environment compared to South Africa's macroeconomic environment and highlights the trends which help us draw conclusions with regard to the Namibian monetary policy within the Common Monetary Union.

The prime lending rate is the rate of interest at which commercial banks lend to the public/borrowers. Repo rate (Repurchase rate) is the rate at which commercial banks borrow the Namibian Dollar/South African Rand from the Bank of Namibia/Reserve Bank of South Africa, respectively. The prime rate shown on the chart is the average of the prime rates charged by Namibia and South Africa's commercial banks and is calculated by the Bank of Namibia/Reserve Bank of South Africa.

Although there are times when the Bank of Namibia chose not to engage with the South African Reserve Bank, the chart shows a strong co-movement in prime lending rate and repo rate in the long run.

2.3 Theoretical review of monetary theory

Theoretically, there are various positions that explain the monetary policy's effect on the economic growth in monetary economics. This review shows the key determinants of monetary policy and common variables supported by monetary theories such as: the Keynesian, the Classical and Post Keynesian economic theories.

2.3.1 Keynesian Liquidity Preference Theory

The Keynesian theory of the demand for money was popularised by John Maynard Keynes in his well-known book, The General Theory of Employment, Interest and Money in 1936. The demand for money therefore forms a basis for analysing monetary policy in a form of exogenous money supply manipulated by the central bank to influence the level of interest desired in an economy. Keynes provides explanations regarding people's desire to hold cash and suggests three motives for this. Mainly, people desire to hold liquid cash for transaction, precautionary, and speculative motives. The transaction motive is relative to the desire of individuals to hold money to administer their day to day expenses. While the precautionary motive is related to people's desire to have money for unforeseen contingencies, the speculative motive refers to the desire to have liquid resources to profit future modifications in interest rates or bond prices. At any point in time, individuals therefore weigh up the benefit of holding cash against the returns, i.e. the interest rate they earn on the money balances.

Keynes (1936) also states that transaction and precautionary motives are highly elastic in relation to income, and relatively inelastic in relation to interest. The amount of cash held based on the transaction and precautionary motives (M1) is a function (L1) of the level of income (Y) in the equation form of M1 = L1 (Y) (Keynes, 1936). The three motives can be summarised mathematically in a demand for money equation known as the liquidity preference function. If M nominates the total liquid money, M1 nominates transactions plus precautionary motives, and M2 the speculative motive, we have M = M1 + M2. While M1 = L1 (Y) and M2 = L2 (r), then total liquidity preference function takes the form of an equation as follows:

$$\frac{M_d}{P} = L(r, Y) \quad \text{...} \quad 2.1$$

Where: $\frac{M_d}{P}$ is the demand for money, r is the interest rate and Y is the real income. A rise in income leads to more transactions whereby requires increase in money supply. While a rise in the interest rate increases the opportunity cost of holding money, reducing the real demand for money balances at the existing level of money supply. According to

Njimanted, Akume, and Mukete (2016), the Keynes' theory of liquidity preference does not provide explanations for different interest rates that appear in the market simultaneously. Njimanted et al. (2016), also suggest other factors such as capital productivity and savings that play a major part in determining interest rate.

Laidler (1982) also reflects on the derivation of the liquidity theory equation. According to Laidler (1982), the Keynes's theory of the demand for money implies that velocity fluctuates with interest rate movements. This is how the liquidity preference function for velocity PY/M is derived. Where PY is the nominal level of income, M is equal to the demand for money in nominal terms (M_d). The liquidity preference Equation 2.1 above can now be written as:

$$\frac{P}{M_d} = \frac{1}{L(r,Y)} \quad \text{2.2}$$

Multiplying both sides of Equation 2.2 by Y and letting Md = M (money market equilibrium) and then solving for velocity yields:

$$V = \frac{PY}{M} = \frac{Y}{L(r,Y)} \quad \text{2.3}$$

Where V is the velocity of money.

Laidler (1982) explains that velocity follows interest rate movements such that it increases with an increase in interest rates because of the negative relationship between demand for money and interest rates. This implies that substantial interest rate fluctuations lead to substantial fluctuations in the velocity of money.

2.3.2 Friedman's Quantity Theory of Money (QTM)

Friedman's quantity theory of money states that the general price level of goods and services is directly proportional to the amount of money in circulation. The theory improved Keynes's liquidity preference theory by treating money like any other asset. Friedman concluded that economic agents such as individuals, firms and governments hold a certain quantity of real, as opposed to nominal money balances. If inflation erodes the purchasing power of the unit of account, economic agents will want to hold higher nominal balances to compensate and keep their real money balances constant. Thus, the theory relates the quantity of money to nominal income and it is based on two assumptions. Firstly, it assumes that velocity of money (V) is constant in the short run. Secondly, quantity (Q) is at full employment level. These two assumptions are applicable to Namibia as well.

Friedman's QTM can be expressed mathematically as an equation of exchange as follows:

$$MV = PQ \qquad \text{2.4}$$

Where: M is the quantity of money; P is the price level; Q is the level of output; and V is the velocity of money, which refers to the number of times that money is used to purchase output.

Friedman's quantity theory proved to be more superior than the Keynes's liquidity preference theory because it is more complex, accounting for equities and goods as well as bonds. Friedman allowed the return on money to vary and to increase above zero, making it more realistic than the Keynes's assumption of zero return. As QTM says, the quantity of money determines the value of money, it forms the cornerstone of monetarism.

The theoretical foundation of monetarism is rooted in the quantity equation popularised by Irving Fisher (1911) whose theory is discussed in the next section.

2.3.3 Irving Fisher's Quantity Theory

The economist Irving Fisher's quantity theory of money states that the quantity of money is the main determinant of the price level or the value of money. Cited in Njimanted et al. (2016), Irving Fisher points out that, "Other things remain unchanged, as the quantity of money in circulation increases, the price level also increases in direct proportion and the value of money decreases and vice versa." If the quantity of money is doubled, the price level will double as well, and the value of money will be one half. In the same manner, if the quantity of money is reduced by one half, the price level will also be reduced by one half and the value of money will double.

Fisher's analysis of the transactions velocity is explained by Mishkin (2007) who explicitly states that the velocity of circulation of money begins with a simple identity, where there are always two parties to each transaction represented by a seller and a buyer. This implies that the value of sales must be equal to the value of receipts for the aggregate economy. This further implies that the value of sales must be equal to the number of transactions conducted over a period of time multiplied by the average price. The diagram in Figure 2.3 below explains Fisher's quantity theory of money (A) and (B) in which figure (A) shows the effect of changes in the quantity of money on the price level. When the quantity of money is M, the price level is P and when the quantity of money is doubled to M_2, the price level is also doubled to P_2. Similarly, when the quantity of money is increased to M_4, the price level also increases by four times to P_4. This relationship is expressed by the curve P = f (M) from the origin at 45°.

In Figure 2.3, the inverse relationship between the quantity of money and the value of money is depicted when the latter is taken on the vertical axis. When the quantity of money is M_1 the value of money is HP. If the quantity of money is doubled to M_2, the value of money becomes one-half of what it was before, $1/P_2$. When the quantity of money increases to M_4, the value of money is reduced by $1/P_4$. This inverse relationship between the quantity of money and the value of money is shown by the downward sloping curve 1/P = f (M).

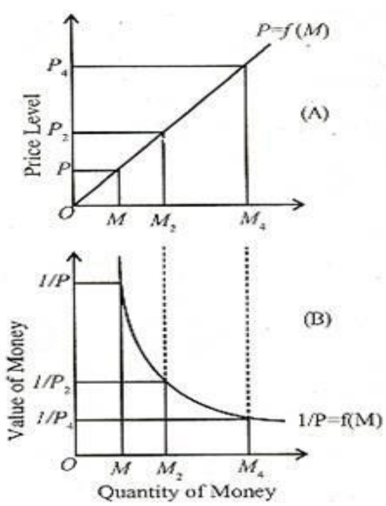

Figure 2.3: *Fisher's quantity theory of money. Adapted from the "Essay on monetary policy and economic growth," by B. Dimitrijević, and I. Lovre, 2013, Journal of Central Banking Theory and Practice, 1(1) p. 118.*

This theory can be expressed mathematically as follows:

$M_S V_T = PT$ *2.5*

Where: M_S is the quantity of money supply, V_T is the number of times that money turns over or money's transactions velocity of circulation; P is the price level; and T is the total amount of goods and services exchanged for money or transactions performed by money. This equation is also known as the equation of exchange and it can be transformed into a relation of quantity theory of money. This theory is based on the determination of the price level and can be shown as follows:

$$\overline{M_S V_T} = P\overline{T} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots 2.6$$

The bars imply that M_S, V_T and T are constants, while the bar on the quantity of money supply ($\overline{M_S}$) signifies that M_S is an exogenous variable. The supply of nominal money is exogenously given, and an equilibrium dictates that the demand must equal supply. This can also be shown mathematically as follows:

$$M_d = k_T P\overline{T} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots 2.7$$

$$k_T = A\frac{1}{\overline{\overline{V_T}}} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots 2.8$$

$$M_d = \overline{M_S} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots 2.9$$

These three equations in 2.7 to 2.8 can be combined into:

$$M_S \frac{1}{k_T} = \overline{M_S V_t} = P\overline{T} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots 2.10$$

From equation 2.10 above, it can be deduced that the supply of money is directly proportional to the level of output and the price level. However, Fisher treats transactions as constant, leaving money demand to solely depend on the price level.

2.3.4 Keynesian and Monetarist Views on Monetary Policy

The one major topic that is highly debated by Keynesian-monetarist is the monetary transmission mechanism. According to Khabo (2002), Keynesians propose a situation whereby the portfolio imbalance does not lead to a decrease in the interest rate. If increases in the money supply do not lead to a reduction in the interest rates, they will result in a situation known as the liquidity trap. A liquidity trap is a situation in which prevailing interest rates are close or equal to zero and thus makes monetary policy ineffective. This is illustrated by the horizontal LM curve and downward sloping IS curve in Figure 2.4 below. The IS curve represents the relationship between the interest rate and the level of income that arises in the market from goods and services, whereas the LM curve represents the relationship between the interest rate and the level of income that arises in the money market (Dimitrijević & Lovre, 2012).

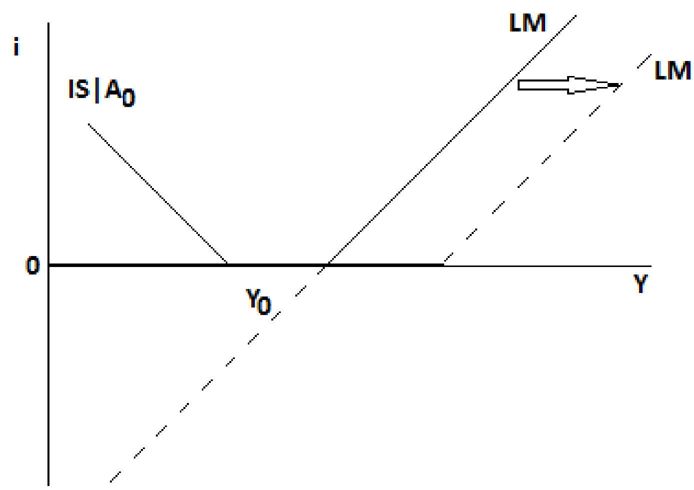

Figure 2.4*: Horizontal LM curve and downward sloping IS curve. Adapted from the "Essay on monetary policy and economic growth," by B. Dimitrijević, and I. Lovre, 2013, Journal of Central Banking Theory and Practice, 1(1), p. 118.*

The changes in the level of output can be affected by changes in the IS curve. However, an increase in the money supply shifts out the LM curve and cannot further drive down the interest rate. Since the interest rates cannot decline, then investments cannot be encouraged by this channel. Thus, the Keynesians argue that the monetary policy will be ineffective in impacting the economic growth and they support the use of fiscal policy to bring about changes in economic growth.

The monetarists dismissed the idea of a liquidity trap. According to Khabo (2002), monetarists argued that the LM curve is vertical rather than horizontal. Thus, the monetarists conceptualised that the demand for money does not depend on the interest rate but rather on the level of income. Consequently, the changes in national income were revealed through the shifts in the LM curve and not the IS curve. By implication, the monetary policy effectively brings about changes in economic growth. This argument is supported by Irvin Fisher's equation of exchange (Ajisafe & Folorunso, 2002). The equation is stated as follows:

$$MV = PY. \qquad 2.11$$

Where M denotes the supply of money, P denotes the price level, Y denotes the level of output and V denotes velocity of circulation. The assumption made by the monetarists is that velocity is constant, and when V is a constant equation (1), this indicates a one-to-one relationship between changes in the stock of money and changes in the value of national income. As a result, equation (1) will be transformed into equation (2) below, where k represents a constant.

$$M = kPY \qquad 2.12$$

This gives a direct monetary transmission mechanism, with changes in money supply directly changing the economy, and explains the basis for the monetarist's argument of the monetary policy's impact on economic growth.

