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# **Monetary Policy Transmission Mechanism and Interest Rate Spreads**

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## Abstract

In contemporary times, monetary policy is evaluated by examining monetary policy shocks represented by changes in nominal interest rates rather than changes in the money supply. In this thesis, we studied three interrelated concepts: the monetary policy transmission mechanism, interest rate spreads and the spread adjusted monetary policy rule. Chapter 1 sets out a theoretical background by reviewing the evolution of monetary policy from money growth targeting to the standard approach of interest rate targeting (pegging) in the new consensus. The new consensus perspective models the economy with a system of three equations: the dynamic forward-looking IS-curve for aggregate demand, an inflation expectation-augmented Phillips curve and the interest rate rule. Monetary policy is defined as fixing the nominal interest rate in order to exert influences on macroeconomic outcomes such as output and expected inflation while allowing the money supply to be determined by interest rate and inflation expectations. Having set out this background, Chapter 2 empirically investigates long-standing questions: how does monetary policy (interest rate policy) affect the economy and how effective is it? This chapter seeks to answer these questions by modelling a monetary policy framework using macroeconomics data from Namibia. Using the new consensus macroeconomic view, this empirical analysis starts from the assumption that money is endogenous, and thus it identifies the bank rate (i.e. Namibia's repo rate) as the policy instrument which starts the monetary transmission mechanism.

We estimated a SVAR and derived structural impulse response functions and cumulative impulse response functions, which showed how output, inflation and bank credit responded to structural shocks, specifically the monetary policy and credit shocks in the short run and the long run. We found that in the short run quarterly real GDP, inflation and private credit declined significantly in response to monetary policy shocks in Namibia. Monetary policy shocks as captured by an unsystematic component of changes in the repo rate considerably caused a sharp decrease for more than three quarters ahead after the first impact in quarterly real GDP. Furthermore, structural impulse response functions showed that real GDP and inflation increased in response to one standard deviation in the private credit shock. In the long run, the cumulative impulse response functions showed that inflation declined and remained below the initial level while responses in other variables were statistically insignificant. South African monetary policy shock caused significant negative responses in private; however, the impacts on quarterly GDP were barely statistically significant in the short run. In all, this empirical evidence shows that the monetary policy of changing the level of repo rate is effective in stabilising GDP, inflation rate and private

credit in the short run; and in the long run domestic monetary policy significantly stabilises inflation too. The structural forecast error variance decompositions show that the variations of output attributed to interest rate shock show that the interest rate channel is relatively strong compared with the credit channel. This is substantiated by the fact that repo rate shocks account for a large variation in output compared with the variation attributed to private credit shock. We conclude in this chapter that domestic monetary policy through the repo rate is effective, while the effects from the South African policy rate are not emphatically convincing in Namibia. Therefore, the Central Bank should keep independent monetary policy actions in order to achieve the goals of price stability.

In Chapter 3 we investigate the subject of ‘interest rate spreads’, which are seen as the transmitting belts of monetary policy effects in the economy. While it is widely acknowledged that the monetary policy transmission mechanism is very important, it is also clear that the successes of monetary policy stabilisation are influenced by the size of spreads in the economy. Interest spreads are double-edged swords, as they amplify and also dampen monetary effects in the economy. Hence, we investigate the unit root process with structural breaks in interest rate spreads, and the macroeconomic and financial fundamentals that seem to explain large changes in spreads in Namibia. Firstly, descriptive statistics show that spreads always exist and gravitate around the mean above zero and that their paths are significantly amplified during crisis periods. Secondly, the Lanne, Saikkonen and Lutkepohl (2002) unit root test for processes with structural breaks shows that spreads have unit root with structural breaks. Most significant endogenous structural breaks identified coincide with the 1998 East Asia financial crisis period, while the global financial crisis only caused a significant structural break in quarterly GDP. Thirdly, using the definitions of the changes in base spread and retail spread, we find that inflation, unconditional inflation, economic growth rate and interest rate volatilities, and changes in the bank rate and risk premium and South Africa’s spread are some of the significant macroeconomic factors that explain changes in interest rate spread in Namibia. Whether we define interest spread as the retail spread, that is, the difference between average lending rate and average deposit rate, or the base spread, which is the difference between prime lending rate and the bank rate, our empirical results indicate that there macroeconomics and financial fundamentals play a statistically significant role in the determination of interest rate spreads.

In the last chapter, we estimate the monetary policy rule augmented with spread - the so-called Spread-adjusted Taylor Rule (STR). The simple Spread-adjusted Taylor rule is

suggested in principle to be used as simple monetary policy strategy that responds to economic or financial shocks, e.g. rising spreads. In an environment of stable prices or weak demand, rising spreads have challenged current new consensus monetary policy strategy. As a result, the monetary policy framework that attaches weight to inflation and output to achieve price stability has been deemed unable to respond sufficiently to financial stress in the face of financial instability. In response to this challenge, the STR explicitly takes into account the spread to address the weakness of the standard monetary policy reaction in the face of financial instability. We apply the Bayesian method to estimate the posterior distributions of parameters in the simple STR. We use theory-based informed priors and empirical Bayesian priors to estimate the posterior means of the STR model. Our results from this empirical estimation show that monetary policy reaction function can be adjusted with credit spread to caution against tight credit conditions and therefore realise the goal of financial stability and price stability simultaneously. The estimated coefficients obtained from the spread-adjusted monetary policy are consistent with the calibrated parameters suggested by (McCulley & Toloui, 2008) and (Curdia & Woodford, 2009). We find that, on average, a higher credit spread is associated with the probability that the policy target will be adjusted downwards by 55 basis points in response to a marginal increase of one per cent in equilibrium spread. This posterior mean is likely to vary between -30 and -79 basis points with 95% credible intervals. Altogether in this chapter we found that a marginal increase in the rate of inflation above the target by one per cent is associated with probability that the repo rate target will be raised by an amount within the range of 42 to 75 basis points, while little can be said about central banks' reaction to a marginal increase in output.

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*This thesis is dedicated to my aging mother who desires to see me graduated as doctor. I love you very much mom!*

### **Author's Declaration**

“I declare that, except where explicit reference is made to the contribution of others, that this dissertation is the result of my own work and has not been submitted for any other degree at the University of Glasgow or any other institution.

Signature \_\_\_\_\_

**Reinhold Kamati**

## Preface

The purpose of changing the level of a monetary policy instrument is to signal to the markets the level of interest rate, which is regarded to be optimal with the goal of monetary stability. In this thesis, we examine the transmission of monetary policy and interest rate spreads in Namibia. Starting with the reviews of money and monetary policy in monetary theories across schools of thought, we investigate the research questions under three interrelated areas.

### *A. Modelling monetary policy in Namibia: SVAR estimation in the new consensus framework.*

1. How effective is the monetary policy of changing interest rate levels in the stabilisation of output and inflation in Namibia?
  - We seek answers to this question by estimating the structural and cumulative impulse response functions of real output, inflation rate and private sector credit to structural shocks from the domestic repo rate, South Africa's repo rate and private credit in the SVAR.
  - Secondly, we estimate and analyse the structural forecast error variance decomposition for output in order to determine the relative strength of interest rate (repo rate) and credit channels in Namibia.

The results from this modelling provide a comprehensive quantitative picture about the transmission mechanism as generated by domestic and South African monetary policy shocks, and further contribute new knowledge about the effectiveness and relative strength of the interest rate and credit channels in Namibia.

### *B. Understanding interest rate spreads in Namibia: an investigation of macroeconomic and financial fundamentals that explain changes in spreads in Namibia.*

In Namibia, interest rate spreads have been a cause of concern and a controversial issue in the financial sector. Specifically, the Central Bank and the general public have expressed enormous interest particularly to understand (i) the dynamic behaviours of interest rate spreads; (ii) the main determinants of interest rate spreads and the consequential effects of large changes in interest rate spreads on households and businesses credits. Our main analysis focused on: *base spread* - the difference between the repo rate (bank rate) and the prime lending rate; *retail spread* - the difference between the average lending rates and the

average deposit rates; *risk premium* (spread), which is the difference between prime lending rate and the short-term risk free rate (three-month T-bills); and *interest rate differential* - this is the difference between domestic repo rate and the South African repo rate. In Chapter 3 we examined:

2. Unit root process and structural breaks in spreads and other macroeconomic fundamentals realised, and whether the degrees of integration in the spreads depend on the presence of structural breaks in these time series.
3. What are the macroeconomic and financial fundamentals that explain the level of spreads in Namibia? Is there a significant relationship between ex ante base spread, retail spread and the macroeconomic fundamentals achieved in the country?

This investigation is motivated by the quest to find empirical evidence that will inform academic debates and policy about how to address the issue of interest rate spreads in Namibia. This empirical evidence contributes immensely to the redevelopment and revision of Namibia's Financial Charter and monetary policy in terms of addressing the issue of spreads. Our primary focuses are time series levels of spreads, and the relationship between macroeconomics fundamentals and changes in the spreads.

### *C. Simple Spread-adjusted Taylor Rule (STR): Empirical evidence*

Finally, many researchers ponder the question of what information is missing or neglected by the new consensus monetary policy strategy, in particular the standard Taylor rule. The Taylor rule is well known to emphasise price stability as an overriding goal for monetary policy stabilisation. However, it has been revealed that price stability is not a sufficient condition for financial stability. We estimate the Spread-adjusted Taylor Rule suggested by Taylor (2008), Curdia and Woodford (2009) and Teranishi (2011). Our objective is to estimate the posterior parameter values in the simple STR and compare it with the standard Taylor Rule using the Bayesian method.

## Abbreviations

ARIMAX- Auto Regression Integrated Moving Average and Exogenous

BoN - Bank of Namibia

CIA- Cash-In-Advance model

CIRF- Cumulative Impulse Response Function

CMA- Common Monetary Area

CMI – Commodity Price Index

CUSUM- Cumulative Sum of Squared Errors Test

DSGE – Dynamic Stochastic General Equilibrium

GDP – Gross Domestic Product

GMM – Generalized Method of Moments

HAC – Heteroscedasticity Auto correlated Consistent

IO –Industrial Organisation

IRS - Interest Rate Spreads

JSE – Johannesburg Stock Exchange

MIU- Money-In-the Utility function

ML – Maximum Likelihood

MMA- Multilateral Monetary Agreement

NCPI – Namibia Consumer Price Index

NK – New Keynesian

NSX – Namibia Stock Exchange

OLS – Ordinary Least Squares

PK - Post-Keynesian

PPI – Producers Price Index

RMA-Rand Monetary Agreement

SA – South Africa

SACU – Southern Africa Custom Union

SARB – South Africa Reserve Bank

SFEVD – Structural Forecast Errors Variance Decomposition

SIRF- Structural Impulse Response Function

STAR- Smooth Transition Autoregressive Model

STR – Spread-Adjusted Taylor Rule

SVAR – Structural Vector Auto regression

SVECM – Structural Vector Error Correction Model

TLSLS - Two Stage Least Squares

VAR – Vector Autoregression

ZAR- South African Rand

## CHAPTER ONE

### **An Essay about Money and Monetary Policy in the Mainstream and Post-Keynesian Economics**

“As a signal of policy stance [i.e. interest rate], (...) interest rate should ideally provide clarity and good controllability. This explains why so many central banks signal with their official rates, which are natural and fully in their control. And to the extent that this policy rate, (...) is also a starting point of monetary transmission, it should ideally be something economically relevant” (Ho, 2010, p. 91).

#### **1.0 Introduction**

Monetary economics has proven to be a complex area in macroeconomics. The complexity stems from the main component of monetary economics, that is: ‘Money’, its origin, nature, and its purposes in the economy. Generally, many evolving debates in monetary economics centre on the nature of money supply and monetary policy, and the transmission mechanisms and effectiveness of monetary policy. In contemporary times, the ‘new macroeconomic consensus’ debate has expanded to include the concept of endogenous money, and the role of monetary policy when money is endogenously determined Arestis and Sawyer (2006).<sup>1</sup> Further, what had been known as monetary policy has changed from the money supply centred monetary policy to interest rate policy, or simply the monetary policy without money.

The new consensus monetary analysis is based on the system of three equations: firstly, the ‘IS curve –with aggregate demand linked to real interest rate’; second, the ‘expectation-augmented Phillips curve’ – that links inflation to output gap and aggregate supply; and third, the monetary policy in the form of Taylor rule (see Laidler, 2007, p. 17). In this new consensus, the monetary policy framework is based on the assumption that money is endogenous, and central banks use controllable instrument, that is the short term bank rate to stabilize the economy. According to Mayes and Toporowski (2007, p. 5) monetary policy is distinctively evaluated through changes in interest rate shocks. Mayes

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<sup>1</sup> Apart from Goodhart (1989) the discussion about endogenous money was rare in the mainstream economics. However, this has changed because many economists agree that money is endogenous and central bank use interest rate as a control instrument to stabilize the economy. For example, Fender (2012) pointed that the assumption that central bank control and target monetary aggregate is irreconcilable with the fact that central banks are lenders of last resorts.

and Toporowski clearly assert that ‘monetary shocks are now supposed to be modelled as changes in interest rates, possibly in exchange rates, rather than as unexpected increases/decreases in the money supply that may be offset by open market operations.’ It is against this background, that in this chapter first we reviewed the historical nature, roles of money and monetary policy in the mainstream economics (i.e. neoclassical, Keynesian and New Keynesian monetary theories) and Post Keynesian (PK) economics. At the end of this chapter we summarize what we have learned from the literature review about money and monetary policy; and we explained how this review informs our empirical studies in chapter two to five.

The primary objective of this chapter is to set out the theoretical position of money and monetary policy in and outside the mainstream economics. We used this theoretical exposition to form the basis for the empirical studies examined in this thesis. The empirical studies we examined are: the transmission channels and effectiveness of monetary policy in Namibia; determinants of interest rate spreads, cointegration and dynamic effects of spreads on mortgages, consumers and instalment credits; and lastly, we empirically estimate the simple Spread-adjusted Taylor Rule (STR). An exposition of monetary theories in the mainstream and post Keynesian economics will help us to understand the evolution of monetary policy (i.e. the transition from money growth targeting to interest rate targeting) and its general implications on the development of monetary policy frameworks in the developing countries. From this literature review, we aim to provide explanations why modern monetary policy frameworks do not emphasize the money supply, but rather short term interest rate as the policy instrument. Finally, this exposition will clarify our decision why we used the repo rate as the policy instrument that generates monetary policy effects in the empirical estimation ahead. Ho (2010), identified the short term interest rate as the monetary instrument that generates the transmission mechanism to market rates, through intermediation spreads, to private sector credit and finally the real sector. In support of this view, we define monetary policy as ‘fixing of some nominal short term bank rate’ and willingness to lend at that rate set by the central bank (Woodford, 2011).

As the case is now, there is an equal recommendations for the interest rate setting monetary policy approach both in the mainstream and post Keynesian paradigms (Palley, 2003). For instance, Palley (2003) alleges that all sides (mainstream and some Post Keynesians) agree that interest rate is the appropriate policy instrument required to conduct monetary policy, and therefore agents adjust their demand for money to the price of money

which is the interest rates.<sup>2</sup> Similarly, Romer (2006) asserts that central bank follows an interest rate rule and adjust money so that market interest rates can follow the interest rate target which is consistent with zero output gap and inflation target. We argue that approaching the subject of monetary policy in this way overcomes the contradictions of exogenous money and aligns with real practice of contemporary monetary policy.

### **1.1 Organisation of the chapter**

This chapter is divided into three main-sections. Section one discusses the historical nature of money and monetary policy in the mainstream and Post-Keynesian monetary theories. Section two discusses the importance of the monetary transmission mechanisms and clarifies the referenced interest rate in the ‘new consensus’ interest-rate targeting framework. Section three concludes with what we have learned about the nature and roles of money and monetary policy and how these influence the evaluation of monetary in contemporary times. We state here that this literature review is limited to the discussion about money and monetary policy excluding detailed treatments of real side of the economy.

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<sup>2</sup> See also (Laidler, 2007, pp. 15-17) and (Mayes & Toporowski, 2007)

## 1.2. Monetary Theories: Money and Monetary Policy Perspectives<sup>3</sup>

### 1.2.1 Monetary Theory in the Neoclassical Economics

Our main aim for reviewing Neoclassical monetary theory is to trace the nature of money, its functions, monetary policy, and the transmissions of monetary effects to the real economy, if any exists. According to Knoop (2010), the cornerstone of neoclassical is based on the tenets of classical theory which assumes perfect competition, use of real variables in decision making and application of representative agent models with agents that have the same preferences and act alike in every way. There are three common theoretical approaches to the analysis of money. One, money is incorporated in the utility function whereby consumers derive utility directly from real balances, or money is assumed to ‘save labour time in making payments’ in the utility function (see Handa, 2000, pp. 81-82). Second, money is held in advance to cater for certain types of transactions – the so-called Cash-In-Advanced (CIA) models. The third approach is that, money is used to transfer purchasing power from one period to another –this is called Overlapping generation model (OLG). In all these approaches the common thread is the general equilibrium analysis.<sup>4</sup> The set up (as shown in Appendix A.1) is that we have agents (households and firms) with rational behaviours, who decide to maximize utility under rational expectation conditions.

However, one of the weaknesses of general equilibrium is that it does not explain how money came to exist; but rather it determines the relative prices that should prevail when all markets are simultaneously in equilibrium. Canova (2007, p. 52) points out that ‘discovering monetary role in general equilibrium is very difficult with a full set of Arrow-Debrue claims, money is a redundant asset’. Walrasian equilibrium neglects importance of nominal variables and emphasizes real variables in determining equilibrium quantities. Thus, neoclassical economists use the quantity theory of money to explain the nature and functions of money. This is done either in a partial equilibrium of the quantity theory of money as in equation (1.1) below or it is slotted in the utility function in the full dynamic general equilibrium (A.1) in the Appendix. Denis (1981) purports that the role of money in Neoclassical economics is not to determine relative prices, as this is derived from general

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<sup>3</sup> Our review excludes discussion about the New Classical Economics, and the Real Business Cycle theories. Economic models of these two do not contain much on the nature, role of money, and stabilization through monetary policy. For example, Gottschalk (2005, p. 101) reveals that “money [in RBC] is completely ineffective in these models; and monetary policy makers are powerless.” While New classical seeks to re-establish the classical paradigm –competitive markets and the Walrasian equilibrium analysis which neglect the role of nominal variables.

<sup>4</sup> Perloff (2008) defines general equilibrium as the study of how equilibrium is determined in all markets simultaneously. In neoclassical thus we have agent households & firms, technology and competitive markets.

equilibrium. Money is the medium of exchange, as will be later explored comprehensively in relation to its demand.

The Neoclassical theory of money or classical demand for money is one of the oldest theories of money and is linked both to the Salamanca School in Spain in the mid-16th century and to Irvin Fisher in 1911 (Belke & Polleit, 2009). The starting point of analysing money is the famous *ad-hoc* relation for quantity equation of exchange. In the partial equilibrium, the equation of exchange can be stated in absolute terms as follows:

$$MV = PT, \quad (1.1)$$

whereby  $M$  is the stock of money narrowly defined as currency and notes plus demand deposits, this component is exogenously determined;  $V$  is the transaction velocity of the quantity of money in circulation;  $P$  is the general price level, and  $T$  stands for the number of transactions which take place during a given period. The amount of transactions is assumed to depend on the length of payments and expenditure patterns (Dennis, 1981). This relation constitutes an identity; however, this identity can be turned into a theory of price level by making the following assumptions:

- (i) The velocity  $\bar{V}$  is determined by the structure of the banking system and fixed at least in the short run. This means that velocity is independent of the variables within the quantity equation.
- (ii) There is a fixed relationship between output (real income) and the number of transactions taking place. This relationship therefore enables us to replace the number of transactions ( $T$ ) which take place during a given year with real income ( $Y$ ) on the right hand side of the equation.
- (iii) The level of real income ( $Y$ ) is determined by real factors in the labour market – independent of the quantity of money; Neo-classicists assume income  $\bar{Y}$  is fixed for the purpose of analysing the money market. Thus, the quantity theory will become  $M\bar{V} = P\bar{Y}$ , and therefore determines the price level as follows:

$$P = [\bar{V}/\bar{Y}]M. \quad (1.2)$$

Similarly, in relative terms the constant growth rate of money supply is derived as follows. We assume here that real money supply –real money balances – is equal to real income in equilibrium. Let us suppose  $P$ ,  $M$ , and  $Y$  grow at some growth rates respectively. Whereby  $M_t = (1 + \mu)M_{t-1}$  - simply this can indicate that government grows money at some constant

growth rate  $\mu$  ; and  $Y_t = (1 + \nu)Y_{t-1}$ , the real income grows at some exogenous growth rate  $\nu$  ; finally, the aim is to derive and show that the growth rate of inflation is given as follows:

$$\pi_t \approx \mu - \nu.$$

$$\frac{(1+\mu)M_{t-1}}{(1+\pi)P_{t-1}} = (1 + \nu)Y_{t-1} \quad (1.3)$$

Applying the logarithmic operation on (1.3) and using the approximation  $\ln(1 + \mu) \approx \mu$  and  $\ln(1 + \pi) \approx \pi$ , we get:

$$\mu - \pi = \nu \quad (1.4)^5$$

$$\Rightarrow \pi \approx \mu - \nu.$$

There are important observations from the above equations. They show how money enters the economy, and illustrate the nature and roles of monetary policy in neoclassical economy. First, money enters the system as a commodity used to finance transactions and therefore, it plays a passive role to fulfil demand and supply as goods are exchanged in the economy. Money is simply a medium of exchange ‘a veil’; that is, it is held for the purposes of transactions, to facilitate trades of goods and services (Cagan, 1989). Given that the quantity theory assumes that money is controlled by government implies also that growth rate  $\mu$  is determined exogenously; but the arbitrary determination of  $\mu$  is only possible if the monetary authority is ready to violate the principle of lender of last resort to the financial sector in the economy. Secondly, the rate of inflation is positively related to the growth rate of money supply and negatively related to the growth rate of real income. Hence, when money supply grows faster than the growth rate of real income, this will generate inflation on the long run. It also implies that government as issuer of currency can control inflation by growing money at a nominal target equal to expected growth rate of real income. Third, money does not affect output (real income); output is determined by real factors such as labour, capital, and productivity (Mankiw & Taylor, 2007). Money does not play any feedback role to real variables; this is why it is regarded as neutral both in the short and long term in the neoclassical monetary theory. This feature is described in the mainstream as the neutrality of money (David, 2008).<sup>6</sup> And generally it means that, any change in the stock of money will lead to an equal proportional changes in the absolute

<sup>5</sup> In equilibrium the real money balances is equal to real income, thus  $\frac{M_t}{P_t} = Y_t \Rightarrow m_t - y_t = 0$ .

<sup>6</sup> If exogenous change in the growth of money produces no effect on real quantities and real prices, this is called super-neutrality. In equation A.51 we showed that real income and neutral interest rate evolves independently from changes in money supply.

price level. In terms of absolute price level, we observe that the price level will not change without a prior change in money supply. The role of money in neoclassical economics is to determine absolute price level and generate inflation in the long run. Fourth, money is not viewed as a financial asset and it does not earn interest, this conclusion is widely contested by Keynesians and Post Keynesians (Knoop, 2008).

Another topic in the neoclassical monetary theory that plays a major role is the interest rate. In the saving-investment economic relationship it is proposed that saving is positively related to interest rate; while investment is negatively related to interest rate. Loan-able funds theory as held by classical theorists postulates that the rate of interest is a real phenomenon –determined by real factors in the economy. Neoclassical assumes that equilibrium market interest rate that equates saving and investment interest rate is determined by marginal utility whereby the marginal rate of substitution is equal to marginal rate of return to capital. This idea is similar to the view held by Austrian school of thought who also argues that people attach greater values on present goods and services than the value of future goods and services. It thus relates interest rate to time preference factor as the main determinant that influences interest rate independent of money terms.<sup>7</sup> Of course, this view of separating the interest rate from money factors was challenged later by Keynesians, as they argue that interest rate is monetary phenomenon. In contrast to time preference, Keynes and followers assume ‘liquidity preferences’ are rooted in people preference either to hold money or bonds. For this reason, Keynes treats interest rate as a monetary phenomenon while neoclassical assumes that interest rate is determined by time preference.

Modern neoclassical models are introduced with micro-foundation properties and money at most assumes a passive role. These models include the dynamic general equilibrium in Benassy (2011) - see A.1 in the appendix, and the basic New Keynesian models by Bergholt (2012), Gali (2008) and Walsh (2010)<sup>8</sup>. Although these micro-founded models provided some intuitions based on optimizing agents, they however reached the same conclusions that money is neutral in the long run, and that it is a passive commodity that facilitates transactions of goods and services. In addition, it concludes that real interest rate evolves independently from money, and money exogenously determines the path of

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<sup>7</sup> See Belke & Polleit (2009) who claim that Austria differs from Neoclassical position in the sense that interest rate is not an impetus to saving nor reward for abstaining from current consumption. It is rather a time preference whereby ‘people assign greater value’ the present goods (savings) more than future goods (investments).

<sup>8</sup> Walsh (2008) explored the role of money in other classical monetary models e.g. Cash-In-Advanced model (CIA), Shopping time model and money-in-the utility function model (MIU).

the price level. However, modern neoclassical showed explicitly that in monopolistic setting firms have market powers to set prices which remain in force until next opportunity to revise the price.

Neoclassical economics with classical monetary model based on quantity equation says less about the transmission channels of monetary policy. The simple conclusion is that the rate of growth of the quantity of money determines inflation and, thus a money-growth target set by central banks will help to stabilize the inflation in the long run. As suggested by the ad-hoc money demand equation (1.2) it clearly shows that there is a direct relationship between money and expected inflation – an increase in the quantity of money leads to proportion increase in the general price level. What then can the monetary policy do in the neoclassical economy? From the relationships illustrated above, we can deduce that central bank's monetary policy influences nominal variables, the path of price level and inflation by changing the level of money supply. However, this is possible when a stable money-inflation relationship exists. Note here that, monetary policy takes the form of adjusting the level of money supply to hit the set monetary target, and it is not about adjusting the nominal interest rate target as it is the case in the current new consensus. However, both old and modern neoclassic monetary models show that this monetary policy cannot affect output in the long run (Belke & Polleit, 2009). Given the conclusion above, neoclassical theorists thus recommend that there is no need for government intervention if markets are allowed to work their way out. The governmental role should be limited and confined to activities that will ensure a free market with no imperfections. If necessary, governments should carry out supply-side policies such as education and training to improve labour productivity. Regarding monetary policy, the growth of money stock should be controlled to maintain price stability and ensure strong and stable long term growth of money supply that is consistent with real income (Sorensen & Whitta-Jacobsen, 2005). In all, the monetary theory in neoclassical shows that when central bank controls money supply, the rate of inflation is determined from the demand for money whether derived in the inter-temporal utility function (such as CIA) or in the classical demand for money partial equilibrium.

### **1.2.2 Criticisms of the Neo-classical monetary theory**

There are several weaknesses in the monetary theory within neoclassical economics. First, the main criticism toward Neoclassical is based on their main assumption of optimizing rational representative agents; firm and household. This 'straight jacket' which runs across all models in neoclassical family neglects important features such as

credit friction-constraints, imperfect markets and incomplete markets that embed all real economies (see for example Gracia, 2011, pp. 4-5). There is a general recognition that agents-based models provide economic and monetary intuitions; however, they fail to stack up to facts and data. Next, the neoclassical theory shows that the natural interest rate is determined in the market for funds by saving and investment demand; but this equilibrium excludes the role of money supply in determining the rate of interest.<sup>9</sup> This is contrary to the relationship between money and interest rate; because there are many empirical studies with clear evidences that money supply affects interest rates. Money supply affects the level of interest rates and the level of credit in the economy (Dennis, 1981). Contrary to what Neo-classicists claim, (Hansegn, 2006) shows that investment demand is less responsive to interest rates. We do not intend to quarrel with them on this point because economists such as (Simpson, 1949) have long asserted that the Neoclassical system needs more integration of monetary economics.<sup>10</sup>

Second, there are genuine doubts about the reality of the assumption of constant income velocity in the quantity theory of money. This is because many studies point to evidence that velocity changes over time. Income velocity will remain constant only if interest rate remains constant and, the level of nominal income in the quantity theory of money does not change. This therefore brings into question the reality of money neutrality as claimed by neoclassical theorists at the level of full employment. Furthermore, neoclassical monetary theory is criticized for its lack of emphasis on the financial system as it does not play significant role at all. It is an undeniable fact that financial system is important, because financial system has the ability to deal with market failure, to create money, and to enhance economic growth Mishkin (2007a) and (Dennis, 1981; Knoop, 2008). Neo-classicists treat money supply as exogenously determined, while there is ample evidence that suggests that money supply is endogenously determined (Goodhart, 1989). Lastly, monetary policy that follows the manipulation of the quantity of monetary base as it was the case in early neoclassical leads to higher inflation and interest rate volatility as monetary authority misses the monetary target. In all, Benassy (2007) indicate that monetary models in neoclassical produce liquidity and price puzzles and results which are at odd with empirical facts.

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<sup>9</sup> In addition Sorensen and Whitta-Jacobsen (2005) reveal that the natural interest rate helps predicts real interest rate. This equilibrium interest rate is determined by the forces of productivity, population growth, and depreciation and saving rate.

<sup>10</sup> We highlight here that there are few exceptions, for example (Gillman's, 2011) recent works incorporate banking with uncertainty however, these works are still at an infant stage.

### 1.2.3. Keynesian's Monetary Theory: Roles of Money and the Nature of Monetary Policy

Keynesian monetary economics revolves around the *liquidity preference theory* - *Keynesian demand for money*- introduced in the monetary sector (Belke & Polleit, 2009). This liquidity preference theory is one of the hallmarks that differentiate Keynesian monetary theory from the general family of neo-classical theories. It explains why people individually express demands for money; i.e. the motives for money as liquid asset (Lewis & Mizen, 2000). In this theory, the demand for money is determined by interactions between income and interest rate that is, the price of demand. Thus, Keynesians argue that, to influence the demand for money, we should either control directly the price for money or indirectly by inducing changes through real income. Theoretically, a change in interest rate, other things being equal, affects individual preferences for holding liquid (cash) and illiquid assets.

Keynesians recognize the importance of the role of money, because it is “first and foremost a financial asset” (Lewis & Mizen, 2000). Money does not affect only the absolute price and quantity of trade, but it affects also the level of financial intermediation, stock prices, and its’ own price -interest rates- (Knoop, 2008). Although there is a clear recognition for active roles of money in the money market, Keynesians assume that money is exogenous. This is usually demonstrated with the two graphs that depict a downward money demand curve and a vertical money supply curve –the later represents the monetary policy instrument in the hand of monetary authority to manipulate it at its own wills. The Keynesian demand for money is divided into three components, although there should not be a sharp divide in the mind of the holder of money (Lewis & Mizen, 2000). These reasons are transaction motives; the precautionary motives, and the speculative motives.

#### (i) Transaction demand for money<sup>11</sup>

The first motive for demand for money is to conduct transactions. This demand refers to nominal balances that individuals hold in their pockets or wallets. Transaction balances depend on the amount of nominal income, the length of interval between receipts and disbursement, and the mechanism of obtaining and delivering cash to individuals (Dennis, 1981). We shall stress here that the transaction motive for holding money is unconnected with the level of interest rate. It is also positively related to individual income; meaning that as income increases, the total number of transactions an individual makes increases. This relationship is represented as follows:

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<sup>11</sup> Transaction demand for money is identical to the quantity theory discussed under neoclassical theory.

$$L(t) = L(Y) = kY \quad (1.5)$$

where  $L(t)$  =demand for transaction balances,  $k$ =income balance coefficient,  $Y$ =nominal income.

(ii) Precautionary demand for money

Precautionary demand for money is one of the major innovations by Keynes in the money demand theory. Keynes argues that people hold money to meet unforeseen (unexpected) expenses such as medical bills, car accidents and any other expenses that require immediate payment (Dennis, 1981). Keynes believes that these balances are held over and above what he terms the 'normal' requirements of planned expenditure. Therefore, he lumped together the transaction demand and precautionary demand for money. So the demand for transaction balances includes the demand for precaution balances.

(iii) Speculative demand for money

The third purpose for holding money is the speculative purpose. Keynes regards money as an asset like other assets that earns return and has an opportunity cost. Although money has a zero rate of return, the opportunity cost of holding money is the interest rate. Therefore lending or investing the money in other assets such as bonds can earn the holder interest. However, there is a risk associated with any asset, hence the return earning on the asset depends on the future interest and the inflation rate. Inflation reduces the purchasing power of money; this reduces the speculative demand for money. Therefore in Keynesian economics the demand to hold speculative balance is a decision to liquidate cash or interest bearing bonds (Belke & Polleit, 2009). The speculative demand for balances is as follows:

$$L(s) = L(r) = R - dr \quad (1.6)$$

where  $R$ =autonomous speculative component,  $d$ =interest elasticity,  $r$ =representative interest rate.

The total demand for money ( $Md$ .) therefore combines the demand for transaction balances and speculative balances, which varies positively with income and negatively with interest rate.

$$Md = L(Y, r) \quad (1.7)$$

where,  $Y$  is the income and  $r$  is the interest rate. A rise in income leads to more transactions thereby requires increase in money supply. While a rise in the interest rate increases the opportunity cost of holding money thereby reducing the real demand for money balances at the existing level of money supply.

Interest rate in the liquidity preference theory is different from the natural interest rate determined in the general equilibrium under neoclassical theory. Natural rate of interest is the interest rate that makes savings equal to investment demand in neoclassical economics. Belke and Polleit (2009), and Sorenson and Whitta-Jacobsen (2005) reveal that this natural real interest rate is determined by real factors –productivity and real saving rate. Hence, in the neoclassical monetary theory real interest rate is real factor phenomenon.

In contrast, interest rates in Keynesian are determined by two factors: demand and supply of money; thus, it is viewed as monetary phenomenon. It equates the demand for money and the supply of money in the money markets. This market interest rate can be above or below the natural interest rate. Sorenson and Whitta-Jacobsen (2005, p. 445) assert that this is short term interest rate, since “the closest substitutes for money are the most liquid interest bearing assets with short term to maturity”. The role of the interest rate in the Keynesian monetary model is the reward of parting with liquidity. This feature makes interest rate a viable tool for government interventions through the monetary authority in the financial market to manage the economy in the short term. In addition, early Keynesians use money supply sparingly for stabilization purposes while fiscal spending is encouraged to induce domestic spending and expansion in investments and private consumption. This is because monetary policy through monetary channel is dotted with uncertainty and significant lags in monetary policy effects.

Surprisingly, neoclassical and Keynesian economists take that there is a connection between the two views of interest rates. This is asserted by Lewis and Mizen (2000) who claim that “whether it’s the rate of interest which is determined in the money market under stock conditions or in the bond market under flow condition it is largely a semantic.” Keynes disputed the theory of loan-able funds because he had less faith in the market. Therefore, he reasoned that when people increase their savings, this reduces consumption and further decreases aggregate demand. His conclusions are therefore that investment is a function of interest rate as claimed by classicalists which see it as a function of business confidence and other economic factors (Dennis, 1981).

Monetary policy in early Keynesians takes the ‘quantity-oriented’ view and its effects are transmitted indirectly through money markets to households, firms, and finally the total economy. It affects the availability of financial intermediary credit as central bank adjusts the level of money supply.<sup>12</sup> For example, an increase in money supply (exogenous supply by central bank) puts downward pressure on market interest rates thereby making additional funds available for investments at lower terms. This will further cause demand for investments to increase and subsequently, output will expand. Money is not neutral as it determines interest rates in the money market which impacts further on the profitability of investments. Money affects economic activity in the short term if there is a spare capacity in the economy and also as it fulfils its role as medium of exchange and transaction purposes as shown in (A.13) in Appendix. Hence, within the liquidity theory, the exogenous money supply was the monetary policy instrument that stimulates the economy in the short term.

However, Romer (2006) and Alvarez, Lucas and Weber (2001, p. 219) point out that in modern Keynesian theory, money is no more assumed exogenous, but rather endogenous. This means that central banks do not explicitly target money supply or use it to set off the transmission mechanism in the economy. Money supply figures form part of set of financial and economic information that feeds into monetary policy processes. Central banks set a nominal interest rate target which is based on the interest rate rule such as the Taylor rule. Nowadays central banks adjust money supply through market operations to keep interest rate close to the target. The money market equilibrium condition for real balances is now defined as follows:

$$\frac{M}{P} = L(r + \pi^e, Y), \quad (1.8)$$

whereby  $M$  is the money supply,  $P$  is the price level,  $r$  is the real interest rate,  $\pi$  and  $\pi^e$  is the rate of inflation and expected inflation. The interest rate rule is implicitly given as follows:

$$r = r(Y, \pi), \quad (1.9),$$

$$M = L(r(Y, \pi) + \pi^e, Y) \quad (1.10),$$

while the nominal money supply endogenously is determined by interest rate rule, expected inflation and output. In this arrangement, money supply is less relevant and thus

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<sup>12</sup> Bindseil (2004) reveals that the implementation of monetary policy takes a quantity oriented view in the Keynesian and monetarism.

dumped to the background as information variable. Modern Keynesians emphasize fiscal spending or concentrate on stabilizing output fluctuations and the inflation rate in the short term through interest rate rule.

What then are the roles of monetary policy in Keynesian economics? The role of monetary policy is primarily to stabilize aggregate demand indirectly through financial markets by adjusting the level of liquidity in the money markets or set new interest rate target according to interest rate rule. Monetary policy is effective in stimulating the economy when unemployment is increasing, or when the economy is overheating. However, the effectiveness of monetary policy is doubted by early Keynesians because of uncertainty in financial markets.<sup>13</sup> For example, banks might refuse to lend (i.e. the new available credit) to one-another or to non-financial sectors when risk exposures in the economy cannot be ascertained. In addition, some Keynesians believe that monetary policy is ineffective if households decide to reduce their spending when they expect that government will raise taxes in the future to compensate for today spending.

Keynesians view inflation as a cost-push phenomena, meaning excess demand is the main cause of inflation in the long run. Monetary policy is therefore useful to muzzle demand-inflation to stabilize the economy by inducing a recession in the domestic economy. This view is supported by New Keynesian advocacy for interest rate policy to manage aggregate demand, thus regard interest rate setting policy as a demand management policy. In summary, money supply is exogenous and its role as monetary policy instrument in Keynesian is to influence the price of money which is the interest rate; this encourages investment indirectly and consequently increases output. However, in the Keynesian era, the difficult part was on how to balance the operations of monetary policy in order to avoid damages to the economy. As Gottschalk (2005, p. 11) reveals, “the task of demand policy is to strike the right balance between sustaining high employment level and keeping inflation under control (...) this is because monetary policy operates with lags, and trade unions bid for high wages when inflation is rising thereby risking out spiral of wage inflation.’ This therefore provides preference for fiscal policy as tool to stimulate the economy in Keynesian economy than the monetary policy.

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<sup>13</sup> Other reasons that motivate skeptics about effectiveness of monetary policy are: due to precautionary measures, households increase money holding in bad times, and become skeptical about central banks ability to respond in time to economy shocks. Gottschalk (2005) reveals that although it was suggested in the early Keynesian models that monetary policy is powerful; nevertheless it was used to support fiscal policy in stabilizing the economy.

Early Keynesian economists argue that the perception that increases in money supply will always lead to inflation is flawed (Dennis, 1981). Money supply cannot lead to inflation if the economy is operating below full employment capacity. This is because excess money supply will find extra demand, which will make the economy move close to full employment. Furthermore, we should point out that the impact of monetary expansion in Keynesian economics depends on investment elasticity and the stability of the demand for money function. The smaller the elasticity of interest rate on investments, the smaller the effect passed through to the real economy (Lewis & Mizen, 2000).

Several criticisms have been put forth against the policy activism of Keynesian economics. First, Keynesian activist economic policy can generate and/or prolong inflation, unemployment, and instability in the economy.<sup>14</sup> For example, monetarist such as Schwartz (2009) argues that Keynesian discretionary monetary policy was responsible for the great depression in the 1929. And similarly, the discretionary monetary policy is the main culprit that caused the 2008-09 financial crises. For example, it is alleged that low interest rate that stays for a prolonged period creates asset price bubbles from cheap credit in the financial markets. These low rates entice businesses and households to take more loans which in the long run become unsustainable. In addition, the preference of low interest rate policy particularly in developing countries is not always viable because of limited fiscal space to adjust.

Greenwald and Stiglitz (2006) argue that monetary policy in the Keynesian economic did not help to lift Japan out of deflation; this shows that it is not effective in reviving the economy as it fails to stimulate investments when a country is experiencing deflation problem. In developing countries, where the banking sector and financial markets are undeveloped, less credit facilities are used, hence the use of monetary policy to manage aggregate demand is usually limited. On the contrary, it turns out that the impacts of monetary policy are very severe because they are highly concentrated on the few sectors of the economy.

In summary, Keynesian monetary theory recognizes the active role of money in the economy. Money affects economic activity in the short run<sup>15</sup>, the quantity of trade, the level of financial intermediation, and its own price that is, interest rate. Romer (2006) shows that Keynesians have dropped the use of money supply as a policy instrument

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<sup>14</sup> In practice there is no exact formula that states how much liquidity we should inject into or drain out in the economy.

<sup>15</sup> This is possible because prices and nominal wages are sticky in the short run.

because money is endogenous. Alternatively, interest rate is set as policy target which is maintained through open market operation to keep interest rate close to the policy rate target.

#### 1.2.4 Monetarism

Cagan (1989) defines Monetarism as a theory associated with the view that the quantity theory of money affects economic activity and price level, and that, to control inflation, monetary policy must target the growth of money supply. This school of thought was spearheaded by the Chicago School of economics and Milton Friedman, acclaimed to be the torch bearer was later joined by Anne Schwartz.<sup>16</sup> As the name implies Monetarists emphasize the role of money and the link between money growth and inflation (De Long, 2000). The monetary policy transmission mechanism is directly described by money-inflation in the quantity equation as opposed to indirect link through financial markets described earlier in the Keynesian monetary theory. In his early works, Milton Friedman (1968), the god-father of monetarism asserts that there were clear evidences that monetary policy strongly affects the real variables in the short term. Thus, on this ground the growth rate of money formed a target base in order to achieve economic growth in the short term. In the early 1950s Friedman led a counter-revolution against Keynesian activism to re-establish neoclassical economics with some modification. Thus, Cagan (1989), Friedman and Laidler (1982) advocated the control of money supply as a policy instrument superior to Keynesian fiscal policy for economic management.<sup>17</sup>

The theoretical foundation of Monetarism is rooted in the quantity equation popularized by Irvin Fisher in 1911 (Cagan, 1989). In the quantity equation, monetarists illustrate how monetary policy is linked to inflation as opposed to the Philips curve relationship in the Keynesian. We discussed this quantity equation under the neoclassical monetary theory's section. Using the logs (small case letters) and differences ( $\Delta$ ), the inflation relationship in the Monetarist theory is given as follows:

$$\Delta p_t = \Delta m_t + \Delta v - \Delta y_t, \quad (\Delta v \approx 0) \quad (1.11)$$

This equation shows that the rate of change in the general price level is equal to the growth rate of money less the real output growth, holding changes in the velocity constant.

<sup>16</sup> However, DeLong (2000) asserts that it's Fishers' *In Appreciation and Interest* (1896) that propelled the intellectual fire that became known as Monetarism; therefore the first Monetarism is Irvin Fishers' Monetarism.

<sup>17</sup> Gottschalk (2005, p. 12) writes that: 'the monetarists' position was sustained by the experience of stagflation in the 1970s when the expectation-augment Philips curve empirically fared much better than its traditional counterpart.' He revealed further that the traditional Philips curve was formulated in nominal wages while the expectation-augmented Philips curve was formulated in changes of expected real wages.

Thus, deducing from the quantity theory, Monetarists claim that there is a consistent relationship, although an imprecise one, between the growth rates of money supply and that nominal income or money and inflation are tied together (Friedman, Goodhart, & Wood, 2003). Monetarist economists believe that inflation is caused by too much money chasing few goods or too much liquidity in the economy relative to output produced (Neills & Parker, 2004). DeLong (2000, p. 83) purported that “to understand the determination of prices [...] look at the stock of money and the quantities in the economy of those assets that constitute readily spendable purchasing power.” Thus to control inflation, it is essential to restrain the growth of money supply; of course, this understanding by Monetarism led to the notion of monetary rules such as the monetary aggregate targeting.

It is important to note the differences here, that money plays an important larger role in monetarism than in Keynesian transmission mechanism. This is clear from the implied direct link between money balances and inflation in the equation (1.11) above. On the contrast, Keynesian place large role on availability of credit to influence the investment growth and economic growth. This emphasis is similar to the position taken by most Post Keynesians who claim that it is credit (i.e. inside money) that matters most.<sup>18</sup>

Another fundamental that differentiates monetarism from Keynesian is the emphasis of real wage as the main determinant of demand and supply of labour. This view by monetarists led to a reformulation of Phillips curve in terms of real wage rather than nominal wage (Gottschalk (2005)). It is reinforced by the assumption that wage contracts are set with forward looking nature which points to expectation as a major determinant of wage inflation. The core assumptions of Monetarism are quite similar to those of Neoclassicism with the exceptions of the effects of money and equilibrium in the labour markets (Blinder, 1997). Money supply is not neutral in the short run; it affects output through aggregate demand. The labour markets do clear because of imperfections through stick prices and wages, and this happens at the natural rate of unemployment. Labour wages are sticky; and equilibrium in the labour market is settled at natural rate. This natural rate is equal to measured employment plus an unnatural increment as a result of disparity between expected inflation and actual inflation (Leeson, 1997).

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<sup>18</sup> See Greenwald and Stiglitz (2006).

#### **1.2.4.1 Nature, Roles of Money, and Monetary Policy in Monetarism.**

In Monetarism, money supply (a stock) is exogenously determined and fully controlled by government.<sup>19</sup> Monetarists re-evaluate the quantity theory of money presented by neoclassical economists; their main argument being that fluctuations in the economy are always matched by changes in the money supply or generally in the growth of credit money. If money supply grows faster than the growth rate of real income there will be inflation. This is why Monetarists are always associated with the statement that “Inflation is always and everywhere a monetary phenomena” (Friedman et al., 2003, p. 29).