The Keynesian theory asserts that a change in money supply may affect the level of output indirectly via the interest rate and investment. In other words, the demand for money is determined by interactions between income and interest rate. As such, to influence the demand for money, one should either control directly the price for money or indirectly, by inducing changes through real income (Walsh, 2010). In contrast, in the Keynesian theory interest rates are determined by two factors: demand and supply of money; thus, it is viewed as a monetary phenomenon.

Moreover, the function of interest rates in the Keynesian monetary model is what makes the interest rate a viable tool for government interventions through monetary authority in the financial market to manage the economy in the short term. This model is determined by the three stages of the Keynesian transmission mechanism, called the cost of the capital channel. The stages are summarised as, money →interest rate → investment→income. This means that with the increase in the money supply, the interest rate falls while investment and income rise. The rise in price level raises the nominal income which leads to an increase in the transactions and precautionary demand for money, thereby bringing a feedback effect on the economy (Khabo, 2002). Moreover, the rise in price level raises the nominal income which leads to an increase in the transactions and precautionary demand for money, thereby bringing a "feedback effect" on the economy.

Walsh (2010), concurs with the Keynesian theory. Cited in Walsh (2010), Friedman the god-father of monetarism asserts that there was clear evidence that the monetary policy strongly affects the real variables in the short term. However, it is important to note that money plays a more important and larger role in monetarism than in the Keynesian transmission mechanism.

Monetarists agree that money matters for two main reasons: (i) it engenders inflation in the long term; (ii) it drives economic activity and fluctuation in the short run. Henceforth, the monetary policy is effective in influencing the economic activity in the short term. However, in the long term, money growth is the main cause of inflation. Contrarily, in the short run, because of nominal inflexibilities in wages and prices, money affects real income. This indicates that money is not neutral, because it leads to an increase in aggregate demand in the short run, other things being equal.

In this section, we learned that the debate whether money supply is exogenous or endogenous goes back a long way. One can certainly trace the argument that the money supply must be endogenous in a modern economy back to the end of the nineteenth century. In the new macroeconomic consensus, nominal quantity of money is endogenously determined to achieve the desired nominal interest rate. This consensus is clearly spelled out by Walsh (2010), who says that most central banks today use the short-term nominal interest rate as their monetary policy instrument for implementing monetary policy to impact economic growth. Whereas Keynesians argue that the monetary policy's impact on economic growth is ineffective, Monetarists are of the view that changes in monetary policy will impact economic growth.

2.4 Review of empirical studies concerning monetary policy and influence on economic growth

Many studies have been presented on the monetary policy and its influence on economic growth. In developing countries, studies have indicated that the monetary policy has many impacts on the economic development. This is evident in the monetary theory, which states that the monetary policy influences the supply of money and interest rate to accomplish the objectives of the manifestation of the ruling party (Laidler, 2007).

In a study conducted by Onayemi (2013), the results indicated that monetary stability contributed towards price stability in the Nigerian economy since the variation in the price level is mainly caused by money supply. The study also concluded that inflation in Nigeria is to an extent a monetary phenomenon. The study used the Johansen co-integrating result which indicated evidence of a long-run relationship. In another study, Adefeso and Mobolaji (2010) estimated the relative effectiveness of fiscal and monetary policy on economic growth in Nigeria. The result of the study indicated that the effects of the monetary policy are stronger than that of the fiscal policy. Other scholars, Hameed and Amen (2011), used the regression analysis technique. They proved that the interest rate has a minor relationship with GDP but the growth in money supply greatly affects the GDP of an economy. Another study by Nouri and Samimi (2011) examined the impact of monetary policy on the economic growth in Iran using money supply as a measure of monetary policy. The study used data covering the period 1974 to 2008, and the ordinary least squares (OLS) technique was adapted. Findings of the study indicated a positive significant relationship between money supply and economic activities.

Furthermore, in another study by Ridhwan, de Groot, Rietveld, and Nijkamp (2011), the researchers employed Vector Autoregression (VAR) models to measure the impact of monetary policy shocks on regional output in Indonesia. The observations on impulse response functions from the estimated models revealed considerable regional differences in policy responses. The researchers concluded that the differential regional effects of monetary policy were related to sectoral composition, thus providing evidence for the relevance of the interest rate channel of monetary policy. Another study by Hussain, Sabir and Kashif (2016) examined the impact of macroeconomic variables on the GDP of Pakistan. The study involved a 32-year time series data from 1980 to 2011 and employed descriptive statistics and multiple regression investigation to analyse the data. The results indicated an inverse relationship between the inflation rate with GDP and interest rate with GDP, while the exchange rate possessed a positive relation with GDP.

Even though most of the studies cited above confirm the existence of a strong link between the monetary policy and GDP of an economy, they focused more on non-CMA countries. Therefore, it becomes vital to consider some studies undertaken in CMA countries given that the CMA countries share similarities with Namibia, and there could be similar studies on Namibia. For instance, Tjirongo (1998), Tjirongo (1995), Ikhide and Uanguta (2010) have done studies on CMA countries. Tjirongo (1998) employed the autoregressive (AR) and autoregressive distributed lag (ADL) models to test the symmetry of shocks in the Southern African region. The study adopted firstly, the AR and ADL models and secondly, estimated to derive residuals. The study also performed correlation tests to measure the degree of association among the shocks. The results reveal strong positive correlations between real GDP "shocks" in Southern Africa and SACU countries. The empirical study thus supports the existence of correlated shocks among most countries especially, the CMA countries. However, for non-SACU countries, Tjirongo's (1998) results show that there is no correlation with those of SACU.

Another study by Ikhide and Uanguta (2010) employed three steps to examine how a change in the policy instrument of the Reserve Bank of South Africa affected money, credit and the level of prices in Lesotho, Namibia and Swaziland's (LNS) economies and consequently assessed the capability of these economies to undertake independent monetary policies. The first step was the qualitative analysis of the flow of capital. Secondly, the study used a narrative approach to obtain Cumulative Forecast Errors (CFE) from a univariate forecasting equation for each principal variable in each country. Thirdly, a VAR model was run for each country to determine the direction and impact of the monetary policy undertaken by South Africa on key economic variables in the LNS countries and Botswana. In the study, the results of both the impulse response functions and cumulated forecast errors showed that the lending rates, level of prices and money supply responded instantaneously to changes in the repo rate by the South African reserve bank. The analysis confirmed that the South African repo rate was the relevant policy instrument.

In another study by Ridhwana et al. (2011), the researchers performed a meta-analysis to identify the causes of variation on the impact of monetary policies on economic development. The observations used in the analysis were drawn from primary studies that uniformly employed Vector Autoregressive (VAR) models. The researchers' discovered that the capital intensity, financial deepening, the inflation rate, and economic size play a significant role in the variation of the impact of monetary policies.

A recent study by Kamati (2014) examined the effectiveness of the monetary policy instrument in stabilising the inflation and output in Namibia. The study utilised SVAR to analyse interest rate shocks on real GDP, inflation and private credit in Namibia. The findings indicated that domestic repo rate significantly reduced quarterly real GDP, inflation and private credit in Namibia

What emerged from this literature review is that, most researchers have used linear regression, VECM and VAR techniques to investigate the relationships between the interest rate/Monetary policy instrument, inflation and economic growth/GDP level. Also, most of the researchers have adapted the Keynesian monetary model. In this vein, this study will follow the proposition that monetary policy can be used as a stabilizing tool to manage the economy in medium term. Instead of adjusting money supply as was the case in Keynesian monetary theory, this study assumes that the central bank rather adjusts the bank rate (policy rate) to moderate the demand for money and credit in the economy thereby influencing the aggregate demand and aggregate prices in the short run in the domestic economy.

CHAPTER THREE

3 RESEARCH METHODS

3.1 Introduction

The study adopted an econometric model to determine the impact of monetary policy on Namibia's economic growth. Econometrics may be interpreted as the application of mathematics to statistics for the clarification of economic forces and the measurement of their effects. This study covered the period between 1996 - 2016 based on the monetary policy indicators adopted by the Bank of Namibia of impacting real economic activity and inflation in Namibia. The simple linear regression was used to model the relation between the variables (Repo rate, Inflation, and GDP growth rate). Long and short-run dynamics were established using different techniques such as the Augmented Dickey-Fuller (ADF) Unit Root test, Johansen Co-integration test, and Vector Auto Regression. The study's time frame was determined by the data availability from different sources as listed below.

3.2 Data Sources and estimation techniques

The study used preliminary national account data from the Bank of Namibia and Namibia Statistic Agency over a period of 2000: Q1 to 2016: Q4. The period for data collected gave sixty-four (64) data points which were statistically adequate for the study. The study used econometric techniques of unit root to test for stationarity of time series data. Among these approaches was the Augmented Dickey Fuller (ADF) test followed by the Engle-Granger (E-G) process of co-integration. Furthermore, the multivariate systems of equation approach (VAR models) were adopted as a technique to estimate the various parameters specified in equations (4.6) to equation (4.9). The VAR methodology superficially resembled simultaneous equation modeling in that it considered several endogenous variables together. Each endogenous variable was explained by its lagged, or past values and the lagged values of all other endogenous variables in the model. Usually, there are no exogenous variables in the model (Nwafor, Odok, Atsu and Esuabana, 2016, p.80). It is, therefore, an advantage because the VAR model avoids the imposition of potentially spurious constraints that are employed in the specification of structural models.

3.3 Model Specification

Two models were used in this study to examine the effects or the relationship between a dependent (responsible) variable and a number of independent (explanatory) variables. The Bank of Namibia (BoN) uses the monetary policy to influence economic activities, but BoN does not have direct control over the pace of economic growth. Rather, it uses policy tools (Repo rate) to accomplish this task. Changes in repo rate influence inflation and change in inflation influences economic activities.

3.3.1 Simple linear regression model

This model focused on the three variables, namely, the growth in GDP, Repo, and Inflation. In this study, the dependent variable was the Gross Domestic Product (GDP) and the independent or explanatory variables were the inflation and interest rates. The main objective of this model was to establish if there is a relationship between the dependent and explanatory variables. More specifically, the study intended to establish if there was statistically significance between the two variables. The model specified is, therefore:

$$\Delta X2_t = b_0 + b_1 \Delta X_{1_t} + \varepsilon_t \quad \text{3.1}$$

$$\Delta Y_t = b_0 + b_1 \Delta X_{2_t} + \varepsilon_t \quad \text{3.2}$$

Letting Δ = growth rate, GDP at time t =Y_t, Repo rate at time t =X_{1t}, and Inflation at time t =X_{2t} , while b_0 and b_1 denote the parameters or constant and ε_t is the error term normally distributed with a zero mean and a constant variance. The model is re-specified as:

$$\Delta Inflation_t = b_0 + b_1 \Delta Repo_t + \varepsilon_t \ldots\ldots 3.3$$
$$\Delta GDP_t = b_0 + b_1 \Delta Inflation_t + \varepsilon_t \ldots\ldots 3.4$$

3.3.2 Vector Autoregressive (VAR) model

A VAR model is a natural extension of the univariate autoregressive model for forecasting a collection of variables to dynamic multivariate time series (Toda & Philips, 1991). The study used the VAR model as an extension to the previous section to describe the dynamic behaviours of interdependencies and lags among variables. The model comprises of one equation per variable, and the right hand side of each equation includes a constant and lags of all the variables in the system. The variables on the right hand side of the equation are the determinant (independent/explanatory variables) of the growth GDP (dependent variable). Where; ΔGDP refers to growth in GDP; IR is Interest Rate (repo); INF is inflation rate; REER is Real Exchange Rate; e is the Error Term.

A series of four-variable VAR equations is estimated:

$$\Delta GDP = f(IR_t, INFLA_t, \Delta REER_t) \ldots\ldots 3.5$$
$$IR_t = f(\Delta GDP_t, INFLA_t, \Delta REER_t \ldots\ldots 3.6$$
$$INFLA_t = f(\Delta GDP_t, IR_t, \Delta REER_t. \ldots\ldots 3.7$$
$$R\Delta EER_t = f(\Delta GDP_t, IR_t, INFLA_t \ldots\ldots 3.8$$

In the following relation equations 3.6 to 3.9 exogenous variables can influence endogenous variables at time t, at time t-1 and at time t-2. This relation therefore specifies a VAR model which can be represented by the equations (3.6 to 3.9).