Monetarism agrees that money matters for two distinctive reasons: (i) engender inflation in the long term; (ii) drives economic activity and fluctuation in the short run. Hence it was particularly in their interest to demonstrate that monetary policy is effective in influencing economic activity in the short term. In the long term money growth is the main source of inflation. While in the short run, because of nominal rigidities 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. This may lead to full employment; however as time goes on people will soon catch up with this policy of monetary expansion.<sup>20</sup> Therefore, the policy effects on aggregate demand will be short lived and the increase in money supply only generates inflation in the long run, and any efforts to reduce unemployment below the natural rate of unemployment will result in inflation.

Monetarists hold the view that the transmission mechanism of monetary policy is complex; this is because there are time lags between a change in money and its ultimate effect on price level.<sup>21</sup> This suggests that policy makers cannot precisely tell when and to what extent their policy actions will affect the real economy. Thus, whatever decision taken about money today may affect the future price level, but this will be subjected to a series of lag effects. On this basis, some believe that financial markets are competitive, many monetarists do not assign much importance to this transmission that emphasises credit channel (Gottschalk, 2005). Thus, to avoid policy mistakes advanced by Keynesian

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<sup>19</sup> This is supported by the fact of Monetarists’ faith in independent central banks’ ability to control money supply.

<sup>20</sup> See (Gottschalk, 2005). This argument is enforced by rational expectation, which implies that agents form expectations about the behaviors of policy makers. If government changes its policy, agents may not recognize this immediately; they learn the rule eventually and adjust their behaviors accordingly.

<sup>21</sup> Fender (2012) pointed out that monetary aggregates are available with lag as opposed to interest rate which is available instantaneously. As Rittenberg and Tregarthen (2009, p. 412) write: ‘macroeconomic policy makers must contend with recognition, implementation, and impact lags.’

activisms, Monetarists argue for monetary policy rules to stabilize aggregate demand (Cagan, 1989; Karl, 1968).

Monetarists advocate for money growth targeting rule as an instrument to reduce fluctuations which drive business cycles. Many believe that private sector is inherently stable, and this stability can be jeopardized by so called discretionary policy advanced in Keynesian economics. To avoid this strategy, central banks should thus grow money supply at a constant growth rate and this will produce a moderate growth in inflation, without high fluctuations in output and employment (Friedman, 1968). In summary, money is exogenous and controlled by monetary authority. Its role is to facilitate the exchanges of goods and services in the economy. In addition, monetarists took money supply as the monetary policy instrument which has real effects in the short run; however, in the long it is considered as the main source of inflation in the economy. Therefore, monetary authority should figure out the growth rate of money supply that is consistent with the growth rate of real income in order to control inflation.

#### ***1.2.4.2 Criticisms of Monetarism***

As early as the 1970s a barrage of criticisms was hurled against Monetarists for their theoretical beliefs. First, Monetarism emphasizes causality from money supply to inflation. Economists such as Mishkin (2007a) argue that this direct causal relationship between money supply and inflation is not easily predictable.<sup>22</sup> Thus, there is no consensus view that causation is unidirectional, because there is nothing that prevents the possibility of reverse causation (Mishkin, F. S., 2007a; Neills & Parker, 2004). In addition, there is challenge on the exact monetary aggregate to be used as a target because money supply definitions are always changing to reflect what is being used as money in the financial system.

Second, the assumption of constant velocity in the quantity theory of money has severally been challenged on empirical grounds with data from developed and developing countries (Mishkin, F. S., 2007a; Neills & Parker, 2004). Therefore, these doubts hanging on the validity of this assumption signify a problem of disentangling the effects of income velocity on inflation from the effects of money supply.

Third, Monetarists believe that money supply is exogenous and that central banks can firmly control it. However, many economists in the mainstream have discarded it and the consensus view is that money supply is endogenously determined (Goodhart, 1989).

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<sup>22</sup>See also Friedman B, (2000). The relationship between money and either income and prices had broken down, the alleged cause of this are deregulation, and financial innovations.

For instance, Bindseil (2004) reveals that today's central banker would argue that this proposal that is, growth target of money would lead to extreme interest rate volatility and would make any systematic control of credit, money, prices, and business activity impossible. Romer (2006, p. 227) claims that "central bank follows an interest rate rule" and adjust money so that interest rate can follow the rule. Therefore, money is endogenously determined by interest rule, inflation expectation and output. Thus the monetary policy instrument that central banks can confidently control is the short term nominal interest rate rather than money supply.<sup>23</sup> Finally, Fender (2012) argues that it is difficult to reconcile the function of lenders of last resort with the assumption that central bank strictly target monetary aggregate. This is because when there is liquidity shortages that threaten financial stability central banks will intervene thereby abandoning the target.

#### **1.2.5. New Keynesian monetary theory: A new macroeconomic consensus perspective<sup>24</sup>**

During the last century, particularly after the great depression, the field of economics was frequently characterized by debates among different schools of thought. Different camps were vying for a place of dominance in terms of a superior theory that explains the macroeconomics problems prevailing at their time. However, the scene has changed such that there seems to be a broader consensus in macroeconomics than ever before. Alvarez, Lucas, and Weber (2001, p. 219) point out that:

in this new consensus 'discussion of monetary policy is centred on a class of policies known as "Taylor rules," rules that specify the interest rate set by central bank as an increasing function of inflation rate or inflation forecast'.

These monetary policy rules are commonly analyzed with the New Keynesian theory which is based on dynamic general equilibrium consistent stochastic models. It all begins with the desire to base standard macroeconomic models on households' behaviours and their parameters derived from first principles of micro-foundation. Most models that gain the consensus allow some forms of rigidities either in wages and prices that results in imperfect competition and firm's market powers in the short run. Households, firms and

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<sup>23</sup> Freidman B, (2000) reasons that there was never theoretical basis for knowing which measure of money was the right one to target (M1, M2, or M3), and even within countries, empirical evidence on which money had the close relationship with income and prices was mixed.

<sup>24</sup> Our discussion in this section focuses largely on those aspects that enjoy the consensus among monetary economists from inside and outside mainstream. Finally, we outline the criticisms against some of theoretical aspects propagated in New Keynesian monetary theory. These criticisms include such as alienation of money-finance from macroeconomy, and inability to match empirical data to some conclusions of new Keynesian models.

government all optimize to achieve intertemporal and intratemporal equilibriums.<sup>25</sup> Some firms are subject constraint so they cannot change the prices of goods and services they sell frequently as they would like. Models that start from these the principles enjoy support from economists such as Gali (2008), Gordon (2008), De Long (2000), Mankiw (1993), Romer (1993), and criticisms from some post keynesians such as Sawyer (2009), and Fontana and Setterfield (2009). This wide subscription by economists from mainstream and some from post Keynesian is possibly explained by the fact that it (New Keynesian) embodies elements of several of its predecessors such as Classical, Old Keynesian, Monetarists, and Real Business Cycles (Gottschalk, 2005).<sup>26</sup> For example, Knoop (2010) points out that this strand embraces market failure and price inflexibility, natural hypothesis, rational expectation and microeconomic founded assumptions for households and firms. In addition, Money is endogenous with the passive role to react to nominal interest – a price set and controlled by the central bank. In this consensus the nominal interest rate serves as the monetary policy instrument that solves the equilibrium values rather than money supply as held before. In a nutshell the basic model set up consists of the following features. A representative household's life time money-in-utility function which is maximized subject to budget constraint as follow:

$$\max_{C_t, N_t, B_t, \frac{M_t}{P_t}} E_0 \sum_{t=0}^{\infty} \beta^t U \left[ \frac{C_t^{1-\sigma}}{1-\sigma} + \frac{\left(\frac{M_t}{P_t}\right)^{1-\nu}}{1-\nu} - \frac{N_t^{1+\varphi}}{1+\varphi} \right]$$

$$\text{s.t. } P_t C_t + M_t + Q_t B_t \leq M_{t-1} + B_{t-1} + W_t N_t + T_t \quad (\text{A.27})$$

$$\mathcal{L} = E_0 \sum_{t=0}^{\infty} \left\{ \beta^t u \left( C_t, N_t, \frac{M_t}{P_t} \right) - \lambda_t (P_t C_t + M_t + Q_t B_t - M_{t-1} - W_t N_t - T_t) \right\}. \quad (\text{A.28})$$

In this basic set up the households consumption level is denoted by  $C_t$ , labour  $N_t$ , and real money balances by  $\frac{M_t}{P_t}$ .<sup>27</sup> Households hold the following preferences on marginal utility of consumption  $u_{Ct} > 0$ , marginal utility of labour (i.e time devoted to market for employment)  $u_{Nt} < 0$ , and real money holding  $u_{Mt} > 0$ . Marginal utilities are increasing in consumption and real money holding while there is disutility from work. This model is solved for first order conditions in the appendix to obtain equilibrium values for

<sup>25</sup> Gottschalk (2005): elucidates inter-temporal optimizing to mean that current choices do not only depend on current and past, but also on future conditions.' See also (Carlin & Soskice, 2006; De Long, 2000; Gordon, 2008; Rittenberg & Tregarthen, 2009).

<sup>26</sup> Surprisingly NK also enjoys recommendation in parts by some Post Keynesians.

<sup>27</sup> Take note, the basic New Keynesian models ignore the endogenous variation of capital. According to (Walsh, 2010, p. 330) because response of capital and investment contribute little to dynamic implied by these models'

households and firms, which then used to analyse the role of monetary policy through the nominal interest rate and exogenous money supply. It worth noting here that the real money balances enter the utility function as a good that provides utility from money services rather than the nominal dollar values. Main important outcomes are the intertemporal consumption condition which shows households' preferences over consumption between now and the future, and the intratemporal equilibrium which shows preference across goods at period  $t$  – i.e. households' marginal rate of substitution between consumption and money, and leisure and real wage. Meanwhile the firms' problem is to minimize the wage bill given the labour  $N_t$  available to spend on the production of goods and services. In addition, firms solve their decision problem by choosing the right price that maximizes their streams of profit given the constraints of revising the optimal price.

One of the key elements of New Keynesian economics is the monopolistic competition; firms are now competitors and set the prices in order to maximize profit (see A.34 & A.35 in the appendix). As in the old Keynesian economics, New Keynesian assumes that markets do not always clear wages and prices do not promptly adjust to respond to demand or supply shocks. These rigidities create avenues for monetary policy to have effects in the short run before prices and wages adjust. Thus, New Keynesian economics seeks to explain the causes and consequences of market imperfections in the labour, product and capital markets based on rational expectation and profit maximization behaviours of workers and firms. Some of the factors that inhibit wages and prices to adjust promptly are menu costs; price setting behaviours of firms, and long term labour contracts such as minimum wage and implicit wage contracts. This monopolistic behaviour is generated by private agents -workers and firms as they pursue their self-interests in labour and product markets. For example, in the monopolistic competition as assumed in the New Keynesians, firms fail to cut the prices for fear of losing their markets to rivals even if such cuts are in the interest of the society. This is co-ordination failure on the part of firms which will result in nominal rigid or sticky prices. The sluggish adjustment makes these shocks to move the economy away from the equilibrium.<sup>28</sup>

Another explanation comes from efficiency wage theory, it claims that productivity rises with real wage as firms want to attract and maintain high skilled employees. This strategy helps firms to cut costs associated with the training and hiring of new workers thus, wages will remain stubbornly sticky because there is no prospect to hire

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<sup>28</sup> Gali (2008, p. 6) pointed out that these 'nominal rigidities makes room for potential welfare-enhancing interventions by the monetary authority in order to minimize the existing distortions'.

workers at low wage in the imperfect labour market (Greenwald & Stiglitz, 1993). In addition, Greenwald & Stiglitz (1993) claim that firms set prices and wages in an uncoordinated fashion, facing considerable uncertainties about the consequences of their actions. In all, firms set prices and wages as shown in the appendix equation (A.35), and these prices remain unchanged for a while and then changed but not all firms change their prices at the same time. These factors therefore, justify the assumption of sticky wages and prices in the New Keynesian.

It is natural that ‘intellectual ideas ebb and flows’ as suggested by (Mankiw, 1993, p. 3). The rise of New Keynesian monetary theory and its current dominant position in modern macroeconomics is attributed to several factors. First, the Lucas critique in the 1970s caused a fundamental shift in macroeconomic modelling, especially of the relationships in the Keynesian system.<sup>29</sup> Hence, New Keynesian economics sprang to life between the 1970s and the 1990s with the aim of remedying Old Keynesian economics with regard to the Lucas critique (Friedman, 1997). Second, Monetarism suffered cracks in their wall, when the acclaimed relationship between money growth and inflation broke down in the early 1980s (Fontana & Venturino, 2003; Wright & Quadrini, 2009), and it was not worth any more pursuing the monetary target that keeps on eluding them. In addition, Monetarists based much of their arguments on empirical findings with little formal theoretical foundation. Similarly, this was compounded further by the disagreement on what is the appropriate measure of money supply to use as the monetary target. Third, New Classical theory which started the emphasis of micro-foundations and inter-temporal optimizing agents has also failed to deliver as an alternative to monetarism. New classical school of thought seeks to re-establish the classical paradigm with new integral approach based on dynamic analysis. New classical concludes that anticipated monetary policy does not produce any effects, thus any action from central bank will have no real effect on real GDP according to rational expectation hypothesis. However, many empirical studies prove contrary as Gottschalk (2005) reveals that the influence of New Classical theory declines because their empirical evidence has generally been unfavourable. Hence, New classical

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<sup>29</sup> Keynesian analysis is comprised of a system of static equations which ignores dynamic relations among variables. It is an ad-hoc of top down modelling approach without micro-foundation which is based on utility maximization principles. On the contrast, Rittenberg & Turner (2009, p. 652) defines New Keynesian economics as ‘a body of macroeconomic thought that stresses the stickiness of prices and the need for activist stabilization policies through the manipulation of aggregate demand to keep the economy operating close to its potential output. It incorporates monetarist ideas about the importance of monetary policy and new classical ideas about the importance of aggregate supply, both in the long and in the short run.’ Rittenberg and Tragerthen (2010) gave two reasons; first, they argue that New Keynesian emerged because it successfully incorporates the relevant components from Monetarists, New Classical and Keynesian theories. Secondly, 1980s and 1990s events undermine the confidence placed in monetarism and New Classical economics; the two schools of thought prevailing then.

stumbled in the sense that people did not predict fiscal and monetary policy of the 1980s in the predictable ways suggested by the New Classical theory; this then casts doubts on the reliability of the New Classical economics (Wright & Quadrini, 2009). These factors exposed the weaknesses in the mainstream theories prevailing at the time. Consequently, some economists started to look elsewhere to find explanations for existing economic problems such as inflation, recurrent recessions and impacts of business cycles.

New Keynesian monetary theory is attracting followers and creating converts across the economics profession. Thus, in many circles it is generally referred to as the New Consensus Macroeconomics (Belke & Polleit, 2009; Rittenberg & Turner, 2009). It is generally acknowledged that New Keynesian theory guides macroeconomics policy in many central banks in the world today (Arestis, P., 2007a). In addition, it has become the basis of quantitative analysis in monetary economics today in institutions like the European Central Bank and the Bank of England (Arestis, P., 2007b; Wren-Lewis, 2007). Many argue that micro-founded models in the new consensus appeal because they provide the tractability of monetary policy effects and transmission channels. Secondly, the common uses of representative agents and monopolistic competition make the private agents to set the price rather than being determined by Walrasian auctioneer in the predecessor general equilibrium models. The dynamic stochastic part allows incorporation of exogenous economic shocks which hit the economy at irregular intervals while analysis within equilibrium allows researchers to do welfare analysis in a model that take into account all markets in a decentralized form, and identify optimum policy that maximize welfare.

Finally, consensus models have raised the role of nominal variables and recast monetary policy from money to interest rates. Prominently, the new Keynesian specific has cemented the idea of endogenous money and the controllability of short term interest rate by central banks. These features are very important in monetary policy analysis because we can deduce from the model which variables respond to monetary and fiscal policies about when, why and by how much. There are postulated nominal anchor either inflation target or price-level target pursued as the mechanism to achieve stabilization for prices and output.<sup>30</sup> The main conclusion is that monetary policy that is, manipulation of interest rate is not neutral in the short term because wages and prices are sticky. Hence, firms, household and central banks are forward-looking; and the nominal interest rate influences overall economic activity through expectation output gap and inflation. We point out here that some of the doctrines in New Keynesian are contested by economists across the

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<sup>30</sup> See Arestis and Sawyer (2002).

divide. However, there is a general consensus around the monetary policy instrument, the opinion that central banks are ready to provide liquidity at the set target, money is endogenous hence money demand relation is redundant, inflation target as means to the end but not an end itself, and the realization that there is no trade-off between inflation and unemployment.

#### ***1.2.5.1 The Nature, Roles of Money, and Monetary Policy in New Keynesian Economics***

Monetary theory in New Keynesian (NK) economics has many interesting aspects and it comes in various shapes of economic models that emphasise representative agents such as household, representative firm, government, and external sector. In order to gain understanding about the features of the NK monetary theory, we start by analysing the three log-linearized macroeconomics equations that form the bedrock of this new consensus. In appendix we gave a summary of the main elements that will help us understand the monetary policy and its transmission thereof in New Keynesian monetary theory. The step by step solutions of the basic New Keynesian model are given in main texts such as (Gali, 2008) and Woodford (Woodford, 2001). In these textbook authors solved the model in (A.28) and construct the three macroeconomics equations in a canonical form. A typical fully solved New Keynesian model contains an expectation-augmented New Philips Curve, a forward-looking dynamic DIS curve, and an interest rate equation describing the policy rule of the central bank (Arestis & Sawyer, 2006; David, 2008; Gali, 2008; Gottschalk, 2005).<sup>31</sup> These standard system of equations in the New Keynesian theory do not have any explicit reference to money (Fontana, 2006). That is there is no explicit role assigned to money as target in the model to control inflation. As a consequence, some economists characterize New Keynesian economics as an economic analysis without money. This is particular when the utility function used has real money balances separable from consumption. The appearance of money ends with identification of money demand equation in (A.33). However, this is not the cashless economy as implied in some cases; this is because money is endogenously determined by financial institution in response to the demand for credit. Money supply is lurking in the background, indicated by Mankiw & Taylor (2007) that money supply is adjusted to whatever level is necessary to ensure that equilibrium interest rate hits the target. This endogenous feature will be discussed in detail under the post Keynesian monetary theory in section 1.3 ahead.

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<sup>31</sup> Recently, some non-linear models of New Keynesian have emerged, see example in Gottschalk (2005).

In this consensus perspective, the role of money within this model is implicitly given and where emphasis is made, its role is to fulfil the function of exchange of goods and services as given in the utility function, and further used as day to day tool for central banks to hit the interest rate target. New Keynesian models do not explicitly identify the liquidity preference/money supply equilibrium (LM) curve, as is done in the Old Keynesian models and thus in this theory, the attention on money is very minimal (McCallum, 2001). However, this characterisation raises questions about the relevance of money in macro models. Does money matter? The obvious answer is that money matters and we concur with (David, 2008) who argues that very few macroeconomists would attempt to argue that money and monetary phenomena are unimportant and undeserving of any attention. This is because when central banks set interest rate than they commit themselves to supply money in response to economic factors that threaten the interest rate-target, this keeps inflation and output gap close to zero. In addition, it is argued that in money matters, because bank money is created to finance production and investments hence, banks money responds to the demand from private firms and households.

The three main character equations are briefly discussed as follows: dynamic DIS-Curve which represents aggregate demand in goods market, the New Phillips curve NPKC which determines aggregate supply and the model is closed up with reaction function of the central bank which shows how central bank reacts to shocks in the economy (Arestis & Sawyer, 2006; McCallum, 2001; Meyer, 2001).<sup>32</sup> These three equations are stated as follows:

$$x_t = E_t(x_{t+1}) - \sigma^{-1}(i_t - E_t\pi_t + \rho) \quad (\text{A.42})$$

$$\pi_t = \beta E_t(\pi_{t+1}) + \kappa x_t \quad (\text{A.39})$$

$$i_t = \pi_t + \rho + \delta_\pi(\pi_t - \pi_t^*) + \delta_x x_t + v_t \quad (\text{A.46})$$

where  $x_t$  is the output-gap,  $i_t$  is the nominal interest rate,  $\pi_t$  is the rate of inflation,  $\pi_t^*$  is the inflation target,  $\rho$  is the equilibrium real rate of interest (that is the rate of interest consistent with zero output gap) and  $E_t$  refers to expectation held at time  $t$  of the variable at time  $t+1$ . Equation (A.42) represents the dynamic investment/saving curve (IS) which is determined by this period's expectation output gap and real interest rate. Empirically this adjusted by including another past terms of output gaps to reflect the persistence in macro

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<sup>32</sup> Mathematical derivation of these equations are given in Appendix A.1 See also Gali (2008), and Walsh (2010) and Chadha (2010).

data. Equation (A.39) is the new Philips curve determined by current output gap and future inflation which captures the forward looking nature in the firms and households. Occasionally, additional terms of lagged inflation are included when empirical data are used to estimate the New Philips curve. In addition, this Philips curve relates inflation to output without suggesting a trade-off as in the old Philips curve. The last equation (A.43) is the monetary policy rule; with nominal interest rate determined by expected inflation, output gap, and deviation from target and equilibrium interest rate. Generally, monetary policy in this new consensus consists of the systematic components – the intercept, expected inflation and output gap; and the non-systematic components represented by the structural shocks ( $v_t$ ). The  $v_t$  is generally expressed as an AR(1) process. As can be seen from equation (A.39) to (A.42) money is absent. However, the presence money can be integrated in several ways as shown by Bessany (2007, pp. 242-249)<sup>33</sup> and Walsh (2010). Commonly, the relationship of money demand from household's optimal conditions given in (A.33) is solved for nominal interest rate. The nominal interest rate is then used to find the price level and nominal variables. Central banks follow an exogenous path of supply to manage the monetary policy.

To characterize the economy in this way indicates by default that money supply is endogenously determined and this reconciles with the 'lender of last resort' function in the central bank mandates. It means that given a choice of interest level, the quantity of money supply is determined by the private sector demand for money as given by (A.33). It also means that banks take the price that is the level of interest rate as given and decide the quantity of credit to supply to credit worthy clients. In addition, banks also decide the sizes of spreads above the level interest rate charged on the reserves. Many economists, especially those that support the 'new consensus', agree that these three equations (A.39), (A.42) and (A.43) characterise the views of how central banks in modern age operate. Howells (2003) argues that central bank operating procedure has always been interest rates, rather than some form of control of monetary base. Mankiw & Taylor (2007) and Romer (2006) argue that using interest rate rather than money supply is more realistic and practical. Thus, money responds to demand conditions within the economy as commercial banks readjust their portfolios when the central bank changes the bench mark rate.<sup>34</sup>

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<sup>33</sup> Bessany (2011, pp. 249-251) examined a monetary experiment where monetary authority peg interest rate and let the quantity of money adopt endogenously.

<sup>34</sup> Rochon (2010) purports that 'banks set the rates of interest leaving money to adjust endogenously through banking activities of the banking system.'

What is the role of interest rate monetary policy in the three-equation model? We can track the role of monetary policy via the nominal interest rate, which is the prime tool for aggregate demand management. In the short run monetary policy is non-neutral due to nominal wages and prices stickiness, while in the long run, monetary policy is neutral. A positive change in short term nominal interest rate affects consumptions and investments and, as a result, determines the output gap. On the transmission mechanism (Fontana, 2006) claims that central banks, through their policies, influence market rates and affect different components of aggregate demand. This takes place because firms respond by adjusting their production levels to meet new demand for their products. In the long run however, all prices adjust and the economy moves back to its natural equilibrium. Hence, this new consensus has firmly established strongly that the short term nominal interest rate is a monetary policy instrument controlled by central banks.<sup>35</sup> This should be so because for a long time, central banks have not been able to control money supply fully as argued by (Palley, 2003).