Thus:

$$GDP_t = A_0 + A_1GDP_{t-1} + A_2GDP_{t-2} + A_3INFLA_{t-1} + A_4INFLA_{t-2} + A_5IR_{t-1} + A_6IR_{t-2} + A_7REER_{t-1} + A_8REER_{t-2} + \varepsilon_1 \qquad 3.9$$

$$IR_t = B_0 + B_1IR_{t-1} + B_2IR_{t-2} + B_3GDP_{t-1} + B_4GDP_{t-2} + B_5INFLA_{t-1} + B_6INFLA_{t-2} + B_7REER_{t-1} + B_8REER_{t-2} + \varepsilon_2 \qquad 3.10$$

$$INFLA_t = C_0 + C_1INFLA_{t-1} + C_2INFLA_{t-2} + C_3IR_{t-1} + C_4IR_{t-2} + C_5GDP_{t-1} + C_6GDP_{t-2} + C_7REER_{t-1} + C_8REER_{t-2} + \varepsilon_3 \qquad 3.11$$

$$REER_t = D_0 + D_1REER_{t-1} + D_2REER_{t-2} + D_3INFLA_{t-1} + D_4INFLA_{t-2} + D_5IR_{t-1} + D_6IR_{t-2} + D_7GDP_{t-1} + D_8GDP_{t-2} + \varepsilon_4 \qquad 3.12$$

The assumption of money and monetary policy is based on this theory. Generally, when interest rates are lowered, more people are able to borrow more money. This results in consumers having more money to spend, causing the economy to grow and the inflation to increase. On the other hand, high interest rates make savings more attractive and encourage more savings. This results in a less disposable income to spend due to the increase in savings, thus the economy slows down and the inflation decreases.

3.3.3 Definitions of Variables

This section gives a brief description of variables employed in this study.

Economic Growth - According to Black et al. (1997, p.178) in economics, "GDP is defined as the value of all goods and services produced within the geographic territory of an economy in a given interval, such as a year." A well-known formula for GDP has been stated as the total market value of all final goods and services produced in a country in a given year, equal to total consumer, investment and government spending, plus the value of exports, minus the value of imports. The annual GDP growth rate has been taken as a dependent variable in this study.

In this study, GDP is taken as the sum of gross value added by all Namibian producers to the economy plus any product taxes and minus the financial intermediation services indirectly measured and subsidies on products. It is calculated without making deductions for depreciation of fabricated assets or for depletion and degradation of natural resources.

Inflation Rate - Inflation refers to the persistent rise in general price levels. Inflation affects the distribution of both income and wealth (Black et al., 1997, p. 292). Inflation, as measured by the consumer price index, reflects the annual percentage change in the cost to the average consumer of acquiring a basket of goods and services that may be fixed or changed at specified intervals, such as yearly. In Namibia, the consumer price index is based on the representative of a household's basket of goods and services which is adjusted from time to time. Based on the available data, Namibia has experienced a double-digit inflation of varying degrees of severity in early 2003 and in 2008 to 2009. Significant to note is Kamati's (2014, p. 61) observation that, ''A consensus has emerged among practitioners that the instrument of monetary policy ought to be the short-term interest rate, that policy should be focused on the control of inflation, and that inflation can be reduced by increasing short-term interest rates.'' This provides the basis to examine the impact of the monetary policy by controlling inflation in order to produce a conducive environment for economic growth.

Interest Rate - The term interest rate usually refers to the price at which funds can be borrowed. The interest rate referred to in this study is the repo rate. The repo rate is the monetary policy instrument by which the Bank of Namibia (BoN) influences variables such as money, credit, and other asset prices. The repo rate is kept close to the South

African Reserve Bank’s repo rate to maintain the fixed peg as indicated in Figure 2.1 in the previous section. Commercial banks borrow money from the Bank of Namibia at this rate, and this, in turn, affects other interest rates in the economy. Changes to the Repo rate usually consider not only the SARB’s decision about its repo rate, but also the domestic economic conditions, international economic conditions, and future prospects (BoN, 2008). The changes in the repo rate will capture the effect of monetary policy changes on both inflation and economic growth.

Exchange Rate - The price of a unit of domestic currency is expressed in terms of the foreign currency. An exchange rate thus has two components, the domestic currency, and a foreign currency, and can be quoted either directly or indirectly. Namibia’s monetary policy framework is underpinned by the exchange rate system linked to the South African Rand. This link, which requires that Namibia’s currency in circulation is backed by international reserves, ensures that Namibia imports price stability from the anchor country (BoN, 2008). So, the real exchange rate dynamic in the VAR is essential to capture the effect of competitiveness in the economy which also affects the responses of the central bank in circumstances where there is enough room to impact inflation without endangering the fixed peg.

Table 3.1: Description of Variables

Description of the variable		
Abbreviation	**Variable Names**	**Expected sign**
IR	Repo Rate	Negative
INFLA	Inflation	Negative
REER	REER Exchange rate	Positive
GDP	Gross Domestic Product (GDP) in real terms	Positive

Note: Expected sign refers to the estimated sign of coefficient expected from the simple regression.

3.4 Data analysis

The data collected from the secondary source stated in Table 3.1 above were sorted out, edited and collated with the aid of simple tables. This was done to examine the trend and identify possible structural breaks in the data. Further this will assist to explain any anomaly with the regression results. The Econometric analysis, was done using the package called Gretl to test the variable stationarity of the data, and to estimate the single regression and VAR model. The stationary test was essential to avoid spurious regression, and to ensure that regressions provided consistent and meaningful economic results.

Stationarity is a very important characteristic of models containing variables that are non-stationary and that could lead to spurious (misleading) regression results. These could lead to incorrect conclusions thus leading to incorrect policy formulations. Using Gretl, unit root tests were performed in this study to test the statistical properties of the time series. The test analysis used was the Augmented Dickey Fuller unit root test. The values of b0 and b1 in the first model, equation 3.1 and 3.2 on page 27 were obtained by using the ordinary least squares estimation technique with the help of an econometric package (Gretl).

Moreover, in model 1 (linear regression equation), the value of the R^2 is used to determine how strong or weak the GDP growth rate regression equation is. If R^2 value lies between 0.8 and 1, then one can conclude that the regression equation is strong. However, if the value of the R^2 lies between 0 and 0.5, then one can deduce that the regression equation is a weak one. In addition, the value of the R^2 is used to determine by how much the change in the independent variable(s) explain the changes in the dependent variable, called the explained variation.

CHAPTER FOUR

4 RESULTS AND DISCUSSION

4.1 Introduction

This chapter presents the results of the study and discussions thereof. The main objective of this study was to estimate and analyse the impact of monetary policy on economic growth. While it is generally agreed that monetary policy can significantly affect both real economic activity and prices, considerable debate on the effectiveness of monetary policy in CMA countries that have pegged their respective national currencies on the ZAR, remains prevalent. The study estimated how monetary policy effects are transmitted to inflation and economic growth in Namibia.

These models include the analysis of interrelated variables such as changes in interest rate (Repo rate), changes in inflation and changes in exchange rate, to determine how they correlate to changes in the economic growth. The study adopted both the statistical significance as well as the theoretical expectation criteria for accepting or rejecting the null hypothesis which states that key monetary policy indicators have no significant impact on economic growth.

Section 4.2 presents the time series plot results. Section 4.3 presents the results of the descriptive analysis. Section 4.4 shows the results of the regression analysis, and section 4.5 the correlations of variables; section 4.6 focuses on the time series comparison graphs; 4.7 on the Regression analysis results and 4.8 on the VAR model results.

4.4 Time Series Plot

The time series plot was intended to look at the data graphically to determine any potential problems related to it (the data). Simple statistical plots present the initial idea on whether there are structural breaks or drifts in the variables under study. As such, it is helpful to examine the trends and evaluate the stationarity of the data first. All the variables in the data set are plotted against time to give an idea of each variable's movements over time. In Figure 4.1, the plots for ΔGDP and Inflation have a constant mean, thereby suggesting a stationary phenomenon in ΔGDP and Inflation. As for Figure 4.2, REER and Repo rate appear to be trending downward and upward respectively, while their first differences appear to wander around some constant amount. This essentially suggests that the differenced variables are stationary, as they fluctuate around the mean zero. However, the time series plots alone are not sufficient to conclude stationarity, hence, there is a need to apply the ADF test on all variables by performing unit root tests. The unit root test results are highlighted in section 4.3.

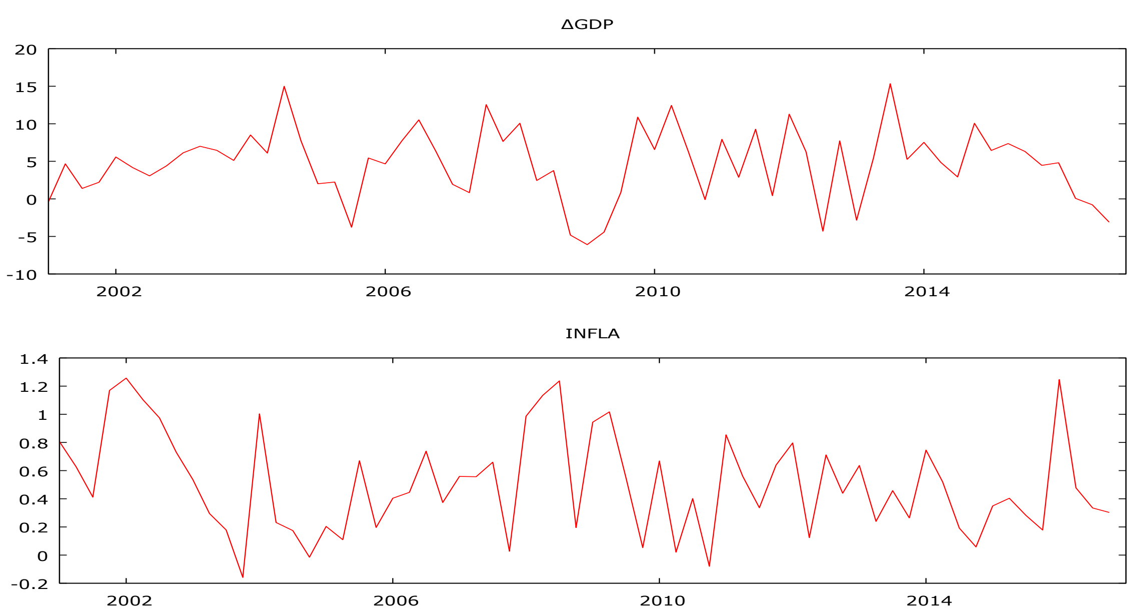

Figure 4.1: *Time Series Plot - ΔGDP and INFLA (Bank of Namibia Publications, 2017).*

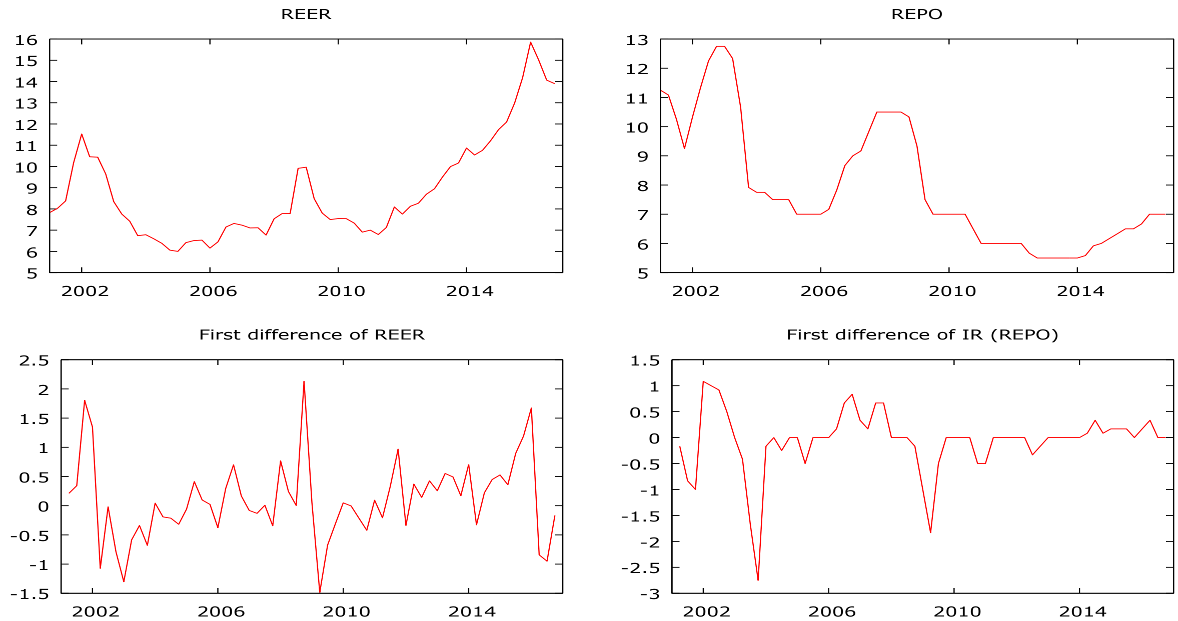

Figure 4.2: *Time Series Plot - REER, differenced REER, REPO, differenced REPO (Bank of Namibia Publications, 2017)*

4.4 Unit root test

The Augmented Dickey Fuller (ADF) test was used to test if a time series has a unit root mean non-stationary. Two possibilities were expected from this analysis: 1) when p-value < significance level, the null hypothesis of unit root must be rejected; meaning that the variable is known to be stationary, and 2) when p-value > significance level, the study has failed to reject the null hypothesis, and therefore concludes that the variable is non-stationary.