New Keynesian economists emphasize the role of rational expectation in their models as shown in equations (A.39 & A.42 in the appendix). The expected output deviation and inflation expectation accommodate the two aggregate relations of the current output gap and inflation. This is because from the micro foundation perspective of households and firms, decisions depend on their expectation of whether or not monetary authorities will stick to the goal of price stability (Dennis, 1981; Wren-Lewis, 2007). Secondly, the probability of whether firms will change their prices is influenced largely by how average prices change. Managing expectation is vital to the central bank because through expectations channel, monetary policy effects are transmitted to the future inflation.

In brief, New Keynesians accept the 'long run' view as deduced from neoclassical theory indicating that there exists a natural rate of output and a natural rate of unemployment and they are determined by aggregate supply in the long run.<sup>36</sup> However in the short run, they differ in the sense that they believe 'contracting frictions' which prevents markets from working perfectly (David, 2008). Furthermore, they differ from Neoclassical and monetarists in the conclusion that shocks are primarily responsible for business cycles. In the choice of monetary policy, New Keynesians favour interest rate

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<sup>35</sup> Of course this does not necessarily mean that they can act as they wish, because they are constrained by what is happening in the foreign sector, see (Bain & Howells, 2003).

<sup>36</sup> See Knoop (2010).

policy to ensure price stability. However, this consensus does not emphasize the so called liquidity effects (liquidity trap) as it was the case in the old Keynesian theory.

#### **1.2.5.2 Criticisms of New Keynesian Monetary Theory**

Although the consensus seems to enjoy the backing of a wide range of economists in the mainstream and surprisingly from some Post Keynesian economists too, it is worth mentioning that there are specific criticisms against the view. First, this new consensus is referred to as Keynesian but some economists argue that it does not say much about Keynes' general theory of employment, interest and money. Perhaps, two protagonists of this claim are Knoop (2010) and Farmer (2010). Knoop (2010) in his summary about what some New Keynesians do not believe in, states that New Keynesians believe that the general theory of employment, interest and money is ambiguous, and a big reason for this ambiguity is its lack of rigor, especially when it comes to explaining the microeconomic foundation of macroeconomic behaviour. As a result, there are no references to the Keynes' *General Theory* in consensus work, although they make use of macroeconomics identities closely similar to the IS-LM framework. Another example is Farmer (2010) who claims that there is no unemployment in the NK model, people work as hard as they wish to at the market wage. This is contrary to the principles of Keynes which indicate that the problem of involuntary unemployment may exist in the labour market. We recognise that Gali (2008) works have tried to incorporate the unemployment and the labour market however; this work is still at infant stage. Thus, these light views among New Keynesians suggest why there are few tenets of the original Keynes in the New Keynesian monetary theory.

Second, (Gordon, 1990) points out that New Keynesian is criticized because it provides too many reasons why wages and prices are sticky. For example, Knoop (2010) list four major causes of price stickiness, and five causes of wage inflexibility in the New Keynesian. Of course, reality is diverse and thus, there are many strands of NK models aimed to justify sticky prices and their immediate consequences on the overall economic activity.

Third, Snowdon and Vane (1997), and (Gordon, 1990) assert that the New Keynesian approach is weak in terms of empirical testing because it is still in an infant stage perhaps, this should not be after two decades of research in the New Keynesian doctrines. For example, Chari, Kehoe, and McGrattan (2009, p. 242) indicate their disagreement around the introduction of shocks and other features of the like in the New Keynesian models. They argue that 'the new shocks are dubiously structural and that the

other features are inconsistent with microeconomic evidence. Until these issues are resolved [they] conclude that New Keynesian models are not useful for policy analysis.’ Thus, there are still doubts about the versatility of this theory. Others like Minford & Srinivasan (2010) argue that monetary policy rules without a role for money (as frequented in NK models) are incomplete and they are not capable of ruling out bubbles. Roger (2010, p. 78) reveals that the New Keynesians are ‘quantity theorists’ in Keynes’ clothing. Clearly, NK contains the transmission mechanism as in the old Keynesian although with explanations based on microeconomics; however, their policy prescriptions are similar to what is offered by monetarists. This claim is supported by evidence which shows that NK fully embraces the ‘monetarists natural rate hypothesis’ whereby output fluctuate around the natural rate and the best that policy makers can do is to minimize the variances of output consequently improve welfare of households.<sup>37</sup> Fourth, Arestis and Sawyer (2010) also claim that new consensus has elevated monetary policy and downgraded other policies (fiscal, and income) as inefficient.<sup>38</sup>

New consensus models are blamed for the 2007-08 financial crises because these models were unable to forecast the looming financial crisis on the horizon. This criticism concurs with the claim by Goodhart (1994) who argues that this new consensus model ( i.e. system of equations (A.39, A.42 & A.43) is a ‘fair weather’ model in that it works only when the economy is faced with stable conditions but cannot function in a high inflation environment. Furthermore, this is supported by the fact that many central banks have added the stimulus Quantitative Easing (QE), Assets-based-reserves requirement and other financial policies in addition to the rule based monetary policy in response to the financial crisis. Nominal interest rates during the financial crisis were cut to the floor-zero level, and thus left central banks with no other options than to shelve interest rate rule policy in favour of QE policy and financial policy in order to achieve both price and financial stability. On a similar note, Arestis (2010) criticises the NK for its over-emphasis on ‘inflation targeting, single-minded focus on excess aggregate demand as a source of inflation pressure, and neglect of destabilizing effects from asset prices inflation. Many economists today agree that inflation targeting which suppose to promote price stability does not guarantee financial stability. Thus, monetary authority should come up with another instrument that simultaneous promotes the goal of price and financial stability in the financial sector. In addition, French-Davis, Nayar, Ocampo, Spiegel, and Stiglitz

<sup>37</sup> Gottschalk (2005, p. 120) writes that the embrace of the natural rate hypothesis by New Keynesian means again that they are coming down on the side of monetarists, since this hypothesis implies that the long run aggregate supply curve is vertical.’

<sup>38</sup> For argument against fiscal policy see Arestis and Sawyer (2002).

(2006) argue that macroeconomic policy should have more instruments and a set of objectives, not just fiscal and monetary policy or price stabilization goal. In the last essay in this thesis, we discussed and estimate the Spread-Adjusted Taylor Rule (STR) suggested as alternative policy instrument that can help central banks to achieve price and financial stability while making environment conducive for economic growth.

### **1.3. Post Keynesian Monetary Theory**

Under this section, we take a brief overview of the nature, roles of money, and monetary policy in macroeconomics as postulated by Post Keynesian economists. Post Keynesian monetary theory is one among many theories that defines the body of heterodox economics.<sup>39</sup> There are two main features that define all Post Keynesian theory, these include the principle of effective demand and dynamic historical time (Lavoie, 2009). By the former, Post Keynesians imply that the demand excludes extra goods that unemployed workers would buy if they were able to get a job; while the latter emphasizes the transition from one equilibrium to another and the effect of conditions that prevailed during the transition period on the final outcome (Lavoie, 2009). Furthermore, (Lavoie, 2009) explains effectively by pointing out that it is this demand that determines the economy both in the short and long run of how supply adapts to demand. Other features that differentiate Post Keynesians include endogenous money, the emphasis on exogenous interest rate, and asset based reserve requirements as a complementary instrument with which to conduct monetary policy (Palley, 2003). In general most prefer the use of government fiscal policy to boost spending and investment during economic contraction and for government to restrain speculation during booms (Fontana, 2006).

In Post Keynesian monetary theory, the concept of endogenous money is the cornerstone. Adherents believe that endogenous money is the outcome of purposeful interaction between economic agents in reserve, credit, and financial markets. According to this argument, money supply is determined by the demand for bank credit from the households and firms' financial market to finance production. For example, Bain and Howells (2003) reveal that central banks having set the official interest rate [...], must meet such demand for reserves as is forthcoming. Thus, central banks must fulfil their mandates as the 'lender of last resort' irrespective of whether the money supply growth rate is above the monetary target. In addition post-Keynesian theory assumes that credit

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<sup>39</sup> Heterodox economics is shaped by the works of Michael Kaleci (1971), Minsk (1949), and Kaldor (1908). In general, many heterodox economists agree with the works of Maynard Keynes especially on the areas of unemployment, uncertainty, role of expectation in financial markets, and effective demand. However, the analyses in heterodox economics start from microeconomic problems, this is in contrast with macroeconomic analysis in Keynesian economics.

creates deposits which cause new loans (Bain & Howells, 2003; Lavoie, 2009). This assumption is opposed to mainstream assumption that deposit determines the amount credit bank are ready to create in the economy.

Post Keynesians made a barrage of criticisms against several aspects of neoclassical economics, and these criticisms had been used constantly to define what they stand for. First, PK theory utterly rejects the 'savings-determine-investments hypothesis as postulated by neoclassical economists. In the PK perspective, savings-determine investments is against the view that the economy is 'demand determined' (Lavoie, 2009). Early Keynesian held the view that economy is demand driven, even so post Keynesians argue that investment determines savings as against the contrary. Extending this further, post-Keynesian individual's resolve to invest is independent from the savings level in the economy. Thus, the proposition savings-determines-investment is at odds with the investment-determines-savings which is prevalent in the post Keynesian economics.

### **1.3.1 Monetary Theory of Post Keynesian Economics**

Lavoie (2009) reveals that the monetary theory of the Post Keynesians has a long tradition that dates back to the 1830s and 1840s. Large part of this theory concentrates on the nature of money supply; which was why the endogenous money was developed to counter the classical quantity theory of money and the currency theory. Arestis and Sawyer (2006) assert that this view about money is now incorporated in the new macroeconomics consensus by economists in the new Keynesian. Although endogenous money seems to only take centre stage in mainstream economics now, it has been a long-held theory of money.<sup>40</sup> We observe that this recognition has made the monetary policy of interest rate setting clearly relevant and coherent with practical operations of central banking.

Money in Post Keynesian theory originates within the economic system when firms and households began to borrow from the banks (or repay loans as well). Thus, in this process, deposits and bank money are created or destroyed. They are created when banks issue new loans and are destroyed when loans are repaid back. In this view, money is more than a medium of exchange or a stock as commonly expounded in mainstream economics. Money is integrated within the economy and supply arises as a result of the creation of new banks' liabilities within the income generation process (Fontana & Venturino, 2003). Of course, this nature is laid bare in the modern economy where money supply expands as banks allow for overdrafts or extend lines of credit to finance production or new investment projects.

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<sup>40</sup> See Goodhart (1989).

Money assumes an active role in the Post Keynesian monetary theory, as opposed to the passive role it plays in the neoclassical family. Its role is very central in post Keynesian monetary theory; this is because it affects nominal variables both in the short and longer term. Money supply is tied to production as it finances the production process or the upsurge of speculative purchases in financial markets (Fontana & Venturino, 2003). Some argue that money represents the wheels of trade and growth. It goes beyond the so-called 'helicopter drops' as it is labelled in the quantity theory of money and utility models such as Cash-In-Advance models (Mankiw & Taylor, 2007).

However, the nature and roles of endogenous money are divisive issues in Post-Keynesian monetary economics. As a result, there are two sprinter-groups that emphasize endogenous money in microanalysis of the behaviour of banks in the economy (Ahmad & Ahmed, 2006; Dow, 2006; Fontana & Venturino, 2003). The first group holds the view that monetary authority fully accommodates the demand for money (cash and credit) from banks and the public. This group is widely known as the *Accommodationists*. The Accommodationists claim that the money supply curve is flat because at the prevailing interest rate, banks must meet the demand for money from all credit worthy firms and the public (Lavoie, 2009). The second group called the *Structuralists* agrees with the endogenous view of money put forth by the Accommodationists, although their emphasis extends further than the Accommodationists'. They argue that Accommodationists have neglected the structural characteristics of banks and central banks. This will be clarified here. Fontana and Venturino (2003) claim that the differences between these two groups are centred on three arguments. First, the disagreement is based on the degree of control that the central banks exercise over the demand for reserves. They argue that to some extent, central banks exert influence on monetary conditions particularly by setting interest rates, and in addition, the lender of last resort facility is limited (Arestis, P., 2007b). This means there is a limit to its exercising the lender of last resorts function and therefore accommodation is not infinitely elastic. Commercial banks diversify their portfolios to limit risk exposure to a single market or one single large borrower. The second disagreement is based on the meaning and relevance of liquidity preference of commercial banks. For instance, if commercial banks have preferences over the different types of assets they would like to hold, then it would be very difficult to accommodate new credit demand even if it is from credit-worthy agents. The third argument relates to the controversy about the liquidity preferences of the non-banking public (wage earners).

Understanding how the two views of endogenous money work enriches our understanding of the behaviour of central banks in the reserve market, and commercial banks in the credit markets, as well as the interaction between banks and wage earners in the financial markets. For example, it is clear now that the change in the price of reserves sets off the transmission mechanism from reserves market to credit market, and subsequently to the rest of the economy. Generally, most economists whether Post-Keynesians or otherwise believe that money is non-neutral and it matters in the short term. Notwithstanding, there exists a divergent opinion about the influence of money on real activity in the long term. This view is supported by David (2008) who reveals that “very few macroeconomists would attempt to argue that money and monetary phenomena are unimportant and undeserving of any attention”. He further asserts that the contentious issue among macroeconomists concerns the relative importance of money *vis-à-vis* other factors in determining *real* as opposed to *nominal* economic outcomes.

In all, we see that the differences between Accommodationists and Structuralists are based on how each camp view the behaviours of banks in the credit markets (Fontana & Venturino, 2003; Lavoie, 2009). Accommodationists assume that during the adjustment process of money supply, banks are not affected either by changes in their own liquidity ratios or those of their customers. While Structuralists uphold the view that over the business cycle, banks change their requirements for credit in both price and non-price terms in order to maintain their preferred liquidity positions. The structure of loan portfolios will affect the desired level of liquidity each bank would like to hold.

#### ***1.3.1.1. What is the Nature and Role of Monetary Policy in Post Keynesian Monetary theory?***

Palley (2003) purported that the literature on the implications of Post-Keynesian theory of endogenous money on monetary policy is very thin, as this is still in an infant stage. Unlike mainstream economics where the macro analysis about the nature and roles of monetary policy is abundant and well-documented; it is simply not the same with Post Keynesian economics. Post Keynesian monetary theory has been largely confined to the microanalysis of the theory of endogenous money, with fewer details about the transmission mechanisms from interest rate and endogenous money to inflation, output and employment.

In spite of the fact that many Post-Keynesians have been occupied with debates around endogenous money, the current approach in the new macroeconomic consensus on monetary policy has much bearing on the rudiments from Post-Keynesian monetary theory.

Thus, Palley (2003) claims that, although there are wide theoretical differences stemming from various assumptions, the PK recommends interest rate setting monetary policy as is the case in the new consensus. The differences are: mainstream economists claim that monetary targeting and interest are competing strategies for monetary policy implementation. So, it is the contest between money supply and nominal interest rate. However, because money demand is allegedly unstable, and there is a weak relationship between money supply and inflation therefore, interest rate became the monetary policy instrument.<sup>41</sup> Post-Keynesian monetary theory recommends the nominal official interest rate as the controlling instrument for monetary policy to fight inflation because holding down the growth rate of money supply at particular level will generate high interest rates volatility. In addition, many argue that money is an IOU and therefore given the price that is, the bank rate, the private sector has the ability to create inside money to meet excess demand. Hence, interest targeting policy allows money to be demand-determined within the financial system while monetary authority sets the price for liquidity. Achieving inflation target through interest rate setting policy is the ultimate goal in the mainstreams. It is pertinent to mention here that it is not the ultimate target for many post-Keynesians who argue that inflation is the secondary objective in order words, the means to the end and not the end in itself; even though the ultimate target is full employment (Palley, 2003).

Furthermore, there are economists within and without who hold the view that interest rate fixing is insufficient to achieve stability and full employment. Therefore, some post-Keynesians suggest a complementary instrument (such as asset-based-reserve requirements) to address systemic problems that emanate from the balance sheets in the asset markets. The asset-based-reserves requirement is necessary to address asset related problems from the balance sheets of which some do not pose an immediate threat or significant shock to inflation; but however, they present an imminent danger to financial stability, output and employment. In support of this complementary tool, (Palley, 2003) argues that such an instrument is necessary because effective monetary policy should attend to both the real economy and the financial markets. This additional policy instrument is not really new to the debates about monetary policy strategies because many economists have extensively discussed on whether monetary policy should also be addressed to asset prices (Capie & Wood, 2006). In the recent past, Taylor (2008) and McCulley and Toloui (2008) suggested a spread-adjusted Taylor rule which is the standard

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<sup>41</sup> See Froyen (2005), and Palley (2003).

monetary policy augmented with spread to achieve price and financial stability simultaneously.

#### **1.4. What is the Interest Rate?**

Throughout our review of monetary theories, we constantly mentioned interest rate without any attempts to clarify ‘the interest rate’ we are referring to. In brief, we will explain the interest rate before we examine some theoretical and empirical aspects of monetary transmission mechanism in details. It is true that money supply plays significant roles in the management of the economy; thus, for this reasons our emphasis throughout this literature review was placed on the nature and role of money supply, the transition from money-growth targeting to interest rate setting monetary policy and how this changed the evaluation of the transmission mechanism. From this exercise, we explained why the new consensus emphasizes interest rate in monetary policy framework. We find that the role of monetary aggregate as a policy instrument has been assigned to nominal interest rate nowadays.

Now, if it is not money supply but interest rates, then which interest rate? There are various kinds of interest rates in financial markets in fact there is one interest rate for every asset in the market.

As Belke & Polleit (2009, p. 187) write: “there are interest rates for consumers, corporate and mortgage loans; interest rates for savings and time deposits, and those for government and corporate bonds; there are short and long-term interest rates; and there are official interest rates, set by central banks, and interest rates set by supply and demand in the market place; there are interest rates in the form of spot and forward interest rates, and there are nominal and real interest rates.”

The general observation under all schools of thought on monetary theory is that all seem to agree that there are two kinds of reference interest rates that serve as the bench marks for all other market rates. These are: (i) the invisible real interest rate that is, the price of real capital as referred to in some quarters; (ii) and the observable nominal interest rate which is determined by central banks. The former interest rate is invisible or is not to be observed, but it is generally assumed that it depends on real factors such as people’s time preference, productivity and population growth, fiscal policy and risk premium, and institutional structures of financial market.<sup>42</sup> This real interest rate is somehow assumed to be equivalent to natural interest rate in the long run. While the later is determined and

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<sup>42</sup> See Belke and Polleit (2009).

controlled by the central banks (i.e. nominal repo rate, bank rate or federal fund rate), and it influences all other market rates whether short term or long term, the nominal interest rate is the price of credit in the money markets. It plays a central role in monetary policy as a controllable tool or as target instrument to manage aggregate demand (demand shocks) in the short term. Central banks use nominal interest rate to mediate to the market the level of interest rate which is assumed to be optimal with the desired level of inflation and output. Thus policy instrument influences other market rates (both nominal and real) and other macroeconomic variables such as inflation and money supply.<sup>43</sup> Nominal interest rate reflects country risk profile, inflation expectation and political risk. Therefore nominal interest can be divided into two parts real interest and inflation expectation.<sup>44</sup>

Henceforth, the interest rate we are referring to is the nominal rate or the real interest rate which is the difference between nominal interest rate and expected inflation.<sup>45</sup> This can be a discount rate, re-purchase rate, federal fund rate, refinance rate, or bank rate as referred to by different names in many central banks. In all, interest rate refers to the cost of borrowing, opportunity cost of holding cash, a measure of time preference, and the reward of parting with money.

### **1.5. Importance of Monetary Policy Transmission Mechanism**

Lastly, we discuss the theoretical underpinnings of monetary policy transmission mechanism. Primarily, when the central bank changes monetary policy target, the short term market rates react to reflect the change in monetary policy stance. The first reaction is observed in the intermediation spreads, asset prices in asset market and the general expectation of the public about the future course of inflation in the medium term. Agents in the money markets revise their expectations about the future course of inflation, and these revisions could either amplify or dampen the effects of monetary policy depending on the size of spreads in the financial sector. In the second round effects, the market rates are filtered through to domestic demand for goods and services and external demand. This translates to a shift in aggregate demand which affects domestic inflation pressure.

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<sup>43</sup> Freidman B, (2000) writes: ‘although the central bank controls only the short term instruments like Treasury bills, the longer-term rates [...] move in the same direction as short term because banks and other investors are able to substitute among different debt instruments in their asset portfolios. Hence monetary policy affects these other rates as well.’

<sup>44</sup> Wicksel’s 1898 work, *Interest and Prices*, is regarded by many economists as the earliest contribution on this area of macroeconomics. The concept of natural interest rate started with Johan Gustaf Knut Wicksell in 1898 who alleged that natural interest rate has nothing to do with money as this is determined by real phenomena. Belke and Polleit (2009) reveal that the Wicksel’s natural real interest rate is equal to the equilibrium interest rate in the neoclassical theory of interest rate.

<sup>45</sup> This is the interest rate which central banks can conveniently set (control) and maintains its’ level by continuously supplying reserves through buying or selling to the markets.

It is widely accepted that the study of the transmission mechanism is very complex and involve some degree of uncertainty as to how monetary policy is transmitted to macroeconomic outcomes (Belke & Polleit, 2009). There are a host of factors that obscure our understanding of the transmission mechanism, such as variable time lags between the point of recognition to implementation and finally to realisation of the impacts; and the uncertainty around the model and forecasts used in the modelling (Blinder, 1998; Rittenberg & Tregarthen, 2009); and finally, the role of spreads as conduit of monetary policy effects. Mahadeva and Sinclair (2002) also add that because economies are always evolving, this makes it difficult to accurately analyse the transmission mechanism. As we acknowledge the problems mentioned above, we point out that our analysis of these transmission channels in the next chapter is not an exhaustive list of transmission mechanisms of monetary policy but we address those aspects we deemed necessary to develop monetary policy framework in Namibia.

The subject of monetary policy transmission mechanism is now more important than before irrespective of which schools of thought you project it from. Thus, both empirical and theoretical studies on monetary transmission mechanism are important because they help us to answer the questions of when, why and how about the mechanics of monetary policy.

## 1.6. What We Have Learned So Far

In this chapter about monetary theories in the mainstream and Post-Keynesian, we gained important lessons that theoretically inform contemporary empirical works on modelling monetary policy frameworks. Firstly, early mainstream (excluding the Wicksellian era) favoured some form of quantitative instruments such as money supply or exchange rate target for monetary policy, while the Post-Keynesian emphasized the use of interest rate as the policy instrument to conduct monetary policy. Secondly, this literature review shows that the nature and roles of monetary policy have evolved, and the prevailing consensus now is that, interest rate-targeting is the monetary policy approach used to achieve price stability. Interest rate is generally defined as the price for market liquidity (credit) and this price is set and controlled by central banks. Hence, altering the level of interest rate begins the transmission mechanism of monetary policy. Ho (2010, p. 91) states that:

“As a signal of policy stance [i.e. interest rate], (...) interest rate should ideally provide clarity and good controllability. This explains why so many central banks signal with their official rates, which are natural and fully in their control. And to the extent that this policy rate, (...) is also a starting point of monetary transmission, it should ideally be something economically relevant.’