Table 4.1 below suggests that at the 10% level of significance, the ADF tests did not reject the hypothesis of non-stationarity for the interest rate (IR) and the exchange rate (REER) variables test. This required performing the ADF tests by differencing the variables at least once. From section 4.2, it was observed that the differenced variables displayed the tendency of being stationary. Thus, differenced variables will be tested as well to ascertain if this was the case.

The differenced variables reject hypothesis of non-stationarity for both regressions with trend and with no trend for the interest rate and the exchange rate (REER). As such, the study used the differenced interest rate (d_IR) and exchange rate (d_REER) for the rest of the study to examine the impact of monetary policy on inflation and economic growth. The aim was to establish a statistical significant relationship between changes in the interest rate and inflation and, the economic growth, both from single equations and VAR models. As stated in the objectives, the study intends to test whether the changes in monetary policy are statistically significant in influencing the change in GDP and inflation. In the VAR form, the study examined the impulse responses for economic growth and inflation in response to changes in the monetary policy. It was expected that an increase in the repo rate will reduce inflation and economic growth, that is, a dynamic response of downward movement in the economic growth rate and inflation from quarter one to some quarters ahead.

Table 4.1: Stationary Test

Augmented Dickey Fuller test results			
Variable	**with Constant**	**with Constant and Trend**	**null hypothesis**
ΔGDP	0.00	0.00	reject
INFLA	0.00	0.00	reject
IR	0.12	0.07	cannot reject
REER	0.79	0.92	cannot reject
INFLA	0.00	0.00	reject
d_IR	0.00	0.00	reject
d_REER	0.00	0.00	reject

Note. P-value significance 1%, 5% and 10%. Repo and REER failed to reject at 10%

4.4 Descriptive Analysis

Descriptive statistics were performed to examine the distribution of data, and to account for the mean, median, standard deviation. The 16 years average quarterly growth rate of the Gross domestic product shows a high average change of 5.2% per year with a standard deviation of the mean 4.7%. The GDP growth rate shows a maximum (increase) of 15.34% in a quarter with a minimum decrease of -6.09%. The average quarterly growth rate of repo rate shows an average change of 0.07% with a standard deviation of the mean of 0.049%. Furthermore, the interest rate growth rate shows a maximum (increase) of 1.1% and a minimum of -2.4% in 16 years. The average quarterly growth rate of inflation shows an average change of 0.49% with a standard deviation of the mean being 0.36%, a maximum growth of 1.3% and a minimum growth of -0.16%. The average quarterly growth rate as a percentage of the exchange rate shows an average change of 0.10% per quarter, with a standard deviation of the mean being 0.7%, a maximum quarterly growth rate of 2.1% and, a minimum of -1.5%. All variables are fair to moderately symmetric, except for the change in the interest rate and exchange rate which is highly skewed to the right. The Kurtosis for most variables is also close to zero except for the differenced variables which are higher than zero, with the highest of 6.32 for the differenced interest rate.

Table 4.2: Descriptive Statistic

	ΔGDP	**IR (Repo)**	**INFLA**	**REER**	**ΔIR (Repo)**	**ΔREER**
Mean	4.75	7.85	0.51	8.80	0.07	0.10
Standard Error	0.59	0.26	0.04	0.30	0.08	0.09
Median	5.26	7.00	0.45	7.81	0.00	0.05
Standard Deviation	4.72	2.08	0.36	2.39	0.61	0.68
Sample Variance	22.25	4.33	0.13	5.71	0.38	0.46
Kurtosis	0.06	-0.36	-0.59	0.82	6.32	1.29
Skewness	-0.22	0.87	0.41	1.21	1.82	0.53
Range	21.43	7.25	1.42	9.86	3.83	3.61
Minimum	-6.09	5.50	-0.16	6.00	-1.08	-1.48
Maximum	15.34	12.75	1.26	15.86	2.75	2.13
Sum	299.35	494.58	32.54	563.03	4.25	6.07
Count	63.00	63.00	64.00	64.00	63.00	63.00
Largest(1)	15.34	12.75	1.26	15.86	2.75	2.13
Smallest(1)	-6.09	5.50	-0.16	6.00	-1.08	-1.48
Confidence Level (95%)	1.19	0.52	0.09	0.60	0.15	0.17

4.6 Correlations

Tables 4.3 and 4.4 below, present the correlation matrix with all the four variables used in the study. The correlation matrix reveals that the exchange rate (REER) had a positive influence on the GDP growth while the rest of the variables had negative effects. The essence of this correlation matrix was to examine the variables in the data date. As shown in Section 3.2, these variables were anticipated to be negatively correlated, thus the outcome depicts correct signs on the regression coefficient. This further shows that the VAR model will result in a sensible impulse response.

Table 4.3: Correlation Matrix 1

Correlation Coefficients, using the observations 2001:2 - 2016:4 5% critical value (two-tailed) = 0.2480 for n = 63				
ΔGDP	**INFLA**	**ΔIR**	**ΔREER**	
1.0000	-0.1707	-0.2354	0.0434	**ΔGDP**
	1.0000	-0.1797	0.1565	**INFLA**
		1.0000	-0.1637	**ΔIR**
			1.0000	**ΔREER**

Table 4.4: Correlation Matrix 2

Correlation Coefficients, using the observations 2001:2 - 2016:4 5% critical value (two-tailed) = 0.2480 for n = 63				
ΔREPO	**ΔGDP**	**INFLA**	**ΔREER**	
1.0000	-0.2354	-0.1797	-0.1637	**ΔREPO**
	1.0000	-0.1707	0.0434	**ΔGDP**
		1.0000	0.1565	**INFLA**
			1.0000	**ΔREER**

4.7 Time Series Graphs comparison

The graphical representation of data over time in Section 4.2 reveals important insights into how the variables have changed over time. However, comparing two sets of seemingly related data can provide additional insight. Figures 4.3 to 4.5 below enable one to compare two variables on the same graph and to see the relationship between the two variables graphically. The graphs also show that all variables' volatilities have followed a similar trend over the study period but with different intensities. In Figures 4.3 and 4.4, however, the variables are inversely related.

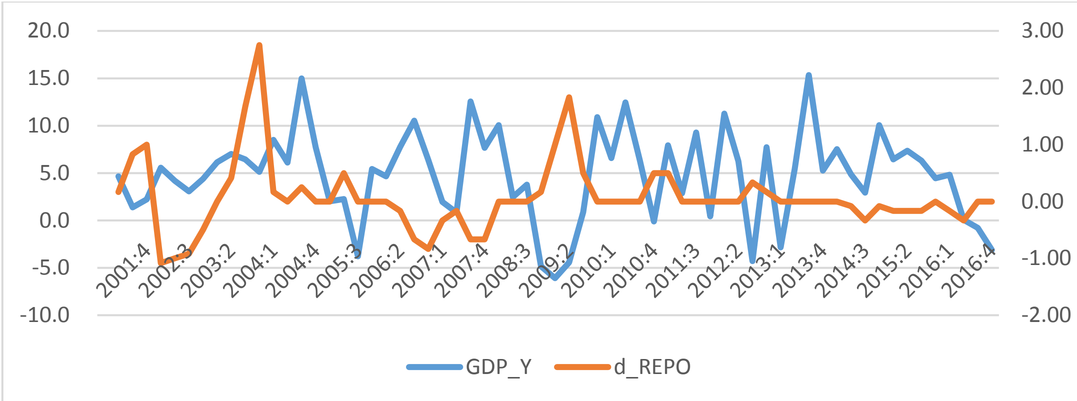

Figure 4.3: Growth in GDP and Change in Interest rate graph

There is a negative relationship between the growth in GDP and Interest rate (Repo) as shown in Figure 4.3 above. The time series graph of Figure 4.3 illustrates a situation where as one variable increases in value, the other variable tends to decrease. This is more evident in 2002 to 2010.

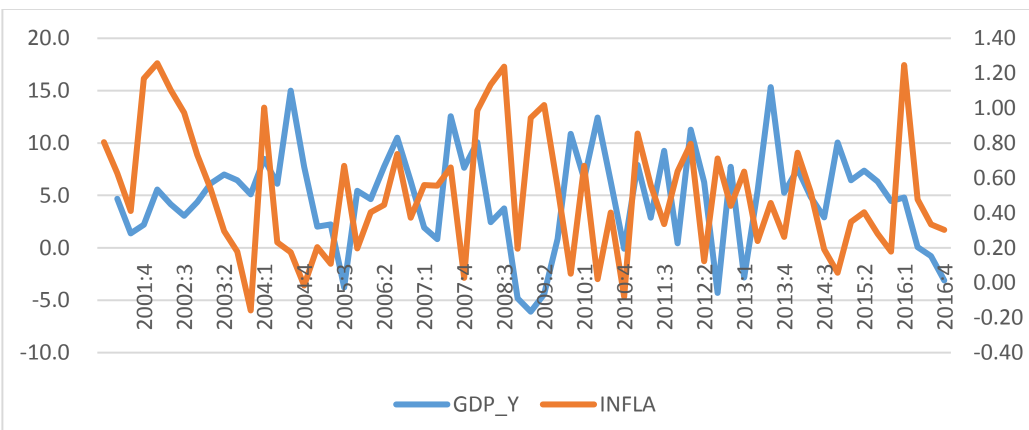

Figure 4.4: Growth in GDP and Change in Inflation rate graph

There is a negative relationship between growth in GDP and Inflation as shown in Figure 4.4 above. The time series graph of Figure 4.4 illustrates a situation where as one variable increases in value, the other variable tends to decrease. This is more evident in 2002 to 2009.

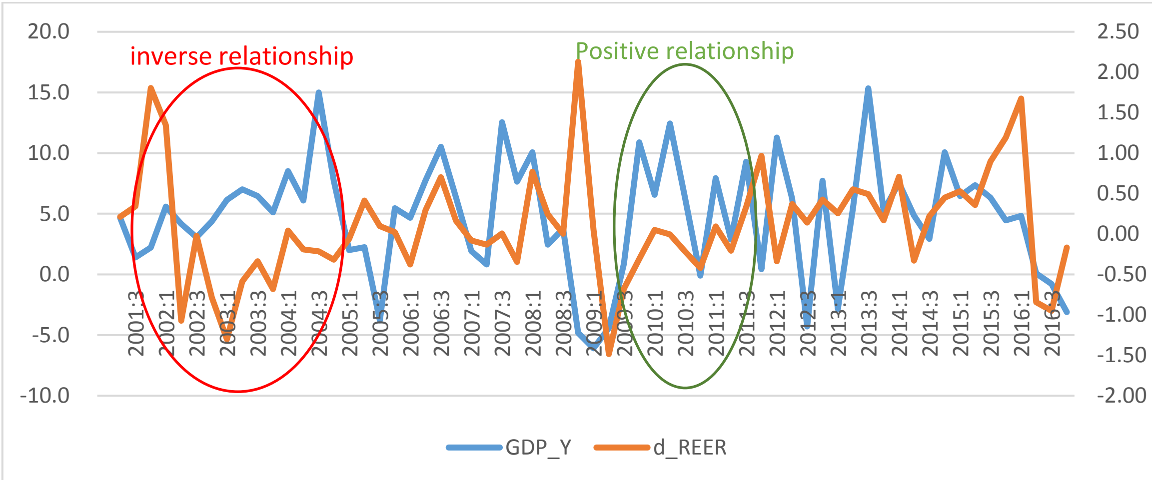

Figure 4.5: Growth in GDP and Change in Exchange rate graph

There is a negative relationship between the growth in GDP and the exchange rate in some quarters, and a positive relationship in between the two variables in other quarters as shown in Figure 4.5 above.

4.8 Regression Analysis

In this section, goodness of fit, individual significance and coefficient analysis of each independent variable and overall significance of the model will be examined. The analysis started by estimating the relationship between economic growth, inflation, change in exchange rate and changes in interest rate. The aim is to establish whether there is a significant relationship between changes in Repo rates and changes in GDP and inflation in Namibia. Subsequently, the change in exchange rate was then removed, to analyse the results with only two variables which are the main monetary policy instruments (change in Repo rate and Inflation).