It accepted that setting interest rates have benefits of signalling effect in the financial markets which argues well for the monetary policy stance and the forward guidance of the general public. On this basis, we chose interest rate (i.e. repo rate) to serve us the policy variable in our empirical works in this thesis.

Thirdly, we observe that there are wide theoretical differences why interest rate is chosen as a monetary policy instrument in the new macroeconomic consensus; however, in this literature review we show that many researchers across the divide equally recommend for interest rate-targeting monetary policy approach. For example, mainstream economists assert that the money-growth and interest targeting are competing strategies for monetary policy implementation, while economists outside the mainstream argue that precise systematic control of money supply (i.e. monetary targeting) is practically impossible thus, monetary targeting cannot be used as a monetary policy instrument. Further arguments for interest rate-targeting are that the money demand relationship is unstable and often it is weak; therefore, it is a less reliable predictor of the future inflation.<sup>46</sup> In addition, interest

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<sup>46</sup> See Crocket (2000), Froyen (2005), Palley (2003), De Grauwe and Polan (2005) and McCandless & Weber (1995).

rate targeting approach helps monetary policy makers to workout pathway from the present to the future i.e. reliable forward guidance. In the case of post-Keynesian theorists, many reject the use of monetary aggregates as the monetary policy instrument on the basis that money supply is endogenous, or simply money is an 'I Owe You' created through the private sector demand. The view of strictly money growth targeting is difficult to reconcile with the 'lender of last resort' function in central banking mandates. Thus, interest rate-targeting framework is practical as it allows money to be demand-determined within the financial system while monetary authority sets the price of liquidity.

As for money, it has disappeared from the scene because it is endogenous, and in contemporary times it is rather used as operational tool to keep nominal interest rate close to the target. Thus, when monetary policy is discussed today the questions about money are left on the background. This review further shows that most economists whether Post-Keynesians or otherwise believe that money is non-neutral and it matters in the short term. However, there are disagreements about the influence of money on real activity in the long term. This view is supported by David (2008) and Greenwald & Stiglitz (1993, p. 23) who reveals that "money matters, at least most of the time, although monetary policy may be ineffective in some periods (like the great depression)." Hence, in the second chapter, we examined both the transmission effects of monetary policy shocks and private credit shock on output and inflation in Namibia. As in Laidler (2007) we posit that the transmission effects of monetary shocks is activated by changes in the repo rate rather than changes in the monetary aggregates.

Fourthly, this literature review shows that new macroeconomic consensus argues for an effective monetary policy instrument(s) that should attend to monetary and financial stability.<sup>47</sup> Some post-Keynesian calls for assets-based requirement in order to improve financial stability, while some in the mainstream suggest an independent financial policy targeted on credit development or the Spread-adjusted Taylor rule that is aimed to address price and financial stability simultaneously. In chapter five of this thesis, we examined the merits of an alternative monetary policy strategy which is the spread-adjusted Taylor rule suggested by (Taylor, 2008) and (McCulley & Toloui, 2008).

In all, the following chapters in this thesis: the transmission mechanism of monetary policy; effects of interest rate spreads in Namibia; and the empirical estimation of Spread adjusted policy hinge on the basis that central banks use short term interest rate

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<sup>47</sup> For example, see executive summary by Bayoumi, Dell'Ariccia, Habermeier, Mancinci-Griffoli, & Valencia (2014, p. 3).

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as the policy instrument that generates transmission mechanism. Therefore, monetary policy is modelled as changes in interest rates rather than increases/decreases of money supply at a predetermined growth target. This basis is supported by economists such as Romer (2006); (Arestis & Sawyer, 2006; Bain & Howells, 2003; Palley, 2003) who assert that interest targeting approach allows central banks to target interest rate and let money to adopt endogenously.

## Appendix A

### Appendix A.1 Money in the Dynamic General Equilibrium: Money-in-the-utility-function (MIU)

This brief section illustrates how money enters most general equilibrium models in the neoclassical monetary economics. It is based on Driscoll (2001) lecture notes however, most materials on MIU are closely presented in the same manner and reaches the same conclusions.

The set up here is the MIU with single agent who derives utility from consumption  $C_t$  and real balances  $\frac{M_t}{P_t} = m_t$ . Money balances provides liquidity and transaction services. For simplicity, the agent receives income  $Y_t = F(K_{t-1})$  and lump-sum transfers  $X_t$ , the money from last period  $\frac{M_{t-1}}{P_t}$ , and capital,  $K_{t-1}$ .  $\theta$  is noted as the discount factor. These incomes are allocated either on consumption, new holding of money balances and new capital.

$$\sum_{t=0}^{\infty} \left(\frac{1}{1+\theta}\right)^t U\left(C_t, \frac{M_t}{P_t}\right) \quad (\text{A.1})$$

Agent maximizes the utility subject to period budget constraints with the  $\lambda_t$  and  $\lambda_{t+1}$  denoting the Lagrange multipliers for period t and t+1.

$$C_t + K_t + \frac{M_t}{P_t} = F(K_{t-1}) + K_{t-1} + \frac{M_{t-1}}{P_t} + X_t, \quad (\text{A.2})$$

$$L_t = \sum_{t=0}^{\infty} \left(\frac{1}{1+\theta}\right)^t U\left(C_t, \frac{M_t}{P_t}\right) - \lambda_t \left(C_t + K_t + \frac{M_t}{P_t} - F(K_{t-1}) - K_{t-1} - \frac{M_{t-1}}{P_t} - X_t\right). \quad (\text{A.3})$$

F.O.C: with respect to  $C_t, M_t, K_t$  yields the following Euler equations:

$$\left(\frac{1}{1+\theta}\right)^t \left(C_t, \frac{M_t}{P_t}\right) - \lambda_t = 0 \quad (\text{A.4})$$

$$\frac{1}{P_t} \left(\frac{1}{1+\theta}\right)^t U_{M_t} \left(C_t, \frac{M_t}{P_t}\right) - \frac{\lambda_t}{P_t} + \frac{\lambda_{t+1}}{P_{t+1}} = 0 \quad (\text{A.5})$$

$$-\lambda_t + \lambda_{t+1} (1 + F'(K_t)) = 0 \quad (\text{A.6})$$

To obtain intertemporal condition we solve for  $\lambda_t$  and  $\lambda_{t+1}$  in (A.4) and (A.5)

$$\left(\frac{1}{1+\theta}\right)^t U_{C_t} = \left(\frac{1}{1+\theta}\right)^{t+1} U_{C_{t+1}} (1 + r_t) \quad (\text{A.6a})$$

$$C_t = \frac{1+r_t}{1+\theta} U_{C_{t+1}} \quad (\text{A.7}).$$

Intratemporal condition between real balances and consumption is obtained by solving out  $\lambda_t$  and  $\lambda_{t+1}$  from

$$\frac{1}{P_t} \left( \frac{1}{1+\theta} \right)^t U_{M_t} \left( C_t, \frac{M_t}{P_t} \right) - \frac{1}{P_t} \left( \frac{1}{1+\theta} \right)^t U_{C_t} \left( C_t, \frac{M_t}{P_t} \right) + \frac{1}{P_t} \left( \frac{1}{1+\theta} \right)^{t+1} U_{C_{t+1}} = 0 \quad (\text{A.8}).$$

By inserting equation (A.7) into (A.8) we can write intratemporal conditions as

$$U_{M_t} = \left( 1 - \frac{P_t}{P_{t+1}} \right) U_{C_t}. \quad (\text{A.8a})$$

Driscoll (2001) illustrates the implications of real balances in MUI by adopting the utility function of the form in (A.9). Of course many other MUI functions<sup>48</sup> with cash-in-advance will yield similar results.

$$U(C_t, m_t) = \frac{(C_t m_t^\alpha)^{1-\sigma}}{1-\sigma} \quad (\text{A.9})$$

We insert the expression relation  $1 + r_t = \frac{(1+i_t)P_t}{P_{t+1}}$  in to the FOC and therefore we can write the intertemporal and intratemporal conditions as follow:

$$\left( \frac{C_t}{C_{t+1}} \right)^{-\sigma} = \frac{1+r_t}{1+\theta} \left( \frac{m_{t+1}}{m_t} \right)^{\alpha(1-\sigma)} \quad (\text{A.10})$$

$$m_t = \alpha \left( 1 + \frac{1}{i_t} \right) C_t \quad (\text{A.11})$$

By taking logs of (A.2.10) and (A.2.11) we can obtain equations

$$\Delta \ln(C_{t+1}) = \frac{r_t - \theta}{\sigma} + \frac{\alpha(1-\sigma)}{\sigma} \Delta \ln(m_{t+1}) \quad (\text{A.12})$$

$$\ln(m_t) = \ln(\alpha) - \ln(i_t) + \ln(C_t) \quad (\text{A.13})$$

The main economic results from (A.12) and (A.13) are that the former represents the main conclusion of neoclassical growth models. It implies that in the long run or at steady state the return on capital is equal to the discounting factor  $r_t = \theta$ .<sup>49</sup> Output is determined by capital and other factors of production without money growth. Hence, the MIU in this neoclassical with capital, flexible prices and no monopolistic competition obeys the

<sup>48</sup> See Bannasy (2007), and Walsh (2010)

<sup>49</sup> In the steady state  $\Delta \ln(C_{t+1}) = 0$ , and  $\Delta \ln(m_{t+1}) = 0$ .

general classical dichotomy. The equation (A.13) gives the standard demand for money derived from general equilibrium. In the new consensus

## Appendix A.2 Basic New Keynesian Model: Classical monetary model

The simple approach in this New Keynesian model which serves a benchmark for new consensus macroeconomic models is the emphasis of microeconomic foundation to estimate deep parameters jointly. Most new consensus models bear the hallmarks monopolistic competition, sticky prices, sticky wages and other rigidity that introduce market imperfections in the short run and further result output below potential level. There are rational agents: optimizing households and firms, government and the central bank. We see price setting by firms as they attempt to maximize profit while households choose optimal consumption to maximize their utility. In what follows, we illustrate the basic elements that help us to understand the three main equations that form the bedrock of modern macroeconomic framework. In this general framework we have forward-looking households, firms and monetary policy authority. We start with the classical monetary model without money in the utility function.

### I. Households

The representative households maximizes a lifetime utility, and discounts future proportionally by a factor  $\beta$  given by,

$$E_0 \sum_{t=0}^{\infty} \beta^t U(C_t, N_t). \quad \text{A.12}$$

Specification  $U(C_t, N_t) = \frac{C_t^{1-\sigma}}{1-\sigma} - \frac{N_t^{1+\varphi}}{1+\varphi}$  consumption level is denoted  $C_t$ ,  $N_t$  is labour supply, no real balances  $\sigma, \varphi > 0$  are elasticity of demand for individual goods and elasticity of labour supply.  $C_t$  can be thought of as consumption basket of all goods  $j$ , and this is a continuum of goods represented by the interval  $[0,1]$ . The  $C_t$  household consumption index is define in the following CES form,

$$C_t = \left[ \int_0^1 c_t(j)^{\frac{\theta-1}{\theta}} dj \right]^{\frac{\theta}{\theta-1}}. \quad \text{A.13}$$

Household first stage problem is to allocate optimal consumption. Household problems are find  $C_t$  at a minimum cost  $c_t$  and the optimal amount of  $c_t$  i.e households must find optimal allocation of a given consumption expenditure across individual goods in the consumption basket. Given  $p_t(j)$  of each differentiated good, we derive the cost of one unit of  $C_t$  as follows:

$$\min \int_0^1 p_t(j) c_t(j) dj + \lambda_t \left[ C_t - \left[ \int_0^1 c_t(j)^{\frac{\theta-1}{\theta}} dj \right]^{\frac{\theta}{\theta-1}} \right] \quad \text{A.14}$$

F.O.C

$$c_t(j) = \left( \frac{p_t(j)}{P_t} \right)^{-\theta} C_t \quad \text{A.15}$$

Equation (A.1.4) gives us the demand for good  $j$  given total demand for  $C_t$ . Intuitively it shows that the share of good  $j$  depends upon its price relative to the price of other goods and the elasticity of demand given by  $\theta$ . As  $\theta \rightarrow \infty$  goods are becoming close substitutes, and therefore firms loose the market power. Hence,  $\theta$  indicates the price elasticity of demand faced by individual firms. The larger  $\theta$  indicates higher degree of more competitive market, the smaller  $\theta$  indicates a higher degree of imperfect competition in the economy. Equation (A.13) is a solution to minimization problem above; thus knowing this household can know how much to consume for each good and decide  $C_t$ .

The price index is defined as follows:

$$P_t = \left[ \int_0^1 P_t(j)^{1-\theta} dj \right]^{\frac{1}{1-\theta}} \equiv \lambda_t. \quad \text{(A.16)}$$

From (A.14) we see that  $\lambda_t$  is the price index appropriate for the consumption bundle in (i.e. a minimum cost of a unit cost of aggregate consumption). Household optimal allocation of consumption and labour:

$$\max_{C_t, N_t, B_t} \{ E_0 \sum_{t=0}^{\infty} \beta^t U(C_t, N_t) \}$$

s.t.

$$P_t C_t + Q_t B_t \leq B_{t-1} + W_t N_t + \Pi_t. \quad \text{(A.17)}$$

$$\mathcal{L} = E_0 \sum_{t=0}^{\infty} \{ \beta^t U(C_t, N_t) - \lambda_t (P_t C_t + Q_t B_t - B_{t-1} + W_t N_t + \Pi_t) \} \quad \text{(A.18)}$$

From the Lagrangian we derive the f.o.c and obtain household's intertemporal decision after optimal allocation of goods and services. This will results in the so called consumption Euler equations and labour-leisure choice:

$$C_t^{-\sigma} = \beta(1 + i_t) E_t \left( \frac{P_t}{P_{t+1}} \right) C_{t+1}^{-\sigma} \quad \text{(A.19)}$$

$$\Rightarrow C_t = E_t(C_{t+1}) - \sigma^{-1}(i_t - E_t \pi_t + \rho). \quad \text{(A.20)}$$

$$C_t^\theta N_t^\varphi = \frac{W_t}{P_t} \quad (\text{A.21})$$

$$Q_t = \frac{i_t}{1+i_t} \quad (\text{A.22})$$

*Log-linearization:* For conveniences these equations are log-linearized and denote the variables with small letter variables.

Let  $\rho = -\ln\beta$  and  $i_t = -\ln Q_t$ ,  $\Delta c_{t+1} \equiv c_{t+1} - c_t \equiv \ln C_{t+1} - \ln C_t = \ln \frac{C_{t+1}}{C_t}$

$$1 = E_t \left[ e^{\ln(\beta Q_t^{-1} (\frac{C_{t+1}}{C_t})^{-\sigma} \frac{P_t}{P_{t+1}})} \right] = E_t (e^{-\rho + i_t - \sigma \Delta c_{t+1} - \pi_{t+1}}) \quad (\text{A.23})$$

Taylor expansion of the Euler equation around the steady state yields:

$$1 = E_t [1 + (\rho - \rho) + (i_t - i) - \sigma(\Delta c_{t+1} - \gamma) - (\pi_{t+1} - \pi)]$$

$$\rho c_t = -i_t + \rho + E_t \pi_{t+1} + \sigma E_t c_{t+1} \quad (\text{A.24})$$

We can write the log-linear zed Euler equation as follows:

$$c_t = E_t(c_{t+1}) - \sigma^{-1}(i_t - E_t \pi_{t+1} - \rho) \quad (\text{A.25})$$

Similarly the linearized labour supply equation is given by:

$$\ln C_t^\sigma N_t^\varphi = \ln \frac{W_t}{P_t}$$

$$\sigma \ln C_t + \varphi \ln N_t = \ln W_t - \ln P_t$$

$$w_t - p_t = \sigma c_t + \varphi n_t \quad (\text{A.26})$$

In order to get a money demand equation we need to introduce real balances in the life time utility function either as separable or inseparable from consumption. Money enters the utility as real because we want to show how the dollar can be exchanged for goods and services. We illustrate how to get the money demand before we derive the optimal condition for the firm.

## II. Money-in-the Utility function: Basic New Keynesian Model

In order to generate the demand of money from the first principles as opposed to ad-hoc from quantity equation we incorporate the real balances in the basic New Keynesian money-in-the utility function. First, the result whether money will have any effects

depends also to whether the utility function is separable or non-separable. We start with the utility where money is separable from consumption function.

$$\max_{C_t, N_t, B_t, \frac{M_t}{P_t}} E_0 \sum_{t=0}^{\infty} \beta^t U \left[ \frac{C_t^{1-\sigma}}{1-\sigma} + \frac{\left(\frac{M_t}{P_t}\right)^{1-\nu}}{1-\nu} - \frac{N_t^{1+\varphi}}{1+\varphi} \right]$$

$$\text{s.t. } P_t C_t + M_t + Q_t B_t \leq M_{t-1} + B_{t-1} + W_t N_t + T_t \quad (\text{A.27})$$

$$\mathcal{L} = E_0 \sum_{t=0}^{\infty} \left\{ \beta^t u \left( C_t, N_t, \frac{M_t}{P_t} \right) - \lambda_t (P_t C_t + M_t + Q_t B_t - M_{t-1} - W_t N_t - T_t) \right\} \quad (\text{A.28})$$

Since the f.o.c. for consumption, labour and bonds are the same as above here we only show the optimal for money holding which gives the money demand equation.

$$\frac{\left(\frac{M_t}{P_t}\right)^{-\nu}}{C_t^{-\sigma}} = \frac{i_t}{1+i_t} \quad (\text{A.29})$$

$$\frac{M_t}{P_t} = C_t^{\frac{\sigma}{\nu}} \left( \frac{1+i_t}{i_t} \right)^{\frac{1}{\nu}} \quad (\text{A.30})$$

Using the same procedures as in (A.30) we log-linearized money demand as follows:

$$\ln \frac{M_t}{P_t} = \ln \left[ C_t^{\frac{\sigma}{\nu}} \left( \frac{1+i_t}{i_t} \right)^{\frac{1}{\nu}} \right] \quad (\text{A.31})$$

$$\Rightarrow m_t - p_t = \frac{\sigma}{\nu} c_t + \frac{1}{\nu} \ln \left( \frac{1+i_t}{i_t} \right)$$

$$\Rightarrow m_t - p_t \approx \frac{\sigma}{\nu} c_t + \frac{1}{\nu} \left[ \ln \left( \frac{1+i}{i} \right) + \frac{1}{\frac{1+i}{i}} \frac{i-(1+i)}{i^2} (i_t - i) \right] = \frac{1}{\nu} \left[ \ln \left( \frac{1+i}{i} \right) + \frac{1}{1+i} \right] + \frac{\sigma}{\nu} c_t -$$

$$\frac{1}{\nu} \frac{1}{(1+i)i} i_t$$

$$m_t - p_t \approx \frac{1}{\nu} \left[ \ln \left( \frac{1+i}{i} \right) + \frac{1}{1+i} \right] + \frac{\sigma}{\nu} c_t - \frac{1}{\nu} \frac{1}{(1+i)i} i_t \quad (\text{A.32})$$

Finally, to find the standard money demand we set  $\eta \equiv \frac{1}{\nu} \frac{1}{(1+i)i}$  and assume all output is consumed  $y_t = c_t$ . Furthermore we ignore the constant  $\frac{1}{\nu} \left[ \ln \left( \frac{1+i}{i} \right) + \frac{1}{1+i} \right]$  and assume the income elasticity of one then the conventional demand for money can be written as follows<sup>50</sup>:

$$m_t - p_t = y_t - \eta i_t \quad (\text{A.33})$$

<sup>50</sup> Income elasticity of one implies that  $\sigma = \nu$ .

One deduction from the equation (A.33) is that if changes in money do not affect the consumption and interest rate then there is a proportional relationship between money and inflation, hence this equilibrium will hold. Thus, equation (A.33) solves equilibrium values of inflation, price level and other nominal variables when monetary policy involves the use of money supply.

### III. Firms

In the New Keynesian setting it is generally assumed that there many firms produce a unique good,  $c_t(j)$  with production function linear in labour  $N_t(j)$ :

$$c_t(j) = Z_t N_t(j) \quad (\text{A.34}),$$

$Z_t$  - measures aggregate total factor productivity.

Price setting: firms set prices taking into account the demand function  $c_t(j)$ . They freely choose optimal price that maximizes discounted future profit; however, they do not know how long before they revise their optimal price. Thus, there is  $\theta$  as probability of being stuck with same price for a given period. To find  $P^*$  the discounted profit subject to the demand for  $c_t(j)$ . The optimal price set by all firms in a log-linearized form is given as follows<sup>51</sup>:

$$p_t^* = (1 - \beta\theta) \sum_{k=0}^{\infty} (\beta\theta)^k E_t (m c_{t+k|t} + p_{t+k}). \quad \text{A.35}$$

$\theta$  is the fraction of firms that kept last period's price;  $(1 - \theta)$  is the fraction of price setters that changed their prices. Optimal price is a function of current, expected marginal cost and aggregate prices – that firms set a price that corresponds to marginal cost given by  $m c_{t+k|t}$  weighted by probability that price remain in place at the horizon  $\theta^k$ . Aggregate price dynamic is given by

$$P_t = [\theta(P_{t-1})^{1-\varepsilon} + (1 - \theta)(p_t^*)^{1-\varepsilon}]^{\frac{1}{1-\varepsilon}} \quad (\text{A.36})$$

$$\Rightarrow \left(\frac{P_t}{P_{t-1}}\right)^{1-\varepsilon} = \left([\theta P_{t-1}^{1-\varepsilon} + (1 - \theta)P_t^{*1-\varepsilon}]^{\frac{1}{1-\varepsilon}} \frac{1}{P_{t-1}}\right)^{1-\varepsilon}$$

$$\Rightarrow \Pi_t^{1-\varepsilon} = \theta + (1 - \theta) \left(\frac{P_t^*}{P_{t-1}}\right)^{1-\varepsilon}$$

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<sup>51</sup> This  $p^*$  is obtained from firm maximization of current market value of profits generated while that price remain in place.

We log-linearize the price  $P_t$  (A.36) around zero inflation –the steady state and that gives inflation in period  $t$ .

$$\pi_t = (1 - \theta)(p_t^* - p_{t-1}) \quad (\text{A.37}).$$

As can be seen (A.37) it is clear that inflation in period ( $t$ ) comes about when firms adjust their prices to a new price that is different from the economy's average price prevailed in the last period.<sup>52</sup> Using equation (A.35) will finally help us to arrive at the inflation-adjustment equation

$$\pi_t = \beta E_t(\pi_{t+1}) + \lambda mc_t, \quad \lambda \equiv \frac{(1-\theta)(1-\beta\theta)}{\theta}. \quad (\text{A.38})$$

The marginal cost is replaced by output gap as to the New Keynesian Philips curve as dependent on expected inflation and output gap.<sup>53</sup>

$$\pi_t = \beta E_t(\pi_{t+1}) + \kappa x_t, \quad \kappa \equiv \lambda \frac{\sigma(1-\alpha)+\varphi+\alpha}{1-\alpha}. \quad (\text{A.39})$$

#### IV. Equilibrium

Using equilibrium conditions, abstracting investment and government spendings, the goods-market clearing is given by:

$$y_t = c_t, \quad (\text{A.40})$$

Hence, using  $y_t = c_t$  and the relationship of the bond price  $Q_t$  to interest rate  $Q_t = 1/(1 + i_t)$  we substitute  $c_t$  with  $y_t$  in the Consumption Euler equation which finally gives us the log-linearized DIS curve:

$$y_t = E_t(y_{t+1}) - \sigma^{-1}(i_t - E_t\pi_t + \rho). \quad (\text{A.41})$$

Using the concept of output gap  $x_t = \hat{y}_t - \hat{y}_t^f$ , we rewrite the IS curve as follows

$$x_t = E_t(x_{t+1}) - \sigma^{-1}(i_t - E_t\pi_t + \rho). \quad (\text{A.42})$$

The two equations (A.39) and (A.42) define the forward looking rational expectation model that forms part of the bedrock of modern macroeconomics analysis. The last component which completes the system represents the monetary authority or government.

#### V. Monetary Policy

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<sup>52</sup> See (Bergholt, 2012)

<sup>53</sup> See (Gali, 2008, pp. 45-48) for derivation of how the marginal cost is related to output gap.

The monetary policy rule that closes the consensus model is expressed as follows:

$$i_t = \delta_\pi \pi_t + \delta_x x_t + v_t, \quad (\text{A.43})$$

The monetary policy (A.43) is substituted in the DIS curve (A.42) to solve the model. This monetary policy explicitly shows how the monetary authority responds to economic conditions while determining the interest rate target which the central bank regards as optimal. The first and the second terms represent the systematic components of monetary policy while the last term indicates the unsystematic component which the monetary authority cannot predict; and further it is generally assumed that  $\delta_\pi > 1$  and  $0 < \delta_x < 1$ .

## VI. The Bedrock

Finally, we have three main equations in three endogenous variables  $x_t, \pi_t$ , and  $i_t$ . The three equations are presented here particularly in the form that can be estimated empirically to real environment and fit data.

$$x_t = E_t(x_{t+1}) - \sigma^{-1}(i_t - E_t \pi_t + \rho). \quad (\text{A.44})$$

Rational expectation dynamic IS-curve links today's output gap with real interest rate. This helps to illustrate the transmission channel of interest rate setting monetary policy.

$$\pi_t = \beta E_t(\pi_{t+1}) + \kappa x_t. \quad (\text{A.45})$$

Equation (A.39) represents the expectation-augmented Philips curve which is the inflation-adjusted equation determined by forward inflation and is proportional to output gap. For inflation to be zero, we need to keep output equal to zero in the long run.

$$i_t = \pi_t + \rho + \delta_\pi(\pi_t - \pi_t^*) + \delta_x x_t + v_t, \quad (\text{A.46})$$

Lastly, the monetary policy set by central bank is used to close the dynamic IS curve while Philips curve determines the output gap and inflation. The main observation from this summary is that monetary policy in equation (A.46) is independent of the level of money supply, and therefore, money assumes a passive role as derived in (A.33). Equation (A.33) shows the level of money supply that central banks should supply to support the monetary policy rule. Hence, this strategy supports the view of endogenous process of money supply.

## VII. The role of money and exogenous path of money supply

As can be seen from (A.39) to (A.46) equilibrium money is absent. However, the presence money can be integrated in several ways as shown by Bessany (2007, pp. 242-249)<sup>54</sup> and Walsh (2010). First, we postulate the money demand from household's optimal conditions.

$$m_t - p_t = y_t - \eta i_t \quad (\text{A.33})$$

We start from the tradition that central banks set the money-growth target or adopt a monetary target that let money supply grow at a rate to deemed necessary to maintain money market equilibrium (see Mankiw, 2012, p. 434). Bergholt (2012) and Walsh (2010) use an example of exogenous money supply path is specified as follows:

$$\Delta m_t = \rho_m \Delta m_{t-1} + \varepsilon_t^m \quad (\text{A.47})$$

whereby  $\varepsilon_t^m$  is an exogenous shock. The money demand equation is then useful to solve for price level in a Fishers' inflation equation by inserting the nominal interest rate in the following price level equation as follows<sup>55</sup>:

$$i_t = \frac{1}{\eta} [y_t - (m_t - p_t)] \quad (\text{A.48})$$

Using the fisher equation for inflation we can determine the price level as

$$p_t = E_t\{p_{t+1}\} + r_t - i_t \quad (\text{A.49})$$

We replace the  $i_t$  in the price level and obtain the following,

$$\begin{aligned} p_t &= E_t\{p_{t+1}\} + r_t - \frac{1}{\eta} [y_t - (m_t - p_t)] \\ \Rightarrow \left(\frac{1}{1+\eta}\right) p_t &= E_t\{p_{t+1}\} + r_t - \frac{1}{\eta} [y_t - m_t] \\ \Rightarrow p_t &= \left(\frac{\eta}{1+\eta}\right) E_t\{p_{t+1}\} + \left(\frac{1}{1+\eta}\right) m_t + u_t \end{aligned} \quad (\text{A.50})$$

Drago () show that  $u_t \equiv \left(\frac{1}{1+\eta}\right) [\eta r_t - y_t]$  evolves independently from real money balances as we see above in the (A.50). Solving (A.50) forward yields

$$p_t = m_t + \sum_{k=1}^{\infty} \left(\frac{\eta}{1+\eta}\right)^k E_t\{\Delta m_{t+k}\} + u_t' \quad (\text{A.51})$$

<sup>54</sup> Benassy (2011, pp. 249-251) examined a monetary experiment where monetary authority peg interest rate and let the quantity of money adopt endogenously.

<sup>55</sup> Fisher equation  $1 + r_t = (1 + i_t)/(1 + \pi_{t+1})$ .

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$u'_t \equiv \sum_{k=0}^{\infty} \left(\frac{\eta}{1+\eta}\right)^k E_t(u_{t+k})$  evolves independently from the money supply i.e. real and interest rate and income are determined by factor outside equation (A.51). From (A.1) we see that the exogenous path money supply  $\Delta m_{t+k}$  determines the price level. Thus, if it possible control money held by some in the mainstream government can follow the exogenous path to determine the desired inflation rate in the long run.

## CHAPTER TWO

### 2. Modelling Monetary Policy in Namibia: A Structural VAR estimation in the new consensus macroeconomic framework

“Within the recent decades, economic researchers have made concerted efforts to explore in more detail the various channels through which monetary policy actions affect the aggregate demand and, ultimately, inflation. In today’s literature, it is widely agreed that some of these channels require particular attention. More specifically, an interest rate channel, an exchange rate channel, some alternative asset price channels and a credit channel are often mentioned” (Gerdesmeier, 2013, p. 140).

#### 2.0. Introduction

At the onset, it is a common knowledge to claim that each central bank has a clear mission and mandates from their respective governments. For example, the mission for the Bank of Namibia’s (BoN) states that “in support of economic growth and development, our mandate is to promote price stability, efficient payment systems, effective banking supervision, reserves management and economic research in order to proactively offer relevant financial and fiscal advice to all our stakeholders” (Bank of Namibia, 2010, p. 7).

While for many central banks there are clearly stated missions and mandates, only some (if not a few) have structural view supported by empirical evidence on how monetary policy affects economic activity in their respective economies. This lack of empirical evidence has affected the development of monetary policy framework in many countries. Central bank’s mission and mandates are not enough, they need to be supported by up-to-date monetary policy frameworks which describe and explain how monetary policy operates within the domestic economy. Monetary policy framework supported by empirical evidence on the transmission mechanism is crucially imperative for every central bank, as it improves the execution of monetary policy. Empirical evidence about what transmission channels that works and how effective they are will improve the transparency of monetary policy. Furthermore, empirical works will help the public to understand the process of macroeconomic stabilization.

King (1994, p. 261) points out that it is not enough to have a clear directional objective, but we must also have an ‘understanding of how the instruments of policy affect the economy, and ultimately inflation’. In addition, King’s view concurs with Ganley (1996, p. 288) who also argues that “monetary authorities need to understand how the

effects of a change in official interest rates are passed through the economy.” Thus, in our efforts to support the development of the monetary policy framework for the Bank of Namibia, we study the monetary policy transmission mechanism within the new consensus view, when money is endogenous.<sup>56</sup> Contemporary monetary policy does not emphasize money as an active monetary policy instrument but rather it is an information variable that should be considered in the monetary policy decisions. Our study aims to provide empirical evidences on how structural shocks such as monetary policy, demand and private credit shocks affect economic activity in Namibia. This chapter is primarily aimed to establish whether or not monetary policy actions of changing the repo rate (i.e. the repo rate in Namibia) significantly influence the time path of GDP, inflation, and private sector credit in the short run and in the long.

Namibia operates a fixed exchange rate arrangement whereby the Namibian Dollar (N\$) is fixed one-to-one with the South African Rand (ZAR) since 1993 after joining the Multilateral Monetary Agreement (MMA).<sup>57</sup> The chronological development of the MMA started with the Rand Monetary Area (RMA) in 1974, which was transformed into a Common Monetary Agreement (CMA) in 1986 and then the MMA when Namibia became a member in 1993. Van Zyl (2003) pointed out that the fixed exchange rate arrangement is shared by Lesotho, Namibia, Swaziland and South Africa creating a common monetary area. All these countries have their central banks and currencies pegged to the ZAR one-to-one. The ZAR circulates freely as legal tender in the CMA and all member states have the same exchange rate against outside currencies. Some economists considered the arrangement in which Namibia operates as the currency board because of regular consultations among governors in the CMA. As argued by Hawkins and Masson (2003), the decisions to forgo national currencies for regional currencies lead to both political and economic stability in the long run. In the case of the CMA, the benefits particularly for Lesotho, Namibia and Swaziland are to maintain stable exchange rates, lower inflation, increase trade export-import volume to and through South Africa, and further maintain access to regional and international financial markets through the Johannesburg Stock

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<sup>56</sup> Bank of Namibia (BoN) is the central bank of the Republic of Namibia; and it is the sole sponsor of this research project. Apart from the above motivations, we also observe that the 2008-2009 financial crisis has revived the debate with rigor about the effectiveness of monetary policy in developed and developing countries (Knoop, 2008).

<sup>57</sup> Namibia has been a de facto member of the previous arrangements because it was under South Africa administration until March 1990. Although the legal name for this agreement is the Multilateral Monetary Agreement by the Act of 1992, we will use CMA as this is the common term used to describe the arrangement in the monetary area. Furthermore, the MMA is within the Southern African Customs Union (SACU), with only Botswana not being a member of the MMA. Van Zyl (2003) recalled that SACU started long before the Union of South Africa was formed in 1910.

Exchange (JSE). One striking difference between the CMA and other monetary unions has to do with the management and control of monetary policy, the objectives of monetary policy and mandates of member states' central banks. These features are not uniform in the CMA. Van Zyl (2003) and Jiang, Iyabo, Kazuko and Leighton (2007) acknowledge that the MMA distinguishes its aim which is to advance the economic development of and facilitate equitable distribution of benefits to member states while allowing each member state to take responsibility for its own monetary policy and control its domestic financial institutions. It means there is no single monetary policy for the monetary area. It also means that the MMA allows the Bank of Namibia to change the policy interest rate either in response to a change in South Africa's policy rate or exclusively to the domestic macroeconomic environment. Thus, with this flexibility in the MMA, we observe that monetary policy rates in the rest of the member states deviate from the South African monetary policy rate without endangering the currency peg or the multilateral monetary agreement in place. Mainstream economists argue that the deviations are not possible in the fixed exchange rate peg. This is because countries with a currency peg arrangement lose their monetary independence. However, we argue that this view does not entirely describe the practicalities in the fixed exchange rate arrangements. For example, we observe that for the past two decades the situation in the CMA (particularly in Namibia) has been different from what theories describe should prevail in a fixed exchange rate economy. On many occasions, Namibia had a lower repo rate than the South African repo rate, and this existed without experiencing large capital outflows or facing any imminent speculation attacks as occasionally alluded to in the literature.

Of course, there are some drawbacks in the CMA, as Van Zyl (2003) pointed out in an analysis of the MMA in southern Africa. For example, Van Zyl (2003) revealed that the MMA arrangement has some drawbacks such as the so-called 'lack of monetary policy discretion' and the non-formal framework of consultation between central banks in the monetary area, and the inherent exposure to volatility through South Africa's mineral-commodities driven economy. On monetary policy discretion, we argue differently that while the South African Reserve Bank (SARB) gives the direction of monetary policy for the CMA, this is always done in consultation with the other member states. Furthermore, it is not true that other member states follow to the letter the instructions from the SARB (if there are any) when formulating their monetary policy actions for stabilisation. We use the example of the last financial crisis to illustrate how each member state reacted to the global financial crisis. For example, the Central Bank of Namibia's

response to the recent global financial crisis was very different from that of the SARB. In the case of South Africa, the central bank and government both embarked on large fiscal and monetary policy expansions to stimulate the economy and mitigate the effects of financial crisis. However, the responses of the Bank of Namibia and the government were mild, primarily targeted against unemployment, pervasive inequalities and the lack of financial inclusion in Namibia. Of course, one important phenomenon that prevailed before the crisis was that Namibia's repo rate was already lower than South Africa's repo rate and the ratio of international reserves was higher enough to help the central bank through the crisis period. Thus, combining these factors with the flexibility to manage domestic monetary policy might explain why individual monetary policy matters in the CMA. In addition, the credibility to manage foreign reserves to preserve the currency peg in the CMA might also explain why monetary policy rates deviate within from the anchor country. Hence, the MMA arrangement gives leverage in the short term for the Bank of Namibia to deviate from South Africa's policy rate in order to pursue stabilisation actions that are in its own economic interests. In all, the MMA presents the opportunity to central banks to use the repo rate to influence economic activity in the short run without waiting for South Africa to take similar steps. The main concern for us is whether these independent actions of changing the repo rate in Namibia produce significant transmission to output and inflation.

### **2.1.1 Motivation of the study**

Although there are many empirical works on the transmission mechanism in advanced economies; however, in Namibia; a developing country which greatly relies on the banking sector as a main source of finance for economic activity, there is little known about efficacy of monetary policy. The gap exists because there is lack of documented empirical evidence about the monetary policy transmission from nominal interest rate (i.e. repo rate) to real economic activity, and the size and strength of individual transmission channels such as interest rate and credit channels. As a result of this gap on empirical evidences, it is generally observed that some central bankers cannot confidently answer questions of when, why, and how much in relation to the transmission mechanism of monetary policy in their respective countries. For example, to what extend does the policy of changing the level of repo rate significantly influences real GDP and inflation. In addition, other questions the necessity of changing the repo rate in the face of SA's monetary policy direct influence in Namibia. Bayoumi, Dell'Aricecia, Habermeier, Mancinci-Griffoli, and Valencia (2014, p. 3) revealed that '... there is much we do not know about some of the transmission channels' and therefore we should reconsiders our

monetary policy rules. We believe that this study is necessary especially in developing countries which of recent have adopted the indirect approach of implementing monetary policy, with fewer directives and less direct controls and more uses of indirect instruments based on market mechanisms and incentives.<sup>58</sup> In addition, even if empirical evidence exists, we argue that it is in the central banks' interest to continually revise the quantitative picture of the transmission mechanism over time even if there are past empirical evidence on the subject.<sup>59</sup> Another motivation for this study is based on cultural and structural differences that exist in many countries. On the differences, Greenwald and Stiglitz (1993, p. 32) reveal that "the impact of monetary policy in developing countries is likely to be different from the impacts in United States and other advanced industrial countries." Fetai and Izet (2010) claim that these differences in transmission mechanisms are generated by factors such as the size of the economy, openness, and level of financial development, preferences, political and administrative institutions in place. This claim is supported by Agenor and Montiel (2007, p. 4) who assert that "transmission channels may vary across countries and overtime, depending on the state of financial markets development." Thus, we emphasize that an empirical study about transmission channels and effectiveness of monetary policy is highly welcome in Namibia. Specifically, this study is aimed to help the revision and redevelopment monetary policy framework currently at the Bank of Namibia. This chapter makes the following contributions: it provides empirical evidence on how shocks from SA monetary policy and domestic monetary policy affect real economic activity; the relative size of credit and interest rate channel and finally, whether the 1998 East Asian and the global financial crisis 2008-10 have significant long run effects on domestic variables.

### 2.1.2 Objectives of the Study

The primary objective of this study is to examine the effectiveness transmission mechanisms generated by changing the level of repo rate in Namibia. We sought any statistically significant empirical evidence of monetary policy effects on economic and financial activity in Namibia through the Structural Vector Auto Regression (SVAR) method.<sup>60</sup> Sousa and Zaghini (2007, p. 7) claim that this method allows the modelling of recursive and non-recursive structures of the economy with a parsimonious set of variables

<sup>58</sup> See Ho (2010) on the survey about implementing monetary policy in the 2000s .

<sup>59</sup> See (Knoop, 2008; Mahadeva & Sinclair, 2002; Moschitz, 2004).

<sup>60</sup> An alternative method is called structural vector error correction model (S-VECM) –this method takes into account the presence of cointegration in the vector auto-regression model. This method was not possible for our analysis because some of the variables such inflation were reported as growth rates. For example, the consumer price index was reconstructed to extend the coverage, and it was also rebased about four times since 1990.

and it facilitates the interpretation of the contemporaneous correlation among disturbances. SVAR method has become the main tool of evaluating the effectiveness of monetary policy and the transmission channels of monetary policy. Thus, using SVAR our specific objectives are:

- (i) Estimate short run structural impulse response functions (sirtf) of real economic output, inflation rate, and bank money (private sector credit) to the following structural shocks: monetary policy (both domestic and foreign), demand shock and private credit shocks.<sup>61</sup>
- (ii) Estimate and analyze the relative strength of interest rate (repo rate) and credit channels in Namibia by analyzing the structural forecast error variance decomposition (sfevd) of output. We focused on interest rate and credit channels because they are always given distinct elaborations in the monetary policy statement issued by the bank of Namibia. This is an indication that BoN pays serious attention to the transmission through repo rate and private credit channels.
- (iii) Estimate the long run cumulative impulse response functions (cirtf) of real GDP and inflation to a domestic monetary policy shock. This estimation is aimed to establish whether there are significant long run effects of changing the level of repo rate on inflation rate in Namibia.

This study adopts the new consensus monetary policy theoretical framework where central bank sets interest rate target and lets money supply adapt endogenously. In chapter we provided the theoretical underpinnings for interest rate setting monetary policy, and this chapter empirically test the effectiveness of changing interest rate levels in Namibia. This chapter contributes to the empirical literature by providing a comprehensive quantitative picture about the transmission mechanism of monetary policy for the past two decades in Namibia. Furthermore, we provide empirical evidence about relative strength of interest rate and credit channels in Namibia.

In the earlier part of the thesis, we reviewed fundamental monetary theories of monetary policy in two dimensions - across macroeconomic schools of thought, and the historical perspective dimension. The chapter summarised the theoretical foundations for the 'new macroeconomics consensus' and prevalent interest rate-targeting policy in contemporary central banking. In that essay, we learned the evolution of monetary theory

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<sup>61</sup> In our structural economic model, we have a shock on SA's repo rate and Namibia's repo rate. These two shocks are meant to differentiate between domestic and foreign monetary policy effects in Namibia. Further, we estimate two separate SVAR models one with Namibia repo rate and another with SA repo rate as the policy instrument.

and the transition of monetary policy from the money-growth targeting approach in the 20th century to the contemporary all dominating interest rate-targeting monetary policy in the 21<sup>st</sup> century.<sup>62</sup> We conclude that currently, and for diverse reasons, many central banks have abandoned money-growth targets and now set interest rate targets as a way to implement monetary policy. Central bank's nominal interest rate is the monetary policy instrument and it's not money supply. When central banks adjust the level of nominal bank rate this sets off the transmission mechanism of monetary policy. Finally, monetary policy effects is evaluated through interest rate shocks rather than money supply shock. Therefore, with this understanding in mind we used the repo rate as the monetary policy instrument that generates the transmission effects in SVAR model.

Section one gives the introduction, motivation and objectives of the chapter; section 2.2 reviews empirical studies on the transmission mechanism of monetary policy in the developed and developing countries. Section 2.3 and 2.4 explain the SVAR methodology and the economic model used to examine the transmission mechanism, and the last section 2.5 presents empirical results starting with graph presentations, structural impulse responses, and the conclusion.

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<sup>62</sup> On this same topic, (David, 2008, p. 177) asserts that “central banks view themselves not as determiner of the money supply, but as determiner of the nominal interest rate.” He further reveals that “given the choice of interest rate, the money supply is endogenously determined by the private sector's demand for money.” Similarly, (Agenor & Montiel, 2007) write that ‘the central bank sets the refinance rate and provides unlimited access to liquidity at that rate.’ (see also Alvarez, Lucas, & Weber, 2001, p. 219).

## 2.2 Empirical studies on the transmission mechanism of monetary policy

Empirical works on the transmission mechanism of monetary policy are abundant; however, most empirical studies focus on the monetary transmission mechanism in advanced economies. In the case of developing countries this topic is less researched as argued by Gavin and Kemme (2009). This state of affairs stems from multiple problems that prevent smooth analysis of monetary policy in developing countries. First, there is a problem of data collection and compilation especially in the real sector of the economy.<sup>63</sup> Mahadeva and Sinclair (2002) point out that monetary analysis of transmission channels requires good quality data in order to provide correct policy advices. Therefore, without good quality data and comprehensive quantitative analysis monetary policies are based on guess works and speculations. Second, research about the monetary policy transmission mechanism is complex while the research capacity in developing countries is limited because of limited research skills, lack of commitment and shortage of funds from governments. Third, the financial systems in developing economies are undeveloped, often exist in two tier system formal and informal; and they also tend to have fairly dominant public sector activities with the government crowding out private firms. All these factors were alleged to inhibit research works on monetary policy transmission mechanism in developing countries. As a result, some countries operate monetary policy without a clear set of monetary policy framework that stipulate the policy instrument, target and how the ultimate objectives will be achieved. Finally, there is apathy toward analysis of monetary transmission mechanism from some academics community. Some economists are of the view that there is nothing to say any more about monetary policy transmission mechanism. However, for central perspective the tasks of advising and revising monetary policy framework require up to date information about the how, when and why of the current transmission mechanism. We are of the view that monetary policy transmission mechanism is a timeless topic, and it remains an important topic as long as the businesses of economic stabilization exist.

Traditionally, empirical works that examine the transmission channels assumed that central banks control the money supply (Estreall & Mishkin, 1995). From this perspective, money supply was used as the monetary policy instrument that the central banks can adjust to stabilize output and inflation in the economy. We argue that this assumption has been rendered obsolete and incongruent with modern frameworks of monetary policy. Alvarez et.al (2001, p. 219) points out that:

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<sup>63</sup> Real sector variables include: GDP, PPI, CPI, GDP Deflator etc. These variables are less frequent in nature; thus, there are fewer observations and sometimes gaps for each time series.

“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.”

With the reasons of what we have leaned in chapter one, our position supports the view that the central bank sets interest rate as the policy instrument to stabilize the economy.<sup>64</sup> Therefore, in the following review of empirical studies on transmission channels, we did not include those studies that investigate the role of the money channel.<sup>65</sup> First, we present a literature review of empirical studies that evaluate the effectiveness of monetary policy shocks through the interest rate channel. Within this section a range of papers on monetary transmission mechanism in developed and developing economies are covered. Second, we examine the empirical studies that assess the credit channel, with the purpose of knowing how credit responds to monetary policy shocks. Finally, we examine the asset price channel and exchange rate. The last two channels dominate literature on this topic in the past 10 years since the East Asia financial crisis, tech bubble in the US and the global meltdown in 2007-08. As we address in the first chapter many policy makers in contemporary times want to understand the role of asset prices play in transmission mechanism and what role they should play and what weights they should be assigned in the monetary policy rule.