4.8.1 Simple linear regression model

Table 4.5: OLS Output (ΔGDP as dependent variable)

Dependent variable: ΔGDP				
	coefficient	**std. error**	**t-ratio**	**p-value**
Part A: with all variables				
const	6.35	1.023	6.21	0.00***
ΔIR	−2.07	0.97	−2.13	0.03 **
ΔREER	0.23	0.87	0.27	0.78
INFLA	−2.95	1.66	−1.77	0.08 *
DW=1.72, R^2 = 10.35%, Estimated model with all three variables is $\frac{\Delta GDP}{S.E.} = \frac{6.36}{(0.94)} - \frac{2.08\Delta Repo}{(1.07)} + \frac{0.24\Delta REER}{(1.00)} - \frac{3INFLA}{(1.34)}$				
Part B: with two variables				
const	6.35	1.02	0.63	0.00***
ΔREPO	-2.11	0.96	2.014	0.0485 **
INFLA	-2.90	1.64	−2.115	0.0386 **
DW=1.72				
DW=1.72, R2 = 10.35% Estimated model with two variables model is $\frac{\Delta GDP}{S.E.} = \frac{6.36}{(1.015)} - \frac{2.11\Delta Repo}{(1.636)} - \frac{2.9INFLA}{(1.049)}$ R^2 = 10.22%				

Note: *indicate the significance level: * = significant at 1%, ** = significant at 5% and ***= significant at 10%. DW= Durbin-Watson

The estimated coefficient for ΔRepo and inflation in Table 4.5-part A above was negative. This implies an inverse relationship between changes in Repo rate and inflation rate on the ΔGDP. This is indicated by the coefficient of -2.08 and -3, illustrating the magnitude by which GDP would change (in this case would decrease) per unit change in the Repo rate and in inflation, respectively. The results were also significant at the 10 and 5 per cent levels of significance. What this means is that a rise in changes in ΔRepo rate or in inflation reduces growth in output while a fall stimulates economic activities. This was also confirmed by the graphical representation in Figure 4.3. Premised on this result, the null hypothesis was rejected.

One can therefore deduce that changes in Repo and inflation have a significant effect on economic growth of Namibia. This effect is consistent with the status-quo or theoretical expectation of the study. Thus affirming the theoretic evidence in section 2.2 of the monetary transmission mechanism in Namibia which states that the monetary policy tightening or increase in repo rates leads to a significant–reduction in output. This transmission mechanism is based on the theory which illustrates that increasing the interest rate(s) can contract the money supply because higher interest rates encourage savings and discourage borrowing. Both effects reduce the output.

On the other hand, the coefficient of determinations was found to be low, indicating that the explanatory variables included in the model have approximately, a 10 percent ability to predict the behaviour of ΔGDP. This means that 90 percent was caused by other variables not found in the equation but indicated by the error term. Thus, in Section 4.7.2 this study has included some lagged variables using the VAR model. The VAR model helps the study to include as many lags as possible to take care of the serial correlation and delayed effects of monetary policy. The evidence in the theoretical and empirical studies in Chapter 2 above, reveals that, because of rigidities in the marketplace, it takes time for the economy to react completely to a change in the interest rate. Consequently, the study was motivated to run a VAR model to expand the OLS by capturing the linear interdependencies among the multiple variable time series.

The change in the exchange rate (ΔREER) in Table 4.5-part A was examined as well. One notes that the t-ratio was quite low, and its associated p-value was much larger than 0.05. The study could not reject the null hypothesis since the coefficient is equal to 0. In addition, because a coefficient of 0 essentially erases the contribution of the ΔREER in the ΔGDP regression equation, the study was better off without the ΔREER of the model entirely. This is supported by Studenmund (2014) who observes that "if irrelevant variables are included in the equation, they will reduce the coefficient of determinations however, they will have an insignificant t-score, and have little impact on the other variables' coefficients." Thus, further analysis in Tables 4.6 to 4.9 below with the exclusion of ΔREER to test this theory. Conversely, when a typical omitted relevant variable is included in the equation, its inclusion probably will increase the coefficient of determination and change at least one other coefficient (Studenmund, 2014, p.188).

In Table 4.5-part B, the ΔREER variable was dropped. The estimated coefficients of the ΔRepo and INFLA appear to be statistically significant at 5% in the direction hypothesised, but the coefficient of determinations has reduced. This explains the study's theoretic point of view that the ΔREER is an important variable in the equation. It is however important to note that although the ΔREER turned out to be statistically insignificant, and made the results look bad, it should be left in the equation. The reduction in the coefficient of determination signified that all explanatory variables were supposed to be kept in the equation. These results also strengthen the study's intention to analyse the data using the VAR model.

The study also analysed Durbin-Watson (DW) in Table 4.5. This was done to determine the possibility of serial correlation. The findings were inconclusive as DW was slightly lower then 1.77 (Critical DW value). These results formed the basis for the Durbin-Watson Test Statistics table. The table illustrates that, at 5% significance level, if $DW<1.44$, the study should reject the null of no serial correlation; and if $DW>1.77$ the study should fail to reject the null of no serial correlation. However, if 1.44<DW>1.77, the test is inclusive (Studenmund, 2014, p.547).

4.8.2 Vector Auto regression model

The VAR model output is similar to the OLS model of output, however, the main difference is that it includes the results of more than one equation. As explained in Section 3.3.2, the VAR model is useful in describing the dynamic behaviour of the economic time series and forecasting. The model often provides a more superior forecast to those from univariate time series models and elaborates theory-based simultaneous equation models. This is very useful in the analysis of interrelationships between the different time series. The model further, provides important features such as testing causality and impulse response analysis. In this section, the variables were transformed into logarithmic variables to take care of the outliers for better observations.

The first step was to determine whether the variables were stationary. This had been done in the previous section. Hence, the model used the differences and lagged differences to estimate a VAR model. The section is organised as follows: (1) Optimal lag order was determined; (2) the estimated model from VAR; (3) Granger causality; and (4) impulse response.

4.8.2.1 Optimal lag order

Table 4.6 presents the results on the optimal lag length. As indicated in the two methods, (HQC and BIC), the 1^{st} lag was chosen, whilst AIC chose lag 4. According to Brooks (2008), when choosing the optimum number of lags using the information criterion the chosen number of lags minimises the value of the given information criterion. As such, the 4th lag was selected.

Table 4.6: Var Lag Selection

VAR system, maximum lag order 8					
lags	**loglik**	**p(LR)**	**AIC**	**BIC**	**HQC**
1	-248.44		9.91	10.78*	10.25*
2	-239.12	0.29	10.15	11.61	10.71
3	-223.89	0.02	10.18	12.22	10.97
4	-200.50	0.00	9.91*	12.54	10.93
5	-180.36	0.00	9.76	12.97	11.00
6	-164.78	0.01	9.77	13.57	11.24
7	-137.25	0.00	9.35	13.73	11.05
8	-107.18	0.00	8.84	13.81	10.76

Note: The asterisks below indicate the best (that is, minimised) values of the respective information criteria, AIC = Akaike criterion, BIC = Schwarz Bayesian criterion and HQC = Hannan-Quinn criterion.

4.8.2.2 Estimated results from Vector Auto-Regressive Model (VAR)

The multivariate vector auto regression model for the four variables in respect of the gross domestic product, interest rate (repo rate), real exchange rate and inflation rate are listed below. See Appendix A for the VAR model gretl output, from which the following results were interpreted.

The VAR model Equation A3 in Appendix A represents the ΔGDP regression for Namibia. The results show that the previous two quarters ΔRepo positively influenced the current quarter ΔGDP. These results were not statistically significant. As a result, the null hypothesis could not be rejected. Conversely, the ΔRepo result of the fourth quarter lag negatively influenced the current year ΔGDP. These results were statically significant at 5% confidence level. The results seem to imply that when holding other explanatory variables constant, every one per cent increase in the previous fourth quarter's

ΔRepo, decreased current quarters ΔGDP by 1.79 units. This confirmed the inverse relationship from the OLS model in Section 4.7.1 and, thus the null hypothesis was rejected.

The estimated parameter for the inflation rate on the ΔGDP resembles the ΔRepo. The coefficients of the previous two quarters had a positive insignificant relationship on ΔGDP. However, the previous three quarter's inflation rates had a negative significant impact on the current quarter ΔGDP. This impact was statistically significant at 1% confidence level. This statistic significance implies that every percentage increase in the inflation rate of three quarters could have retarded the current quarter's ΔGDP by 6.07847 unit, all things being equal. This result was expected; hence the null hypothesis was rejected.

The coefficient of the R^2 shows that 52% of the variation in ΔGDP is explained by the estimated relations. The ΔGDP regression was also tested for autocorrelation and established that DW=1.78. This implies that, given the amount of data in the study, there was no autocorrelation. However more lagged variables can be included to improve the model.

Although the findings contrast with the expected priori, they are corroborated by Hussain et al. (2016), Sindano (2014) and Nghifenwa (2009), who also found an adverse relationship between the interest rate and economic growth in Namibia. Furthermore, the empirical results reflect that economic activities in Namibia are determined by interest rate; the effect was not statistically significant in the long run. Logically, this was expected since the volume of monetary policy during the period of study has not been substantial to influence real output significantly. These findings are also consistent with the theoretical expectations and correlate with studies by Hussan, Sabir and Kashif (2016) who also reported a negative influence of inflation on the economic growth in Pakistan, Mamalepot (2004) in CEMAC (cited in Njimanted et al.,2016) and Ngoa and Ondoa (2011) in Cameroon. Given Namibia's state of the economy in general and particularly, the quantity theory of money, the researcher accepts the alternative hypothesis that change in Repo and in inflation has an impact on the level of the economic growth in Namibia.

The results obtained from Equation B1 in Appendix B, illustrated the improved model, where the DW increased to 1.98. This is an indication that the overall estimated model's coefficient of determination was high, which shows an excellent overall fit. The rest of the coefficient signs remained the same. The coefficient of the R^2 also improved to 77%. According to Studenmund (2014), such a fit implies that no estimation is required. The relationship is completely deterministic, and the slope and intercept can be calculated from the coordinates of any two points. In addition, the Durbin–Watson statistic of 1.98 indicates that the hypothesis of no positive serial correlation cannot be rejected. Using the evidence presented, the researcher concludes that the estimated model was appropriate for the study. By the same token, adding lagged variables improved the study's model.
The monetary policy transmission mechanism was also confirmed, thus indicating that the monetary policy works with variable time lags. Such a logic is explained by the theory which states that changes in short term interest rates affect the spending and savings behaviour of households and businesses over time and therefore feed through the circular flow of income and spending.

Such a view strengthens the study's assumption that the monetary policy instrument has a significant impact on the economic growth in Namibia. Consequently, the study underpins the view that whether economic growth is measured by aggregate demand or by real output, the Repo and inflation remain important factors in economic growth.

4.8.2.3 Granger Causality Test

According to Greene (2000), the Granger causality is a circumstance in which one series consistently changes before another series variable, and testing for causality in both ways and directions through testing the hypothesis. This test is essential in this study because it gives one an opportunity to determine which series leads to the other series, which was not tested in section 4.7.1.

Table 4.7: Granger Causality Test

Null Hypothesis (ΔGDP)	**Lag**	**F-Statistic**	**Prob.**	**Conclusion (Hypothesis)**
ΔGDP does not Granger Cause ΔRepo	4	1.04	0.40	Fail to reject
ΔRepo does not Granger Cause ΔGDP	4	0.97	0.43	Fail to reject
ΔGDP does not Granger Cause ΔINFLA	4	0.52	0.72	Fail to reject
ΔINFLA does not Granger Cause ΔGDP	4	2.82	0.04	Reject
ΔGDP does not Granger Cause ΔREER	4	1.14	0.35	Fail to reject
ΔREER does not Granger Cause ΔGDP	4	2.89	0.03	Reject
ΔRepo does not Granger Cause ΔINFLA	4	1.29	0.04	Reject
ΔINFLA does not Granger Cause ΔRepo	4	1.99	0.01	Reject
ΔREER does not Granger Cause ΔINFLA	4	4.36	0.01	Reject
ΔINFLA does not Granger Cause ΔREER	4	1.48	0.23	Fail to reject
ΔREER does not Granger Cause ΔRepo	4	0.80	0.53	Fail to reject
ΔRepo does not Granger Cause ΔREER	4	0.77	0.55	Fail to reject

Notes: The p-values less than 5% means that we reject the null hypothesis.

Table 4.7 above shows that the study adapted the Granger causality test to examine the casual relationship between ∆GDP, ∆Repo, ∆INFLA and ∆REER. The results illustrated that, (1) changes in the Repo Granger-cause changes in inflation; (2) changes in inflation Granger-cause changes in economic activities, and in ∆Repo; (3) on the other hand, changes in exchange rate Granger-cause changes in inflation and economic activities. This indicates that a bi-directional causality runs through ∆Repo to ∆INFLA and ∆INFLA to ∆Repo.

Using the Granger causality test only, a single unidirectional causality in the case whereby ∆Repo Granger causes ∆GDP was also discovered. This unidirectional causality means that passed lagged values of the ∆Repo can be used to predict future values or levels of ∆GDP. This confirms that the ∆Repo can indeed be used by monetary authorities to influence the ∆GDP in the Namibian economy. In addition, passed lagged values of the ∆Repo can also be used to predict future values or levels of inflation and vice versa.

4.8.2.4 Impulse response analysis

In this subsection, the researcher assesses empirically the effects of monetary instrument (Repo rate) shocks on economic growth and other variables. The Impulse response analysis, which enables one to observe the dynamic behaviour of the endogenous variables is in the VAR model.