### **2.2.1 Empirical Studies on Interest Rate Channel**

There are several applied studies that examine whether changes in interest rate significantly influences economic activity. For example, Bernanke and Gertler (1995) and Mojo and Peersman (2003) produce empirical works with evidences, which support that monetary policy operates through the interest rate channel. Bernanke & Gertler (1995) used the SVAR approach to analyse the effects of monetary policy shocks in the US economy. These authors applied a semi-structural VAR and identified the innovation in federal funds rate as the exogenous shock (i.e. a monetary policy instrument), and their system includes real GDP and GDP deflator as measures of economic activity. Bernanke and Gretler’s results show that output declines in response to a positive monetary policy

<sup>64</sup> This view is supported by Post Keynesians such as (Arestis & Sawyer, 2006; Hansegenn, 2006; Palley, 2003), as well as by mainstream economists such as (Bain & Howells, 2003; Goodhart, 2007; McCallum, 2001).

<sup>65</sup> Money supply channels have been argued for by many authors; however, here we present (McCallum, 2001, p. 157) who purported that the “model without monetary aggregates does not imply that inflation is a non monetary phenomenon.” Although the theoretical model seems to suggest misspecification, McCallum (2001) asserts that this effect is very minimal in quantitative terms. He therefore concluded his observation by claiming that “policy analysis in a model without money and based on interest rate rule is not fundamentally misguided.”

shock. They indicate that the general price index responds after the fourth quarter; this seems to show that it lags behind the response in output. These findings confirm the operation of the interest rate channel through which monetary policy impacts the real economy in the US. On the same topic, Mojon and Peersman (2003) examine the monetary transmission process in 10 countries in the Euro area. Using the method of structural VAR, they evaluate cross-country differences in the transmission mechanism. Mojon and Peersman included variables such as world commodity price index, US GDP and short term interest rates.<sup>66</sup> The world commodity index and the US GDP group are assumed exogenous and they are used to represent world inflation and capture the so-called 'price puzzle i.e after a increase in monetary policy shock inflation goes up rather than going down' associated with the VAR studies (Favero, 2001). Evidence from Mojon and Peersman's study indicates that output and price react to random shocks from the interest rate. Firstly, output temporarily falls and reaches a trough around the fourth quarter, and thereafter, price levels decline in response to a positive shock in the interest rate. These results are compatible with the general outcomes of VAR studies. The stylized facts of the effects of contraction of monetary policy shock on output, prices and interest rate are aggregate output initial falls, which is represented by a j-shaped response; aggregate prices initially rose steadily and starts to decline after the 3-quarter; and interest rates initially rose in response to a monetary policy shock (Favero, 2001; Christiano, Eichbaum, and Evans 1996).

Regarding the research on developing countries, we selectively surveyed the empirical studies that examine the interest rate channel in economies with a fixed peg (e.g. Oman) and flexible exchange rates (India, Uganda, and South Africa).<sup>67</sup> In this view, we present the work of (Al-Raisi, Pattanaik, & Al Raisi, 2007) in Oman, (Kapur & Patra, 2010) in India, (Antigi-Ego, 2000) in Uganda and (Smal & de Jager, 2001) in South Africa.

Al-Raisi et al. (2007) investigate the transmission mechanism in Oman, using two econometric methods which include the structural New Keynesian model with three equations (i.e. Output gap, New Keynesian Phillips curve and monetary policy reaction function), and the SVAR approach. The structural equation model and SVAR both produce evidence that suggests that changes in interest rates do not influence aggregate demand and

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<sup>66</sup> SVAR and semi-SVAR represent the structure of the economy. These can be recursive or non-recursive depending on the hypothesis being tested. Most SVARs are non-recursive because this represents a system of equation with each equation describing a particular structure of the economy.

<sup>67</sup> Oman has a similar exchange rate policy setting to Namibia. India and South Africa both have monetary policy frameworks that follow the rationale of the New Consensus model with no emphasis on money supply.

aggregate supply in Oman. They noted that these results are ascribed to the lack of responses by market-determined interest rate to interest rate policy in Oman. Al-Raisi et al.(2007) argue that the weak transmission mechanism of monetary policy is due to the fact that Oman does not have an independent monetary policy. This might be explained by the fact that households in Oman respond to monetary policy in the anchor country. In addition, Al-Raisi et al. (2007) also discover the evidences of the interest rate puzzle (or IS puzzle) and the ‘Phillips curve puzzle’ which are common occurrences in the analysis of transmission mechanism using the SVAR method. Interest rate puzzles turn up in other empirical studies about transmission mechanism such as Mojo & Peersman (2003) and Westerway (2002). The IS puzzle implies that an increase in real interest rate leads to an increase in aggregate demand instead of a decline; while the Phillips curve puzzle denotes the empirical finding of a negative relationship between output and inflation (i.e. prices increase when monetary policy is tightened). To solve the puzzles, Kim & Roubini (2000) and Mojo & Peersman (2003) included the current world oil price index in US dollars in the VAR model; while Favero (2001) included the world commodity price index to counter the problem of the price puzzle as exhibited by the Phillips curve relation.

Kapur and Patra (2010) applied the Generalized Method of Moments (GMM) to estimate the structural New Keynesian model in order to examine monetary policy effects without any reference to money supply in India.<sup>68</sup> They modelled monetary policy within the so-called ‘live policy-making environment’ as referred to by (Westerway, 2002). The sample period is from 1997:2 to 2009:3 and the variables in the model are: GDP, GDP deflator, repo rate by the Reserve Bank of India, US Federal Fund rate and the World index on non-fuel commodity prices. Evidence from their model suggests that aggregate demand as measured by output gap reacts to monetary policy through the interest rate channel. Kapur and Patra (2010) also found that aggregate demand reacts with at least three quarters delay; while inflation takes seven quarters to react to a change in the interest rate in India. They conclude that monetary policy has an impact on real activity and inflation with waning effects in the long run. Kapur and Patra’s study resonates well with our thesis that embraces the consensus view which does not emphasize the role of money.

Antigi-Ego (2000) examines how interest rate compares with monetary base targeting as a monetary policy instrument in the Ugandan economy. He constructed a small structural VAR model that captures the structural dynamic features representing Uganda’s

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<sup>68</sup> GMM is favoured by economists such as Biha, Galles and Jondeau (2004) because it captures the forward looking component of monetary policy better than the OLS and VAR methods. The incorporation of forward lags makes the estimation to include beliefs about the future conditions of the economy.

economy. Antigi-Ego used the model to compare the monetary base and interest rate operating procedures for monetary policy with a sample from 1981:1 to 1997:4. The SVAR results indicate that the transmission effects from interest rate is rapid compared to the effects from base money. He claimed that it takes less than six months for a 1% rise in the interest rate to cause an approximately equal fall in inflation. Antigi-Ego reveals that base money is slower in Uganda and that transmission effects take a year for a change in base money to impact on the interest rate through the money market. Therefore, he argues that there is favourable evidence to support a move to an interest rate setting strategy in Uganda.

Smal and de Jager (2001) investigate the monetary transmission mechanism in South Africa with the aim of giving a description of how monetary policy has evolved in the past two decades. In year 2000, South Africa adopted the Inflation-Targeting in their monetary policy framework with the inflation target set in a range of 3-6 percent. Smal and de Jager's macro-econometric model comprises three equations that define aggregate demand, aggregate supply and monetary policy rule to represent the reaction function of the South Africa Reserve Bank. In their model the repo rate is the monetary policy instrument by which the reserve bank influences variables such as money, credit and other asset prices. Smal and de Jager's results indicate that the repo rate has a significant impacts on real output and inflation in South Africa. The study further shows that monetary policy effects are felt after four to six quarters which thus confirms the existence of the interest rate channel in South Africa.

Brischetto and Voss (1999) examined monetary policy effects in Australia using the structural VAR model similar to Kim and Roubini (2000). Their model includes variables such as World Oil price index in US dollars, Federal fund rate, domestic output, domestic price index, monetary aggregates, domestic policy rate, and exchange rate.<sup>69</sup> The oil price index is included to capture anticipated inflation, while the Federal fund rate is included to control the response of domestic monetary policy to US financial variables. In this study Brischetto and Voss used the official cash rate as policy instrument which has been an official instrument over the sample period in Australia. Brischetto and Voss (1999, p. 1) described the results of monetary policy shocks thus: "it has delayed and gradual effects on the price level and small temporary effects on output". In addition, the results are consistent with other empirical works in Australia and other similar economies.

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<sup>69</sup> The model by Kim and Roubini (1999) has the following variables: World oil price index in current US dollar, Federal Fund rate, domestic output, domestic price level, domestic policy rate, and exchange rate.

### 2.2.2 Empirical studies on the credit channel

Turning to a survey of the literature on the credit channel, Kashyap and Stein (2000) and Suzuki (2004) provide comparable methods that evaluate monetary policy through the credit channel. In their papers, they illustrated the importance of bank credit in the transmission mechanism of monetary policy. Generally, the credit channel emphasizes that monetary policy tightening affects the supply of bank credit. The squeezed credit supplies therefore constrain business investments, reduce planned production, and ultimately total output. Under the broad credit view, economists analyze monetary policy effects under the assumption that bank loans and bonds are imperfect substitutes in the capital market. Thus, an increase in monetary policy instrument (i.e. a rise in interest rate) shifts the loan supply and consequently reduces the amount of credit available to make new loans.<sup>70</sup>

In this section, we present a review that covers the studies that examine the monetary policy effects on firms' balance sheets as well as those that examine the commercial banks lending behaviours in response to monetary policy shocks. These two credit views are called balance sheet channel and lending channel.<sup>71</sup> Jimenez, Ongena, Peydro and Saurina (2011, p. 2301) have revealed that the identification of monetary policy effects through the credit channel is a 'steep challenge'; this is because monetary policy tightening affects bank credit in both supply and demand.<sup>72</sup> Thus, to overcome this problem individual studies devised different techniques; this makes the results from these models rarely comparable, but nevertheless very informative. For example, Jimenez et al. (2011) used the firms' loan application to gauge the monetary policy effects on the probability that a particular loan is granted. Another avenue that explores the effects of monetary policy on output through credit channel is the use of credit rationing models. Credit rationing models suggest that there is a threshold level after which monetary policy effects become stronger when credit market rigidity surpasses this particular point (Shao, 2010). However, the weakness of credit rationing models is that the threshold level is unknown, and it depends on the sample space in the study; i.e. it changes from sample to sample.

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<sup>70</sup> Post Keynesians dispute these views because they believe bank credit is independent of amount of deposits or reserve at commercial banks (Kriesler & Lavoie, 2007). They argue that credit is demand determined by the economic activity. Thus, monetary policy contraction constrains demand (from households and businesses) and leads to credit rationing by financial institutions.

<sup>71</sup> Bernanke and Blinder (1988) formalized the lending channel while the balance sheet channel of monetary policy was formalized by Bernanke and Gertler (1989).

<sup>72</sup> Jimenez et al. (2011) provides full details of empirical strategy followed to overcome the problem of identification.

Kashyap and Stein (2000, p. 30) examine bank business lending behaviours by disaggregating lending from large banks and lending from small banks. These authors claim that “it is hard to deny the existence of lending channel of transmission mechanism at least in the US” referring to the sample period from 1976 to 1993. Using a GMM Two-Step method and pooled data from the US financial sector on insured commercial banks, the evidence from this study suggests that bank business lending declines when monetary policy is tightened giving evidence of a lending channel.<sup>73</sup> Kashyap and Stein’s results show that total loans and loans from smaller banks respond to monetary policy tightening, while loans by large sized banks remain unaffected by monetary policy tightening. Of course previous work on the same topic by Kashyap, Stein and Wilcox (1996) supports the line that small bank lending falls substantially in comparison to larger bank lending in response to a monetary policy shock. In a similar fashion, Sengonul and Thorbecke (2005) examined the effects of monetary policy contraction on banks with weak balance sheets in Turkey. Using the Kashyap and Stein methodology, the results indicate that banks with weak balance sheets curtail their lending in the wake of new increases in the interest rate. Thus, Sengonul and Thorbecke (2005) argue that banks apply this strategy in order to rebuild their liquidity positions.

Suzuki (2004) investigates the evidences on both views of the credit channel in the Japanese economy. Suzuki’s structural VAR model includes the following variables: output, consumer price index, monetary aggregates and overnight call rate for interest rate (proxy for a Japanese central bank instrument), base money, and quantity of loan outstanding, loan price, exchange rate, and US federal interest rate. Suzuki finds evidence that monetary policy tightening in Japan affects the real economy by shifting the supply schedule of bank loans. However, he also indicates that it is difficult to tell whether this contraction in bank loans is a result of the leftward shift in supply of loans or the leftward shift in the demand schedule of loans.

Shabbir (2008) examines the monetary transmission channels in two pacific countries: Fiji and Papa New Guinea (PNG). He applies the structural VAR model to investigate the monetary and credit channels, and analyzes the forecast error decomposition to compare the relative strength of monetary channel and credit channel in the two countries.<sup>74</sup> The model has six variables (i.e. central bank reserves, bank deposits,

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<sup>73</sup> The GMM 2-Step method is given in detail by (Kashyap & Stein, 2000) in their paper.

<sup>74</sup> Shabbir’s (2008) results have added another dimension (relative strength) to the analysis of transmission channels which is rarely emphasized in other studies that investigate the monetary transmission mechanism.

bank loans, effective exchange rate, consumer price index and total output) that he utilises to capture the economic structures of these two Pacific Islands. The results suggest that there is evidence to support the monetary channel, as reserves and deposits accounts for large variation in output in Fiji. The credit and exchange rate channels did not account for a significant role in output variation in Fiji. In the case of PNG the result is reversed, credit channel plays a significant role as it accounts for a large variation in output. These results seem to react to changes in credit conditions within the PNG economy. Shabbir (2008) further claims that such evidences are in line with the stylized facts for the bank lending channel. The common understanding about credit lending channel is that it is more pronounced in less developed countries than in countries with established financial market. This is because; the financial sector in less developed countries rarely offers alternatives to firms apart from bank's finance. Shabbir further reveals that there is lack of developed financial market in the Fiji as compared to PNG which, according to him, could be a result of the difference in transmission channel between the two countries.

Jimenez et al. (2011) analyzed the impacts of monetary policy on the supply of bank credit in Spain. Using a cross-sectional micro-firm-level data and accounting for time-varying firm heterogeneity in demand for loans, their study specifically focused on loan applications in Spain.<sup>75</sup> The main findings by Jimenez et al., (2011) suggest that monetary policy reduces loan granting by banks and this is worsened when compounded by bad economic conditions. They argued that the chances that the loan application is granted are negatively affected by higher short-term interest rate and/or low GDP growth. Jimenez et al., (2011) further indicate that loan supply declines and this is especially observed among banks with weak balance sheets. An added unique feature in this study is that it has investigated the possibility of firms switching to other banks when faced with loan supply restrictions. Jimenez et al., (2011, p. 2) assert that 'firms cannot offset the resultant credit restriction by applying to other banks'. This is because substitution for credit denied elsewhere is difficult during cramped economic conditions. Furthermore, the probability of a second round application being rejected varies directly with deterioration of economic conditions.

In an alternative method, Sellon & Morris (1995) examined the hypothesis that monetary policy tightening affects bank business lending in the US. This study explores

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He argued that variance decomposition results are robust because different orderings of variables did not change the results with any significance.

<sup>75</sup> The use of loan applications to examine the reaction of loan supply to monetary policy is necessitated by the steep challenge of identifying the demand and supply of loans schedules (Jimenez et.al, 2010).

the debates as to whether bank business lending plays a role in the monetary transmission mechanism. Using the Effective Federal funds targeting as a measure for monetary policy, they determined the so-called 'policy window periods' when Federal monetary policy was tightened. Gordon and Morris (1995) identified four examples of 'window periods' over the sample period from 1976 to 1994. They asserted that over this period the US Federal monetary policy was occasionally tight. This is shown by the sustained reduction of the bank reserves which were reduced by the US Federal Reserve with the aim of raising the Federal Funds rate. Gordon and Morris (1995) find that bank business lending in each window period rises and there is no evidence of decline until the Federal Reserve begins to reverse the policy. Furthermore, results show that bank business lending lags behind economic activity. All in all, during the policy windows, there was no evidence that monetary policy tightening constrained bank business lending; however, they pointed out that this result does not indicate that credit channel is unimportant or that none existed.

#### **2.2.4 Asset Prices Channels: stock prices, real estate and exchange rates**

In this section we discussed two important transmission channels called asset prices and exchange rate channels. In the last decade, the macroeconomic implications of asset prices have received a lot of attention from academia, central banks and governments. For example, significant research efforts have been made to understand the roles of equity prices, house prices and other real estate prices in the transmission mechanism of monetary policy and macroeconomic stabilization at large. The concerns about these prices are both about whether monetary policy reinforces asset price inflation or asset prices development encourages less active monetary policy stabilization. As a result macroeconomists have suggested that monetary policy should respond systematically to asset prices and exchange rate developments. It means that changes in asset prices and exchange rates should be considered as part of the reaction function for central banks. Monetary policy expansion (i.e. decrease in the repo rate) affects the short-term money market rates and subsequently long term rates.<sup>76</sup> These money market rate adjustments lower investment returns on domestic investment thus causing an outflow of financial capital and exchange rate depreciation. In addition, this expansions change banks and building society lending house prices and equity withdrawal. Asset prices such as stock prices and real estate prices lose their value affecting the economic activity as a whole.

Of course, we found that the area of emphasis in the transmission mechanism of asset prices has different focuses across countries. In the developed world, the focus has

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<sup>76</sup> See also (Mishkin, 1996) and (Goodhart & Hofmann, 2007).

been on the effects of house prices on household wealth, consumption and finally the economy at large. Meanwhile, exchange rate prices have dominated the research focus in transition economies and the emerging markets. Despite these different emphases, many economists agree that asset prices and exchange channels play a very important role in the transmission mechanism. Although financial markets are thin and the financial depth is shallow in transition and developing countries such as Namibia, we find that there is still a significant role of asset prices and exchange rate channel. Thus we cannot ignore the importance of the asset price exchange rate channel in these economies. Montiel and Prisha (2012) showed that the limitation of exploring asset price channel effectively lies in the fact that there is a lack of quality empirical data particularly in developing countries.

#### ***2.2.4.1 Stock and Real estate prices channels***

Firstly, it is empirically shown that monetary policy effects on stock prices have significant influence on investments, firm balance sheets and household wealth and liquidity. The immediate important reference in this topic is the schematic diagrams by Mishkin (1996), which illustrate how various transmission channels work in most advanced economies. Some exemplary works on the topic are Montiel and Prisha (2012), Goodhart and Hofmann (2007), and Benarke and Kiyotaki (1998). Benarke and Kiyotaki (1999) showed that there is a strong link between asset prices and monetary policy with empirical evidence supporting the assumption that a strong sustained growth in asset prices may lead to more borrowing by households and firms. This evidence shows that asset price provides valuable information to determine monetary policy. Nastansky & Strohe (2010) empirically examined the transmission channel of monetary policy through asset prices (i.e. stock and property prices) on aggregate consumption and investments. Using a co-integration procedure Nastansky & Strohe (2010) find that there are significant wealth effects on consumption and investment effects from stock and property prices in Germany.<sup>77</sup> These authors proposed that central banks should aim to understand the transmission mechanism through stock and property prices; however, these prices should not become explicit targets of monetary policy but rather serve as information variables in setting the targets of monetary policy.

Fundamentally, the major strength of wealth effect and investment effect channels depends firstly on whether household mortgages are on variable interest rates; and second, whether the changes in the policy rate are seen as permanent or temporary. Permanent change in the policy rates influences future expectations and consumption spending by

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households, which ultimately affect aggregate demand as a whole in the long run. Goodhart & Hofmann (2007) examined the predictive power of asset prices on output gap and CPI inflation in the G7 countries. From the identified VAR they find that asset prices significantly affect output gap but the response of inflation was generally insignificant. They argued that this might be explained by the forward-looking nature in stock price movements. Monetary policy affects the financial health of firms through debts repayment, firms' investments and their ability to borrow from the financial markets. This relationship is suggested by the Tobin-q theory of investment, which says that investment activity is determined by the ratio of market value to cost of acquiring it. Therefore, when monetary policy expansion results in the increase of stock prices this will lower repayment cost liability of households and non-financial firms. Many firms use the improvements in the net worth and overall balance sheets to borrow from stock markets. The transmission channels, through stock prices, lower capital cost, stimulate investments and subsequently increase output. However, other increases in asset prices lead to asset price speculation, moral hazards and herding in the financial markets. For example, firms with lower net worth have less collateral, which may increase the problem of moral hazard by taking riskier investments, which make them unable to pay back in the long run. Bofinger (2001) argued that monetary policy rates have a strong direct and important effect on firms' balance sheets by reducing or increasing firms' profits and this has final implications for overall investments and firms' demand for labour. Finally, the asset price channel also works through balance sheets as property prices affect financial institutions' willingness to lend. This channel is similar to the credit channel discussed in the last section. For example, (Gerlach & Peng, 2005) examined the relationship between residential properties and property prices using a vector error correction model (VECM). Gerlach and Peng (2005) find that there is a unidirectional causal relationship flowing from property prices to bank lending. This evidence is consistent with (Goodhart & Hofmann, 2007) who find that real property prices for residential and commercial properties have strong and persistent positive effects on bank lending, and further help to explain the long run relationship between real GDP and real interest rate in the 16 industrialized countries.

#### ***2.2.4.2 Exchange rate channel***

Exchange rates have an important role in the transmission mechanism of monetary policy effects. The exchange rate channel comes into play when changes in interest rates impact through capital and current accounts, therefore causing appreciation or depreciation

of real exchange rates.<sup>78</sup> In a flexible exchange rate economy, monetary policy effects on exchange rate are transmitted through the following channels. Firstly, a high interest rate means a stronger currency which leads to the decline in net export demand and lower output. Meanwhile, the low interest rates weaken domestic currency, which results in depreciation of exchange rates and increases in export of domestically-produced goods and services as they become competitive to foreign goods. In the schematic view, (Mishkin, F. S., 2007b) schematic diagrams describe the exchange rate channel as follows: expansion of monetary policy leads to depreciation of domestic interest rates which make the domestic denominated bonds lose attraction for the foreign investors. This reaction locks in the depreciation of domestic currency, which stimulates net exports and increases total income in the economy.

Empirical evidence of the exchange rate channel is diverse in the literature. Montiel and Prisha (2012), Mishkin (2007b), Fetai and Izet (2010) and many other economists argue that the exchange rate channel plays a significant and important role in the transmission mechanism of countries in the transition and emerging markets. Fetai and Izet (2010) examined the effects of exchange rate on real GDP and prices in Macedonia. Using a SVAR method they find that changes in money stocks and exchange rate do not show significant effects on real GDP. However, exchange rate shock effects are rather significantly observed on the price level in Macedonia. Arratibel & Michaelis (2014) examined the impact of monetary policy and exchange rate shocks in Poland. Using a time-varying VAR method they found significant time-varying effects from exchange rate shock on output and consumer prices. Specifically, consumer prices are more responsive to exchange rate than the response from other macroeconomic variables. Other works on exchange rate include (Kim & Roubini, 2000) who investigated the transmission mechanism in a group of small developing countries. They find that the exchange rate channel plays an influential role in transmitting effects from monetary policy to output and prices. In the case, Ghana, Abradu-Otoo, Amoah, and Bawumia (2003) used a structural vector error correction model to examine monetary policy effect through the exchange rate channel. Using a system of seven variables they found strong evidence that the exchange rate channel is the main medium through which monetary policy effects are transmitted to output and inflation.