Figure 4.6 represents the response of economic growth to a shock in change in the Repo rate in the short term. A one standard deviation shock to ∆Repo causes the ∆GDP to peak about 2 quarters then it begins to decrease eventually and steadily below its initial level lasting up to the 4th quarter, before the ΔGDP returns to its initial level. This was statistically significant at the 10% confidence level.

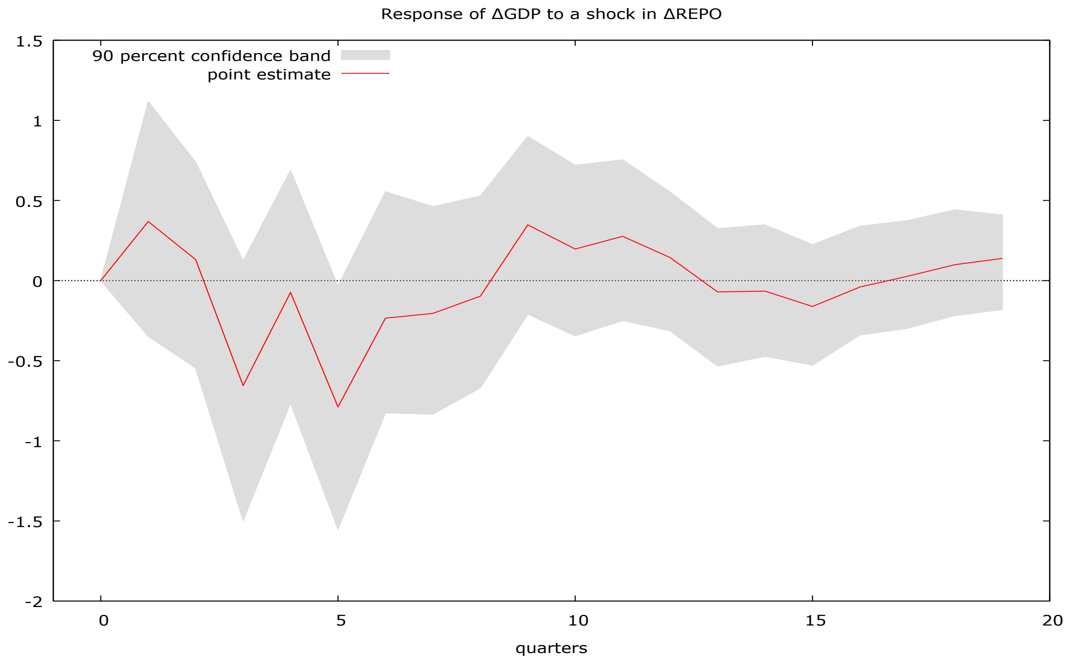

Figure 4.6: Impulse Response of ΔGDP to a shock in ΔRepo

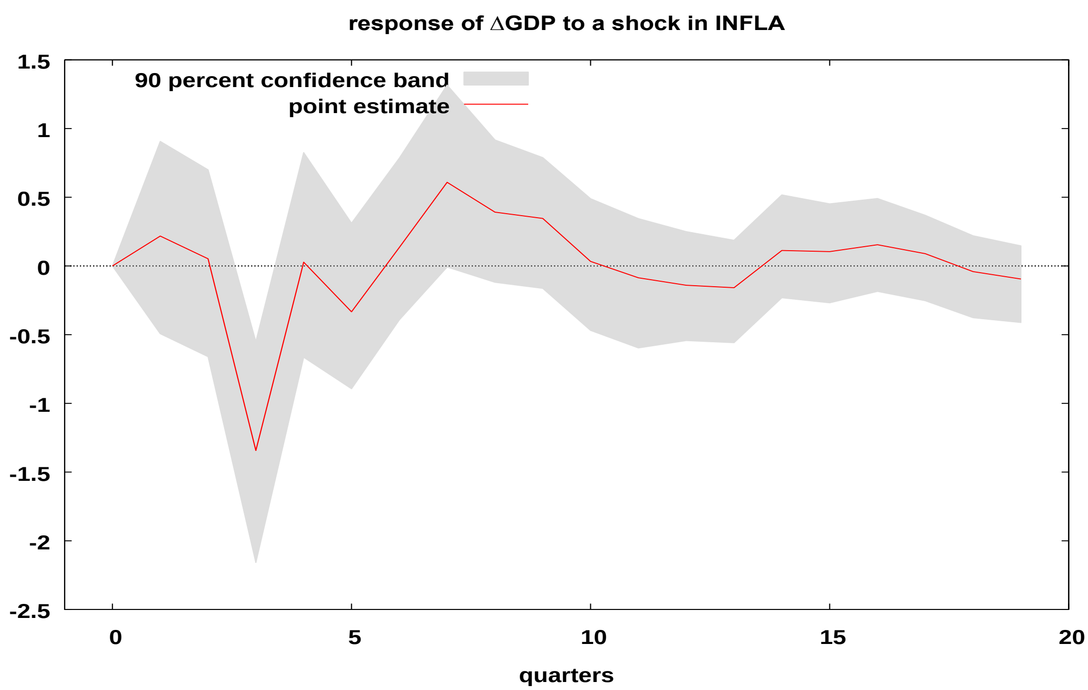

Figure 4.7: Impulse Response of ΔGDP to a shock in Inflation

Figure 4.7 shows how ΔGDP responds to a shock in inflation. A one standard deviation shock to inflation increases the ΔGDP slightly by 0.1% in the first and second quarter; then the ΔGDP begins to decrease in the third quarter steeply below the initial level up to the 4^{th} quarter by 1.5% before returning gradually to its initial level. The result was significant at 10% level of confidence.

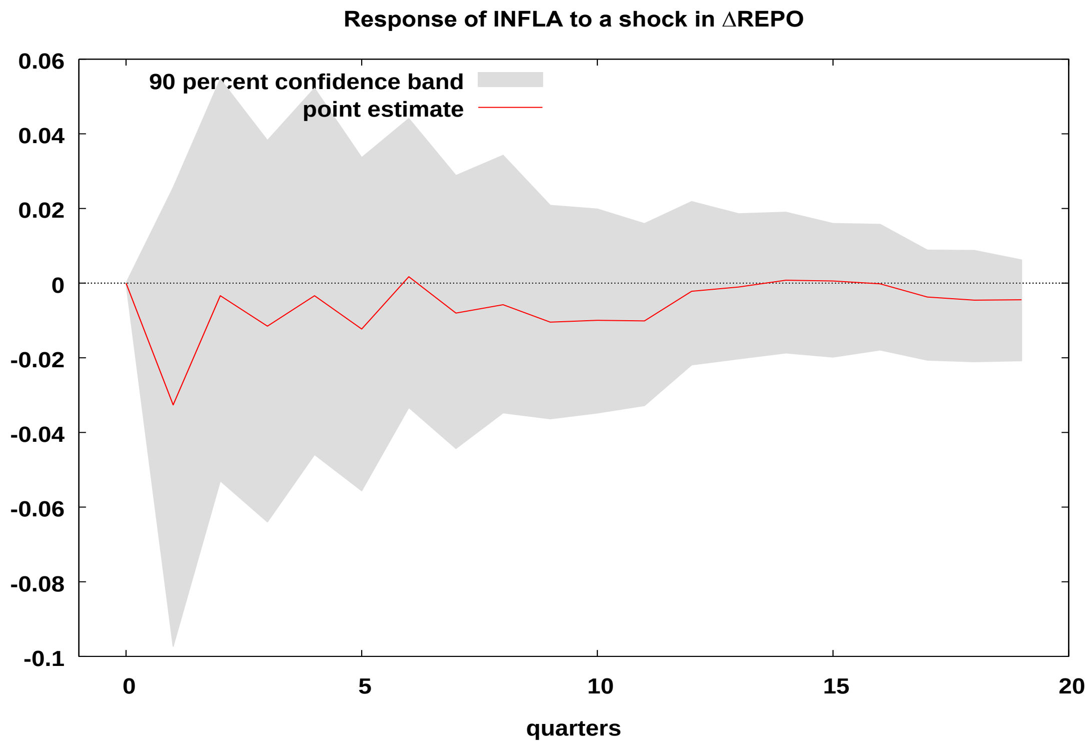

Figure 4.8: Impulse Response of Inflation to a shock in ΔRepo

Figure 4.8 above shows how inflation responds to a shock in ΔRepo. A one standard deviation shock to ΔRepo decreases inflation below its initial level by 0.33% in the first and second quarter; then the ΔGDP begins to fluctuate below its initial level. The result was significant at the 10% level of confidence. This result conforms to the initial expectation of this study and to the economic theory which states that implementing a restrictive monetary policy (i.e. increasing Repo) causes a reduction in inflation. As such, this leads to the conclusion that monetary authorities can make use of the Repo rate to influence the inflation in the direction they like.

The economic growth's impulse response to shocks in changes in Repo shows that the Repo is relatively a strong determining instrument on the economic growth in Namibia. This was buttressed by the strong economic growth variation in response to the Repo rate shocks. Furthermore, the Repo rate shock produced a negative significant response on inflation. This evidence concurs with the theoretical review.

CHAPTER FIVE

5 CONCLUSION AND RECOMMENDATIONS

5.1 Summary of the Study and conclusion

Monetary policy is one of the government tools that plays a significant role in stabilizing the economy whilst influencing economic growth. This study aimed at investigating the impact of the monetary policy on the economic growth in Namibia. Namibia is a member of the Common Monetary Area (CMA). As such, Namibia has opted to surrender its right of having a completely independent monetary system. According to BON (2008), the country has some level of monetary policy discretion because of capital controls and other prudential requirements. These discretionary powers confer liberty upon the Bank of Namibia to maintain its Repo rate at a different level from the Repo rate of the South African Reserve Bank. Evidence from Figure 2.2 illustrated that although there were times when the Bank of Namibia chose not to engage with the South African Reserve Bank, the chart still shows a strong co-movement in prime lending rate and repo rate in the long run. These differences as indicated in this study were minor. Hence, this observation invokes the study's question which looks at how the Repo affects the economic growth in Namibia.

The study examined the use of the Repo rate as a monetary policy instrument, starting with the reviews of the monetary policy background in Namibia in Chapter one. Following was the monetary policy framework and theoretic studies in Chapter 2. This chapter discussed the brief history of Namibia's monetary policy, the views of the transmission mechanism and distinguished between the different economists' theories. It also discussed how the mainstream and post-Keynesian influenced the new consensus monetary policy framework. Furthermore, in Section 2, empirical studies were reviewed to assess how researchers explain the monetary policy's effectiveness. Overall, the study adapted variables such as Interest rate, Exchange rate and inflation.

In Chapter Two, after using data from the Bank of Namibia and identifying the repo rate as the monetary policy instrument that generates the transmission mechanism, the study examined the impact of monetary policy on the economic growth in Namibia by developing a model. With this model, the study was able to investigate how the monetary policy has affected economic growth through the use of the simple linear regression and the vector auto regression analysis.

The study employed various tables and charts, correlation matrices, pair-wise Granger Causality tests and the regression equation estimated by OLS and VAR. The results from the simple linear regression substantiated that inflation and changes in repo rate had a negative significant impact on the Namibian economy. However, the coefficient of determinations was found to be low, indicating that the explanatory variables included in the model have approximately a 10 percent ability to predict the behaviour of the change in the economy. Thus, the vector auto regression model was considered to improve the results.

The evidence in the theoretical and empirical studies in Chapter 2 revealed that, because of rigidities in the marketplace, it takes time for the economy to react completely to a change in the interest rate. Hence, the VAR analysis was carried out to include as many lags as possible to take care of the serial correlation and delayed effects of monetary policy. The result from the VAR model improved, where the DW increased to 1.98 and the coefficient of determination (R^2) increased to 7%. Based on this background the study concluded that the monetary policy instrument (Repo rate) has an inverse impact on the economic growth and thus can significantly influence the economic activities in the short run.

5.2 Recommendations

The VAR model revealed that the monetary policy instrument (Repo rate) was only significant until the fourth quarter. Thus, the study recommended that policy makers should continue to formulate and implement the monetary policy to target economic activities in the short run. However, in the long run the focal point should be to influence the inflation rate. This is because, the VAR results also revealed that there exists a statistically significant relationship with the inflation rate. The inflation rate will culminate in changes in the economic growth and stability in Namibia. This means that under the CMA arrangement, policy makers are still able to stimulate the economy to a certain degree using the monetary policy instrument and without disturbing the peg. Policy makers should continue with the formulation and implementation of the monetary policy to keep the inflation rate low; and hence, enhance economic growth and stability.

The exchange rate was one of the variables that was found to have a direct link with the economic growth. The relationship with the economic growth was also proved to be more significant than the interest rate one. Hence, there is a need to stabilise the exchange rate environment to ensure the monetary policy instrument's effectiveness. It is also recommended in this study that policy makers should also look at other various fiscal policies to strengthen the control of inflation since it was revealed that a unit increase in inflation rate negatively affects the economic growth in the country in the short and long run.

Future researchers can investigate whether Namibia’s monetary policy creates a favourable investment climate that attracts both domestic and foreign investments aimed at promoting a sustainable economic growth.

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7 APPENDICES

7.1 Appendix A: Vector Auto-regression Results

VAR system, lag order 4
OLS estimates, observations 2002:2-2016:4 (T = 59)
Log-likelihood = -213.26482
Determinant of covariance matrix = 0.016208939
AIC = 9.6700
BIC = 12.2053
HQC = 10.6597
Portmanteau test: LB(14) = 187.724, df = 160 [0.0661]

Equation A1: ΔGDP
HAC standard errors, bandwidth 2 (Bartlett kernel)

	Coefficient	*Std. Error*	*t-ratio*	*p-value*	
const	10.19940	3.04415	3.35000	0.00170	***
ΔGDP_1	−0.00280	0.09452	−0.02957	0.97660	
ΔGDP_2	0.06311	0.12770	0.4942	0.6238	
ΔGDP_3	−0.11225	0.07664	−1.46500	0.15060	
ΔGDP_4	−0.45744	0.12442	−3.67700	0.00070	***
INFLA_1	0.96172	1.74391	0.55150	0.58430	
INFLA_2	−0.22946	1.51849	−0.15110	0.88060	
INFLA_3	−6.07847	1.62856	−3.73200	0.00060	***
INFLA_4	−0.13247	1.59090	−0.08327	0.93400	
d_REPO_1	1.19955	1.44463	0.83040	0.41110	
d_REPO_2	0.02475	1.11061	−0.02228	0.98230	
d_REPO_3	-1.21327	1.19546	1.01500	0.31610	
d_REPO_4	−1.79232	0.73313	−2.44500	0.01890	**
d_REER_1	−1.22506	0.72877	−1.68100	0.10040	
d_REER_2	−0.89369	0.71388	−1.25200	0.21770	
d_REER_3	−2.82329	0.79085	−3.57000	0.00090	***
d_REER_4	1.10969	0.86075	1.28900	0.20460	
time	0.01258	0.04130	0.30450	0.76230	

Mean dependent var	4.83902	S.D. dependent var	4.84398
Sum squared resid	663.8769	S.E. of regression	4.02394
R-squared	0.519185	Adjusted R-squared	0.30992
F(17, 41)	4.939229	P-value(F)	0.000014
rho	0.183010	Durbin-Watson	1.782444

F-tests of zero restrictions:

All lags of ΔGDP	F(4, 41) =	4.6856 [0.0033]
All lags of INFLA	F(4, 41) =	4.2096 [0.0060]
All lags of d_REPO	F(4, 41) =	2.0266 [0.1086]
All lags of d_REER	F(4, 41) =	4.4361 [0.0045]
All vars, lag 4	F(4, 41) =	6.1751 [0.0006]

Model estimate $\Delta\text{GDP} = 10.20 - 0.46\Delta\text{GDP}_{t-4} - 6.08\text{INFLA}_{t-4} - 1.79d\_Repo_{t-4} + 1.11\text{REER}_{t-4}$

Equation A2: INFLA
HAC standard errors, bandwidth 2 (Bartlett kernel)

	Coefficient	*Std. Error*	*t-ratio*	*p-value*	
const	0.53165	0.11805	4.50400	<0.00010	***
ΔGDP_1	−0.00185	0.00705	−0.26200	0.79460	
ΔGDP_2	0.00669	0.00998	0.66980	0.50670	
ΔGDP_3	0.00348	0.00632	0.55130	0.58440	
ΔGDP_4	−0.00930	0.00755	−1.2320	0.22510	
INFLA_1	−0.05539	0.17344	−0.31930	0.75110	
INFLA_2	0.08707	0.09953	0.87480	0.38680	
INFLA_3	−0.02734	0.13492	−0.20260	0.84040	
INFLA_4	0.23602	0.09195	2.56700	0.01400	**
d_REPO_1	−0.15764	0.09785	−1.61100	0.11480	
d_REPO_2	0.07166	0.11136	0.64350	0.52350	
d_REPO_3	−0.03417	0.09455	−0.36140	0.71970	
d_REPO_4	0.05897	0.06536	0.90220	0.37220	
d_REER_1	0.22249	0.05555	4.00500	0.00030	***
d_REER_2	0.13690	0.06101	2.24400	0.03030	**
d_REER_3	0.10825	0.07656	1.41400	0.16490	
d_REER_4	0.07692	0.05344	1.43900	0.15760	
time	−0.00630	0.00219	−2.87800	0.00630	***

Mean dependent var	0.479151	S.D. dependent var	0.344865
Sum squared resid	4.263645	S.E. of regression	0.322477
R-squared	0.381905	Adjusted R-squared	0.125622
F(17, 41)	5.188404	P-value(F)	0.00000
rho	0.004572	Durbin-Watson	1.979070

F-tests of zero restrictions:

All lags of GDP_Y	F(4, 41) = 0.53849 [0.7083]
All lags of INFLA	F(4, 41) = 3.1514 [0.0239]
All lags of d_REPO	F(4, 41) = 0.92838 [0.4569]
All lags of d_REER	F(4, 41) = 9.69 [0.0000]
All vars, lag 4	F(4, 41) = 3.1739 [0.0232]

Model estimate: $\text{INFLA} = 0.53 - 0.01\Delta\text{GDP}_{t-4} + 0.24\text{INFLA}_{t-4} + 0.06d\_Repo_{t-4} + 0.08\text{REER}_{t-4}$

Equation A3: d_REPO

HAC standard errors, bandwidth 2 (Bartlett kernel)

	Coefficient	*Std. Error*	*t-ratio*	*p-value*
const	0.292562	0.19368	1.51100	0.13860
ΔGDP_1	0.02222	0.01158	1.92000	0.06180 *
ΔGDP_2	−0.008098	0.01055	−0.76720	0.44740
ΔGDP_3	−0.01066	0.007462	−1.42800	0.16070
ΔGDP_4	−0.00508	0.00932	−0.54540	0.58850
INFLA_1	0.14887	0.18757	0.79370	0.43200
INFLA_2	−0.08308	0.13883	−0.59840	0.55290
INFLA_3	−0.51051	0.15848	−3.22100	0.00250 ***
INFLA_4	−0.16477	0.12508	−1.31700	0.19510
d_REPO_1	0.58123	0.19355	3.00300	0.00450 ***
d_REPO_2	−0.17082	0.14606	−1.16900	0.24900
d_REPO_3	0.17622	0.12571	1.40200	0.16850
d_REPO_4	−0.20472	0.10179	−2.01100	0.05090 *
d_REER_1	−0.047010	0.06715	−0.70010	0.48780
d_REER_2	0.02134	0.14307	0.14920	0.88210
d_REER_3	0.18121	0.09841	1.84100	0.07280 *
d_REER_4	0.14276	0.04674	3.05400	0.00400 ***
time	−0.00167	0.00329	−0.50920	0.61330

Mean dependent var	−0.056497	S.D. dependent var	0.595610
Sum squared resid	8.489747	S.E. of regression	0.455046
R-squared	0.587387	Adjusted R-squared	0.416303
F(17, 41)	8.460137	P-value(F)	0.00000
rho	−0.115088	Durbin-Watson	2.227367

F-tests of zero restrictions:

All lags of GDP_Y	F(4, 41) = 2.6253 [0.0483]
All lags of INFLA	F(4, 41) = 4.1239 [0.0067]
All lags of d_REPO	F(4, 41) = 4.0102 [0.0078]
All lags of d_REER	F(4, 41) = 5.3024 [0.0016]
All vars, lag 4	F(4, 41) = 4.1849 [0.0062]

Model estimate: $\mathrm{d_{Repo}} = 0.29 - 0.01\Delta\mathrm{GDP}_{t-4} - 0.16\mathrm{INFLA}_{t-4} - 0.20 d\_Repo_{t-4} + 0.14\mathrm{REER}_{t-4}$

Equation A4: d_REER

HAC standard errors, bandwidth 2 (Bartlett kernel)

	Coefficient	*Std. Error*	*t-ratio*	*p-value*	
const	−0.0111865	0.398340	−0.02808	0.9777	
GDP_Y_1	−0.00321702	0.0104153	−0.3089	0.7590	
GDP_Y_2	0.0207656	0.0116625	1.781	0.0824	*
GDP_Y_3	0.00759896	0.0162440	0.4678	0.6424	
GDP_Y_4	−0.0262476	0.0111948	−2.345	0.0240	**
INFLA_1	−0.167241	0.318636	−0.5249	0.6025	
INFLA_2	0.220465	0.301087	0.7322	0.4682	
INFLA_3	−0.0150963	0.220041	−0.06861	0.9456	
INFLA_4	−0.637764	0.225504	−2.828	0.0072	***
d_REPO_1	−0.0396038	0.131588	−0.3010	0.7650	
d_REPO_2	0.178179	0.161686	1.102	0.2769	
d_REPO_3	−0.147569	0.128810	−1.146	0.2586	
d_REPO_4	0.263402	0.105297	2.502	0.0165	**
d_REER_1	0.243146	0.111201	2.187	0.0345	**
d_REER_2	−0.230791	0.108963	−2.118	0.0403	**
d_REER_3	0.0879182	0.105324	0.8347	0.4087	
d_REER_4	−0.239307	0.141382	−1.693	0.0981	*
time	0.0112955	0.00459737	2.457	0.0183	**

Mean dependent var	0.040155	S.D. dependent var	0.641302
Sum squared resid	13.34642	S.E. of regression	0.570546
R-squared	0.440485	Adjusted R-squared	0.208491
F(17, 41)	8.908192	P-value(F)	0.00000
rho	0.023706	Durbin-Watson	1.914363

F-tests of zero restrictions:

All lags of GDP_Y	F(4, 41) = 2.5077 [0.0566]
All lags of INFLA	F(4, 41) = 5.4977 [0.0012]
All lags of d_REPO	F(4, 41) = 3.3876 [0.0175]
All lags of d_REER	F(4, 41) = 2.0724 [0.1020]
All vars, lag 4	F(4, 41) = 3.4266 [0.0166]

Model estimate: d_REER$= -0.01 - 0.03\Delta \mathrm{GDP}_{t-4} - 0.64\mathrm{INFLA}_{t-4} - 0.26 d_Repo_{t-4} - 0.24\mathrm{REER}_{t-4}$

For the system as a whole
Null hypothesis: the longest lag is 3
Alternative hypothesis: the longest lag is 4
Likelihood ratio test: Chi-square(16) = 55.2194 [0.0000]

7.2 Appendix B: Vector Auto regression with lag 8

This section is added to analyse the long term effect.

VAR system, lag order 9
OLS estimates, observations 2003:3-2016:4 (T = 54)
Log-likelihood = -85.555747
Determinant of covariance matrix = 0.00027942493
AIC = 8.6502
BIC = 14.1015
HQC = 10.7526
Portmanteau test: LB(13) = 209.452, df = 64 [0.0000]

Equation B1: GDP_Y
HAC standard errors, bandwidth 2 (Bartlett kernel)

	Coefficient	*Std. Error*	*t-ratio*	*p-value*	
const	12.4927	4.03560	3.096	0.0066	***
GDP_Y_1	0.0551285	0.108832	0.5065	0.6190	
GDP_Y_2	−0.127378	0.144988	−0.8785	0.3919	
GDP_Y_3	−0.190452	0.173642	−1.097	0.2880	
GDP_Y_4	−0.325824	0.152978	−2.130	0.0481	**
GDP_Y_5	0.406544	0.136002	2.989	0.0082	***
GDP_Y_6	−0.146313	0.112214	−1.304	0.2097	
GDP_Y_7	−0.144304	0.195917	−0.7366	0.4714	
GDP_Y_8	−0.0192175	0.146248	−0.1314	0.8970	
GDP_Y_9	0.121140	0.128562	0.9423	0.3593	
INFLA_1	−0.557639	2.42666	−0.2298	0.8210	
INFLA_2	−3.54506	1.21146	−2.926	0.0094	***
INFLA_3	−11.6249	2.54752	−4.563	0.0003	***
INFLA_4	4.20121	2.20886	1.902	0.0743	*
INFLA_5	1.00531	2.28254	0.4404	0.6652	
INFLA_6	0.00922847	1.91751	0.004813	0.9962	
INFLA_7	0.395532	2.25987	0.1750	0.8631	
INFLA_8	−2.51740	1.28017	−1.966	0.0658	*
INFLA_9	2.28349	1.53801	1.485	0.1559	
d_REPO_1	2.59343	1.91312	1.356	0.1930	
d_REPO_2	1.63490	1.58301	1.033	0.3162	
d_REPO_3	3.03822	1.36342	2.228	0.0396	**
d_REPO_4	−6.11923	1.18561	−5.161	<0.0001	***
d_REPO_5	1.63695	1.27508	1.284	0.2164	
d_REPO_6	0.515501	1.57193	0.3279	0.7470	
d_REPO_7	2.67814	1.33371	2.008	0.0608	*
d_REPO_8	1.57794	1.23980	1.273	0.2202	
d_REPO_9	−1.68250	1.19333	−1.410	0.1766	
d_REER_1	−0.889655	0.798052	−1.115	0.2805	
d_REER_2	−2.65089	0.817400	−3.243	0.0048	***
d_REER_3	−3.60309	0.861386	−4.183	0.0006	***
d_REER_4	4.19935	0.766443	5.479	<0.0001	***
d_REER_5	−0.478507	1.44345	−0.3315	0.7443	
d_REER_6	−0.683422	0.834445	−0.8190	0.4241	
d_REER_7	−0.771032	1.08087	−0.7133	0.4853	
d_REER_8	1.03720	1.28978	0.8042	0.4324	
d_REER_9	0.886631	0.977981	0.9066	0.3773	

Mean dependent var	4.828466	S.D. dependent var	5.048314

Sum squared resid	305.7333	S.E. of regression	4.240791
R-squared	0.773653	Adjusted R-squared	0.294331
F(36, 17)	61.71124	P-value(F)	0.00000
rho	−0.000021	Durbin-Watson	1.984203

F-tests of zero restrictions:

All lags of GDP_Y	F(9, 17) = 3.2572 [0.0173]
All lags of INFLA	F(9, 17) = 12.562 [0.0000]
All lags of d_REPO	F(9, 17) = 11.125 [0.0000]
All lags of d_REER	F(9, 17) = 9.4905 [0.0000]
All vars, lag 9	F(4, 17) = 1.1196 [0.3799]

Equation B2: INFLA
HAC standard errors, bandwidth 2 (Bartlett kernel)

	Coefficient	*Std. Error*	*t-ratio*	*p-value*	
const	1.52242	0.474958	3.205	0.0052	***
GDP_Y_1	−0.0318777	0.00865098	−3.685	0.0018	***
GDP_Y_2	0.00494780	0.0145917	0.3391	0.7387	
GDP_Y_3	−0.00910074	0.0117915	−0.7718	0.4508	
GDP_Y_4	−0.0202517	0.0107218	−1.889	0.0761	*
GDP_Y_5	−0.0404821	0.0131888	−3.069	0.0069	***
GDP_Y_6	−0.00759805	0.0117858	−0.6447	0.5277	
GDP_Y_7	−0.0162808	0.0143703	−1.133	0.2730	
GDP_Y_8	0.0131393	0.0123606	1.063	0.3026	
GDP_Y_9	−0.0206513	0.0115193	−1.793	0.0908	*
INFLA_1	−0.177715	0.140379	−1.266	0.2226	
INFLA_2	−0.164088	0.120078	−1.367	0.1896	
INFLA_3	−0.0564942	0.105839	−0.5338	0.6004	
INFLA_4	−0.286134	0.157753	−1.814	0.0874	*
INFLA_5	−0.149420	0.146439	−1.020	0.3219	
INFLA_6	−0.0256204	0.245904	−0.1042	0.9182	
INFLA_7	0.0817451	0.180074	0.4540	0.6556	
INFLA_8	0.307508	0.195309	1.574	0.1338	
INFLA_9	−0.233430	0.138766	−1.682	0.1108	
d_REPO_1	−0.106153	0.129957	−0.8168	0.4253	
d_REPO_2	0.0291430	0.123976	0.2351	0.8170	
d_REPO_3	0.237415	0.126755	1.873	0.0784	*
d_REPO_4	0.247193	0.0709306	3.485	0.0028	***
d_REPO_5	0.0224703	0.0810573	0.2772	0.7850	
d_REPO_6	0.307790	0.109741	2.805	0.0122	**
d_REPO_7	−0.157938	0.122001	−1.295	0.2128	
d_REPO_8	0.265326	0.151515	1.751	0.0979	*
d_REPO_9	0.0761571	0.101155	0.7529	0.4618	
d_REER_1	0.105872	0.0417226	2.538	0.0212	**
d_REER_2	0.181288	0.0555864	3.261	0.0046	***
d_REER_3	−0.0749828	0.0852722	−0.8793	0.3915	
d_REER_4	−0.0105259	0.0582202	−0.1808	0.8587	
d_REER_5	0.00851285	0.0713718	0.1193	0.9065	

d_REER_6	−0.0843711	0.0917062	−0.9200	0.3704	
d_REER_7	−0.162056	0.0954983	−1.697	0.1079	
d_REER_8	−0.227906	0.102760	−2.218	0.0405	**
d_REER_9	−0.154567	0.113740	−1.359	0.1919	

Mean dependent var	0.456073	S.D. dependent var	0.340145
Sum squared resid	1.551454	S.E. of regression	0.302096
R-squared	0.746992	Adjusted R-squared	0.211211
F(36, 17)	188.3827	P-value(F)	1.36e-16
rho	0.021456	Durbin-Watson	1.953877

F-tests of zero restrictions:

All lags of GDP_Y	F(9, 17) =	5.2531 [0.0017]
All lags of INFLA	F(9, 17) =	1.909 [0.1200]
All lags of d_REPO	F(9, 17) =	5.6262 [0.0011]
All lags of d_REER	F(9, 17) =	10.295 [0.0000]
All vars, lag 9	F(4, 17) =	1.524 [0.2397]

Equation B3: d_REPO
HAC standard errors, bandwidth 2 (Bartlett kernel)

	Coefficient	*Std. Error*	*t-ratio*	*p-value*	
const	2.72677	0.517066	5.274	<0.0001	***
GDP_Y_1	−0.00213131	0.0103713	−0.2055	0.8396	
GDP_Y_2	−0.0631507	0.0126389	−4.997	0.0001	***
GDP_Y_3	−0.0113590	0.0112503	−1.010	0.3268	
GDP_Y_4	0.0120850	0.0123741	0.9766	0.3424	
GDP_Y_5	−0.0290224	0.0116186	−2.498	0.0230	**
GDP_Y_6	−0.0468202	0.00986733	−4.745	0.0002	***
GDP_Y_7	−0.00743564	0.0132056	−0.5631	0.5807	
GDP_Y_8	−0.0154464	0.0103102	−1.498	0.1524	
GDP_Y_9	−0.0249534	0.00837174	−2.981	0.0084	***
INFLA_1	−0.0670472	0.167778	−0.3996	0.6944	
INFLA_2	−0.501208	0.120221	−4.169	0.0006	***
INFLA_3	−0.806690	0.165610	−4.871	0.0001	***
INFLA_4	−0.680072	0.181702	−3.743	0.0016	***
INFLA_5	−0.675816	0.149605	−4.517	0.0003	***
INFLA_6	0.259212	0.208959	1.240	0.2316	
INFLA_7	−0.243523	0.159042	−1.531	0.1441	
INFLA_8	−0.804053	0.173710	−4.629	0.0002	***
INFLA_9	−0.116678	0.153138	−0.7619	0.4566	
d_REPO_1	0.181006	0.140406	1.289	0.2146	
d_REPO_2	0.247396	0.118377	2.090	0.0520	*
d_REPO_3	0.0186765	0.122177	0.1529	0.8803	
d_REPO_4	0.0670490	0.0968055	0.6926	0.4979	
d_REPO_5	−0.108490	0.0805861	−1.346	0.1959	
d_REPO_6	−0.178100	0.0960603	−1.854	0.0812	*
d_REPO_7	0.378089	0.104292	3.625	0.0021	***
d_REPO_8	0.460051	0.132228	3.479	0.0029	***
d_REPO_9	−0.0575404	0.0974343	−0.5906	0.5626	
d_REER_1	0.116711	0.0432159	2.701	0.0152	**
d_REER_2	−0.210380	0.0847496	−2.482	0.0238	**

d_REER_3	−0.212476	0.0754439	−2.816	0.0119	**
d_REER_4	0.0364033	0.0663331	0.5488	0.5903	
d_REER_5	0.139492	0.0755865	1.845	0.0825	*
d_REER_6	0.429602	0.0873599	4.918	0.0001	***
d_REER_7	−0.207315	0.0993577	−2.087	0.0523	*
d_REER_8	−0.238735	0.102547	−2.328	0.0325	**
d_REER_9	0.182598	0.0809320	2.256	0.0375	**

Mean dependent var	−0.098765	S.D. dependent var	0.582338
Sum squared resid	1.737915	S.E. of regression	0.319735
R-squared	0.903305	Adjusted R-squared	0.698541
F(36, 17)	29.30806	P-value(F)	7.33e-10
rho	−0.008622	Durbin-Watson	1.967388

F-tests of zero restrictions:

All lags of GDP_Y F(9, 17) = 7.7045 [0.0002]
All lags of INFLA F(9, 17) = 12.296 [0.0000]
All lags of d_REPO F(9, 17) = 9.0183 [0.0001]
All lags of d_REER F(9, 17) = 9.2891 [0.0001]
All vars, lag 9 F(4, 17) = 2.5533 [0.0768]

Equation B4: d_REER

HAC standard errors, bandwidth 2 (Bartlett kernel)

	Coefficient	*Std. Error*	*t-ratio*	*p-value*	
const	0.0530016	0.643529	0.08236	0.9353	
GDP_Y_1	0.0252003	0.0183197	1.376	0.1868	
GDP_Y_2	−0.0528415	0.0306350	−1.725	0.1027	
GDP_Y_3	0.0293126	0.0232321	1.262	0.2241	
GDP_Y_4	−0.0148539	0.0177908	−0.8349	0.4153	
GDP_Y_5	0.0220684	0.0226554	0.9741	0.3437	
GDP_Y_6	−0.0590929	0.0351171	−1.683	0.1107	
GDP_Y_7	0.0678172	0.0218122	3.109	0.0064	***
GDP_Y_8	0.00829342	0.0197728	0.4194	0.6801	
GDP_Y_9	0.0323973	0.0257392	1.259	0.2252	
INFLA_1	−0.568108	0.480114	−1.183	0.2530	
INFLA_2	0.227728	0.330851	0.6883	0.5005	
INFLA_3	−0.0110599	0.267304	−0.04138	0.9675	
INFLA_4	−0.548174	0.386517	−1.418	0.1742	
INFLA_5	−0.887281	0.272152	−3.260	0.0046	***
INFLA_6	0.364778	0.379840	0.9603	0.3503	
INFLA_7	0.359534	0.302705	1.188	0.2513	
INFLA_8	0.272426	0.371448	0.7334	0.4733	
INFLA_9	0.425873	0.280750	1.517	0.1477	
d_REPO_1	−0.112752	0.328299	−0.3434	0.7355	
d_REPO_2	0.470355	0.183144	2.568	0.0199	**
d_REPO_3	−0.136385	0.211960	−0.6434	0.5285	
d_REPO_4	0.653680	0.205266	3.185	0.0054	***
d_REPO_5	0.276964	0.228090	1.214	0.2412	
d_REPO_6	−0.542612	0.180565	−3.005	0.0080	***
d_REPO_7	0.367743	0.204626	1.797	0.0901	*
d_REPO_8	−0.220609	0.159713	−1.381	0.1851	

d_REPO_9	0.300476	0.198467	1.514	0.1484	
d_REER_1	0.381899	0.132874	2.874	0.0105	**
d_REER_2	−0.291646	0.105033	−2.777	0.0129	**
d_REER_3	0.157565	0.144450	1.091	0.2906	
d_REER_4	−0.292935	0.186265	−1.573	0.1342	
d_REER_5	−0.00298542	0.186360	−0.01602	0.9874	
d_REER_6	0.448981	0.133868	3.354	0.0038	***
d_REER_7	−0.286379	0.265451	−1.079	0.2957	
d_REER_8	−0.168297	0.157154	−1.071	0.2992	
d_REER_9	0.0377713	0.238634	0.1583	0.8761	

Mean dependent var	0.113700	S.D. dependent var	0.605539
Sum squared resid	6.897013	S.E. of regression	0.636951
R-squared	0.645104	Adjusted R-squared	-0.106439
F(36, 17)	33.16665	P-value(F)	2.67e-10
rho	0.088416	Durbin-Watson	1.788436

F-tests of zero restrictions:

All lags of GDP_Y	F(9, 17) = 2.857 [0.0298]
All lags of INFLA	F(9, 17) = 4.0039 [0.0067]
All lags of d_REPO	F(9, 17) = 2.862 [0.0296]
All lags of d_REER	F(9, 17) = 4.8877 [0.0024]
All vars, lag 9	F(4, 17) = 1.4443 [0.2626]

For the system as a whole
Null hypothesis: the longest lag is 8
Alternative hypothesis: the longest lag is 9
Likelihood ratio test: Chi-square(16) = 36.486 [0.0025]

7.3 Appendix C: Impulse response for all Variables