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<sup>78</sup> Although governments and central banks in advanced countries care about exchange, many have rarely made these as a focus variable in the monetary policy framework. This is explained by the fact that exchange rates are volatile, explosive and fluctuative. Thus many have either left it completely to the market or pegged it to strong currency so as to achieve stability through a nominal anchor.

However, in a fixed exchange rate economy monetary policy effects are transmitted through import prices of goods and services from the anchor country. The effects of domestic monetary policy on exchange rates are curtailed by the exchange rate peg. Another route through which exchange rate effects are transmitted is the future expectation of future exchange rate changes in the anchor country. This happens when nominal interest rate affects the long-term rate thereby changing expectations regarding the future exchange rates.

In summation, in this review of empirical studies about the transmission effects of monetary policy, we have observed the following lessons. First, there is a genuine interest from central banks and applied economists to understand the transmission mechanism of monetary policy; specifically, how fast and to what extent a change in the central bank's interest rate influences the dynamic path of inflation and output. Second, we learnt that it is a daunting task to examine monetary transmission channels, and it requires good innovative ideas to set up a truly representative model. This observation supports the claim by King (1994, p. 263) who attests that the qualitative aspect of the transmission mechanism is 'at least relatively uncontroversial, but turning this qualitative into quantitative is a different story'. Under this review, we observed diverse approaches, and the new consensus model with three equations and the Bernanke and Mihov (1995), and Kim and Roubin (2000) structural VAR approach dominates. As Fetai and Izet (2010) pointed out, SVAR has been used to establish the several channels through which monetary policy effects are transmitted to the economy. We also noted that there is a general recognition that there are potential problems when examining monetary policy issues using the S(VAR) method. Some of the problems encountered include the treatment of lag effects, the size shocks and accounting for anticipated effects of monetary policy.<sup>79</sup> The New Consensus model is the three structural dynamic equations with the IS-curve that represents aggregate demand; Phillips curve represents aggregate supply, and the monetary policy rule in most cases in the form of the Taylor rule (Arestis & Sawyer, 2006; Meyer, 2001). This structural dynamic model appeals to economists today because it illustrates how modern central banks conduct monetary policy. Goodhart (2001), Westerways (2002), and Kapur and Patra (2010) argue that this model recognizes that money supply is endogenous, and as such there is nothing new we can learn from money, which is not provided by the cost of money. Third, we have also noted that the forecast errors of

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<sup>79</sup> See, Norrbin (2000) who discussed the issues about designing the empirical test of the effects of monetary policy.

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decomposition (as obtained through structural VAR) can be used as an avenue to ascertain the relative strength of different transmission channels in the economy.

### 2.3. Methodology: Structural Vector Auto-Regression (SVAR)

The method that is commonly used to analyse the transmission mechanism of monetary policy in contemporary times is the SVAR method. SVAR has significantly impacted and enhanced macroeconomic research, and thus research analyses of the effects of monetary policy in the last decade have been enormous.<sup>80</sup> Bernanke & Mihove (1995), Sims (1980) and Watson and Stock (2001) are some of the works which showed that S(VAR) methods can be used to summarize macroeconomic time series to make forecasts, and provide valuable policy advice for economic decisions. Vector auto regression (VAR) from which SVAR is a component is well known for its remarkable contribution to the field of macro-econometrics in contemporary times. The main contributions lie in its ability to answer important questions about the dynamic interactions conditional upon the future path of variables of interest such as monetary policy rate or tax rate. Through VAR, macro-econometricians have been able to investigate the effects of monetary policy on real GDP and inflation, and the relative strength of individual channels of monetary policy. First, structural VAR provides avenues through which econometricians are able to pin down the effects of monetary policy shocks and trace their expected impact on various macroeconomic variables (Bjornland & Jacobsen, 2010). Through this method we can recover the true structure of the economy and macro-economy behaviours of time series from the national account data. SVAR has become one of the main tools for testing and evaluating the effectiveness of economic policies over time. It is, therefore, well accepted by many as one of the means to empirically test theoretical models with real data. Finally, it is argued that SVAR avoids incredible restrictions in single equations and strict restrictions in DSGE models. In all, this method helps to test formal theories and helps to learn more about the dynamics of the macroeconomics over time.

#### 2.3.1 S(VARs) Descriptions

SVAR is defined as a system of  $k$ -equations and  $k$ -variables of stationary linear relation, where current variables are explained by contemporaneous terms, their own lags and the lags of  $k - 1$  remaining variables (Stock and Watson, 2001). A general formal SVAR appears in the following format:

$$AY_t = D\delta_t + \Psi W_t + A_1^* Y_{t-1} + A_2^* Y_{t-2} + \dots + A_p^* Y_{t-p} + B e_t \quad (2.1)^{81}$$

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<sup>80</sup> Christopher Sims won the Nobel Prize in Economics (2011) for his works on VAR and for its usefulness in diagnosis of dynamic economic behaviours through impulse response functions and variance decomposition. Most questions about dynamic behaviour, interactions and the effects of monetary policy shock on variables such as GDP and inflation are answered through SVAR analysis.

<sup>81</sup> See Appendix B.2.4 for more detail on SVAR representation.

The matrix  $A$  with  $k \times k$  dimensions is called an invertible matrix of contemporaneous coefficient relations on  $Y_t$ ; and  $Y_t$  is column vector  $k \times 1$  of endogenous variables. Generally, contains non-policy macroeconomic variables and policy variables assumed under of policy makers. In addition,  $A_t^*$  (for  $i=1, 2 \dots p$ ) are matrices of structural coefficients on the lagged variables in the model. The entries in these matrices represent the dynamic properties of the system while the interaction of variables is represented by cross-variables coefficients.  $\delta_t$  is  $k \times 1$  vector that contains all deterministic terms e.g. a linear trend, seasonal and other user specified dummies to capture the structural breaks, and intercept. While  $W_t$  is a vector of exogenous variables.  $e_t$  is a  $k \times 1$  vector of structural shocks normally distributed with mean zero and its variance-covariance matrix  $\Omega = I$ . The matrix  $B$  is  $k \times k$  –dimensional matrix that specifies which variables are to what extend directly affected by structural shocks. This matrix  $B$  is usually set as a diagonal matrix.

One immediate problem with the SVAR method is that it cannot be estimated as it is in (2.1) using the Ordinary Least Squares (OLS) method. This is because the main standard assumptions about the system in  $y_t$  are that the variables in  $y_t$  are stationary, and the variance-covariance  $cov(y_{it}, \varepsilon_{it}) \neq 0$  are violated in the basic VAR and SVAR models. SVAR in its primitive system violates the OLS assumption of no relation between structural shocks  $e_t$  and independent variables in matrix  $A$ . Thus, using OLS to estimate the matrix  $A$  will produce inconsistent parameter estimates and incorrect impulse response functions. Circumventing this problem requires that we exclude some contemporaneous effects by restricting them to zeros; in this way the system will fulfil the assumption of no correlation and become identified. Explicitly, in order to overcome this problem, econometricians have devised procedures to recover the true structural parameters for the underlying structural VAR model from the standard reduced form VAR model – (see Enders, 2010, pp. 325-338).

A short run SVAR without  $\delta_t$  and  $\Psi_t$  then can be written as follows:

$$A \left( 1 - A_1(L) - A_2(L^2) - \dots - A_p(L^p) \right) Y_t = Au_t = Be_t \quad (2.2)$$

And its standard form reduced form is given as follows:

$$Y_t = A_1^* Y_{t-1} + A_2^* Y_{t-2} + \dots + A_p^* Y_{t-p} + A^{-1} B e_t \quad (2.3)$$

$$Y_t = A_{t-1}^* Y_{t-1} + \dots + A_p^* Y_{t-p} + u_t \quad (2.4)$$

Whereby  $A_{t-i}^* = A_0^{-1}A_{t-i}$

Enders (2010) points out that the departure point to analyse SVAR is to estimate the compact reduced form model, which mimics the predictable movements of variables within the system<sup>82</sup> (see Robinson & Robinson, (1997). From the reduced form VAR we obtain the residuals  $u_t$ . Using equation (2.3), we do linear mapping of residuals  $u_t$  into the  $A^{-1}Be_t$ , hence this can be used to identify the structural shocks by imposing identification restrictions on matrices  $A$  and/or  $B$ . Procedurally, we want to express the non-orthogonal  $u_t$  from the VAR(p) reduced form model as a linear combination of orthogonal structural shocks ( $e_t$ ) in order to obtain the innovation model:

$$u_t = A^{-1}Be_t \text{ or simply } Au_t = Be_t. \quad (2.5)$$

Equation (2.5) gives the general class of innovation model defined as above in (2.1). The structural shocks are identified by placing identifying restrictions on the contemporaneous matrix  $A$  and the matrix  $B$ .  $u_t$  denotes VAR residual vector of dimension  $k \times 1$ , normally independently distributed with full variance-covariance matrix  $\Sigma_u$ . It is commonly acknowledged that the reduced form in (2.4) does not tell us anything about the structure of the economy. Thus, it is necessary to show the mapping of the structural representation in (2.1) into the residuals from the reduced form equation. Equations (2.4) and (2.5) show how the non-orthogonal observable residuals are related to the unobservable structural innovations – that is, expressed as a linear combination of structural shocks. Further, the relation between the variance-covariance matrices of  $u_t$  and  $e_t$  is derived as follows:

$$E(u_t u_t') = A^{-1}BE(e_t e_t')BA^{-1} = \Sigma_u \quad (2.6).$$

A crucial factor in working with SVAR is that without imposing some identifying restrictions, the system of equations remains unidentifiable – there are no unique solutions for the coefficients in the system.<sup>83</sup> Pfaff (2008) shows that there are three common short run identifications of SVAR models, which are all distinguished by the types of restrictions placed on them. **SVAR A-model**: sets matrix  $B$  to  $I_{k \times k}$ . The minimum restriction that must be imposed for exact identification is  $\frac{k(k-1)}{2}$ . **SVAR B-Model**: sets matrix  $A$  to  $I_{k \times k}$  and the minimum restriction that must be imposed for exact identification is the same as in SVAR model A type. **SVAR AB-model**: places the restrictions on both  $A$  and  $B$  matrices.

<sup>82</sup> See also Robinson & Robinson (1997).

<sup>83</sup> This means that given the values of  $\delta_t$ ,  $A_p$ , and  $\Sigma_u$  in the reduced form (2.5) it is not possible to uniquely solve structural parameters of the SVAR in (2.3) without placing some identifying restrictions on matrix  $A_0$ .

The number of restrictions for exact identification on this model is given by  $k^2 + k(k - 1)/2$ . In this study we applied the SVAR A-model and AB-model procedures for structural VAR to extract these structural parameters. The meaning of these sets of identifications in a form of zero restrictions is discussed explicitly in Section 2.4 where we set out the structural economic representation of the model.

### 2.3.1 SVAR: Impulse Response Functions and Forecast Error Variance Decomposition

We mentioned in Section 2.3 that the aim of SVAR is to test formally the theories that form a general structure of the vector auto-regression, and to learn about the historical dynamic behaviours of the economy. However, Enders (2010) pointed out that individual coefficients from VARs or SVARs are of little use in themselves. Hence, we considered two main important outputs of SVAR: the structural impulse response functions (SIRF) and the structural forecast error variance decompositions (SFEVD). Many macro-econometricians agree that these two outputs give a better picture in a palatable manner. The former helps us to show the dynamic response of current and future values of each variable to a one unit change in the current value of one structural shock while assuming that other shocks are equal to zero. The second is the forecast error variance decomposition that provides the relative importance of each structural shock in influencing endogenous variables in the SVAR. Using the VAR in (2.3) the impulse response functions are derived as follows:

Let us take  $L$  as the lag operator, and  $A(L) = \sum_{i=1}^p A_i L^i$ ; then (2.3) can be transformed into a structural vector moving average (SMA) as follows:

$$[A_0 - A(L)]Y_t = B e_t \quad (2.7)$$

$$\Rightarrow Y_t = [A_0 - A(L)]^{-1} B e_t ; \text{ Let } D = [A_0 - A(L)]^{-1}$$

$$Y_t = D_0 e_t + D_1 e_{t-1} + \dots + D_s e_{t-s} \quad (2.8)$$

$$Y_t = \sum_{s=0}^{\infty} D_s e_{t-s} \quad (2.9)$$

The SMA  $Y_t$  is based on an infinite moving average of the structural innovation  $e_t$  in (2.9). The  $(i,j)$ -th element in matrices  $D_s$  stands for the dynamic multipliers - the expected partial impacts of a random change in  $j$ -th variable in the system at time  $t$ , on the  $i$ -th variable within the system at time  $t+s$ . In simple terms the matrices  $D_s$  constitute marginal effects of the innovations in the system on  $y_{t+s}$ . This is expressed as follows:

$$D_s = \frac{\partial Y_{t+s}}{\partial e_t} \quad (2.10)$$

It is very important to emphasize here that as  $s$  increases we will observe the dynamic path of variable  $i$ -th in response to innovation in variable  $j$ . Hence, the structural impulse responses are the plots of  $d_{ij}^{(s)} \in D_s$  vs. for  $i,j=1,2$ . Generally, these expected partial impacts are only meaningful when all other shocks at time  $s$  are set equal to zero (Favero, 2001). This is naturally true in terms of interactions between foreign variables and domestic variables of a small country; however, it is false for the interaction between domestic variables. To overcome this problem, we place restrictions on some of the variables in the system so that the interactions we allow for are justified by economic theory.

Another output that is of interest from the SVAR for our analysis is called the variance of decomposition. This analysis explains the variation in all variables within the system. Under this analysis, we want to find out what portion of the total variance of  $y_t$  is attributed to the random shock in the  $j$ -th shock. This analysis helps us to assess the relative importance (strength) of each variable in the system. Thus, this result will give us the quantitative picture about the relative strengths of interest-rate and credit channels.

## 2.4. Namibian Economic Structure, Economic Model and Identifications

The structural representation model we would like to build in this study aims to reflect how the central bank views the dynamics of the transmission mechanism of monetary policy in Namibia. Many central banks nowadays emphasise a forward looking monetary policy, i.e. altering the economic lever appropriately in order to keep inflation close to the target in the future. This economic lever differs from country to country depending on the monetary and fiscal arrangements in place. For instance, some central banks explicitly target exchange rates, credit growth and international reserves or any combination of these indicators.

First, the overall aim here is to examine the dynamic interactions of endogenous variables in the short run SVAR. Specifically, the objectives are to explain economic theory behind the identification restrictions in the structural VAR in equation (2.12). This non-recursive SVAR will be used to produce the structural impulse response functions of real GDP, the inflation rate, and credit growth to a surprise contraction monetary shock in the repo rate. Money in this model enters as bank money in the form of private sector credit which is endogenously created. Thus, we concentrate on monetary policy actions of changing the controllable interest rate as the policy instrument to stabilize monetary condition.<sup>84</sup> Second, analysis focused on the structural impulse response functions from the short run demand and credit structural shocks. We use this to compare the relative strength of credit shock to domestic monetary policy shock. Monetary policy operates directly or indirectly through other domestic long term interest rates to influence aggregate demand components, particularly consumption and investment. Monetary policy also operates through the balance sheet channel thereby affecting financial fundamentals of firms. The role of spreads as conduit of monetary policy effects is discussed in the next two chapters. Finally, we examined the long run effects of monetary policy shock on output and inflation. The long run results are given by cumulative impulse response functions (cirf). This result is used to shed light about the effectiveness of the policy of changing the repo rate on reducing inflation in the long run.

Most empirical works that analyse the monetary transmission mechanism in the last two decades are based on the New Consensus macroeconomic view which emphasises three crucial aggregate economic relationships.<sup>85</sup> These relationships are examined either

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<sup>84</sup> Evidently, we hold the view that monetary policy operates through changes in the short term interest rate thus, influencing commercial banks to adjust portfolios. We do not emphasize the money supply because this is replaced by the rule in setting interest rate (Cameron & Safaei, 2003; Duguay, 1994).

<sup>85</sup> See (Arestis and Sawyer, 2008; Carlin and Soskice, 2006; and Sinclair, 2002).

as structural models as is the case in Al Raisi et al., (2007), Westerways (2002), Kapur and Patra (2002), Liu and Zhang (2010) or as a system of equations in the form of structural VAR as is the case in Afandi (2005); Brischetto and Voss (1999); Kim and Roubini (1999); and Suzuki (2008). In some studies, for the sake of economic representation, economists add other relevant macroeconomic variables such as foreign reserves, domestic private sector credit, and foreign variables to capture the shocks from the rest of the world.

Experience has shown that no single model can capture the full effects of the shocks on the whole economy. Therefore, the SVAR model should be deemed as truly representative of the economic structure in question. It is important to ensure that the model includes all relevant variables that determine optimal equilibrium in the economy. For example, at a country level the structural economic model should at least include output and price level indicators for the demand and supply sides, and the exchange rate or foreign interest rate equations for the foreign sector to take into account the effects of external shocks. Other important indicators to enter the system of equation are such oil price index or world commodity price index. For our study the SVAR model we have three blocks the foreign sector, non-policy and policy blocks. In the foreign or external we have commodity price index and foreign interest rate which influences each other contemporaneously but deemed exogenous to the domestic variables. The non-policy variables block we placed quarterly real GDP, consumer price index and private sector credit, and in the last block there is the repo rate that responds to all information up to period  $t$  but only affect some non-policy variables from period  $t + 1$ . For our study the SVAR model we have in mind is consist of the following variables:

$$\begin{bmatrix} 1 & a_{0,12} & a_{0,13} & a_{0,14} & a_{0,15} & a_{0,16} \\ a_{0,21} & 1 & a_{0,23} & a_{0,24} & a_{0,25} & a_{0,26} \\ a_{0,31} & a_{0,32} & 1 & a_{0,34} & a_{0,35} & a_{0,36} \\ a_{0,41} & a_{0,42} & a_{43} & 1 & a_{0,45} & a_{0,46} \\ a_{0,51} & a_{0,52} & a_{0,53} & a_{0,54} & 1 & a_{0,56} \\ a_{0,61} & a_{0,62} & a_{0,63} & a_{0,64} & a_{0,65} & 1 \end{bmatrix} \begin{bmatrix} \Delta cmi_t \\ \Delta rs_t \\ \Delta gdp_t \\ inf_t \\ \Delta pcr_t \\ \Delta rn_t \end{bmatrix} = [const] + \begin{bmatrix} a_{1,11} & a_{1,12} & a_{1,13} & a_{1,14} & a_{1,15} & a_{1,16} \\ a_{1,21} & a_{1,22} & a_{1,23} & a_{1,24} & a_{1,25} & a_{1,26} \\ a_{1,31} & a_{1,32} & a_{1,33} & a_{1,34} & a_{1,35} & a_{1,36} \\ a_{1,41} & a_{1,42} & a_{1,43} & a_{1,44} & a_{1,45} & a_{1,46} \\ a_{1,51} & a_{1,52} & a_{1,53} & a_{1,54} & a_{1,55} & a_{1,56} \\ a_{1,61} & a_{1,62} & a_{1,63} & a_{1,64} & a_{1,65} & a_{1,66} \end{bmatrix} \begin{bmatrix} \Delta cmi_{t-1} \\ \Delta rs_{t-1} \\ \Delta gdp_{t-1} \\ inf_{t-1} \\ \Delta pcr_{t-1} \\ \Delta rn_{t-1} \end{bmatrix} + \dots + \\
 \begin{bmatrix} a_{3,11} & a_{3,12} & a_{3,13} & a_{3,14} & a_{3,15} & a_{3,16} \\ a_{3,21} & a_{3,22} & a_{3,23} & a_{3,24} & a_{3,25} & a_{3,26} \\ a_{3,31} & a_{3,32} & a_{3,33} & a_{3,34} & a_{3,35} & a_{3,36} \\ a_{3,41} & a_{3,42} & a_{3,43} & a_{3,44} & a_{3,45} & a_{3,46} \\ a_{3,51} & a_{3,52} & a_{3,53} & a_{3,54} & a_{3,55} & a_{3,56} \\ a_{3,61} & a_{3,62} & a_{3,63} & a_{3,64} & a_{3,65} & a_{3,66} \end{bmatrix} \begin{bmatrix} \Delta cmi_{t-3} \\ \Delta rs_{t-3} \\ \Delta gdp_{t-3} \\ inf_{t-3} \\ \Delta pcr_{t-3} \\ \Delta rn_{t-3} \end{bmatrix} + [d_{11} \quad d_{12}] \begin{bmatrix} D98_t \\ D0708_t \end{bmatrix} + \mathbf{B} \begin{bmatrix} e_t^{cmi} \\ e_t^{rs} \\ e_t^{gdp} \\ e_t^{inf} \\ e_t^{pcr} \\ e_t^{rn} \end{bmatrix} \quad (2.11)$$

$e_t \approx iid(0, \Sigma_k)$ ,  $A_{i=1...3}$  are coefficient matrixes of lagged variables while  $A$  is a contemporaneous coefficient matrix and  $B$  is variance-covariance matrix.<sup>86</sup>

$\Delta cmi_t$ ,  $\Delta gdp_t$ ,  $\Delta rs_t$ ,  $infl_t$ ,  $\Delta pc_t$  and  $\Delta rn_t$  are the growth rates of South Africa's Commodity Price Index, SA's repo rate, Namibia's quarterly real GDP, private sector credit and domestic repo rate.<sup>87</sup>  $Infl_t$  is the rate of inflation derived from the logarithm of Namibia Consumer Price Index (NCPI).  $\Delta rs_t$  and  $\Delta rn_t$  are respectively changes in South Africa's and Namibia's monetary policy rates (commonly known as Repo rates). All time series, except the short term interest rates, are quarterly series seasonally-adjusted; while  $e_t^{cmi}$ ,  $e_t^{rs}$ ,  $e_t^{gdp}$ ,  $e_t^{inf}$ ,  $e_t^{pcr}$  and  $e_t^{rn}$  are serial uncorrelated stochastic structural shocks with the mean zero and variance-covariance equal to  $\Sigma$ . For example,  $e_t^{CMI}$  is commodity price shock,  $e_t^{rs}$  foreign policy rate shock,  $e_t^{gdp}$  is an aggregate demand shock,  $e_t^{Inf}$  cost push shock,  $e_t^{pcr}$  credit shock and  $e_t^{rn}$  is the domestic monetary policy shock.

The vector  $\delta_t$  contains all deterministic terms. Specifically, we employed three dummies to capture important structural breaks: the first, for the period 1998Q1-1999Q4 represents the East Asian financial crisis; the second, for the period 2009Q1-2010Q4 represents the Global financial crisis, and the third, for the period 2003Q1-2004Q1 a spill over effects from the recession in the US. Our sample period extends from 1991:Q1 to 2012:Q3 a total of 87 quarterly observations.<sup>88</sup>

#### 2.4.1 Description of the Structural Economic Representation

We briefly provide the economic theory support for this structural system representation as the economic model adequately to evaluate the monetary policy effects in Namibia. The first row captures the influence of mineral commodities in the domestic economy. We used South Africa (SA) commodity price index  $cmi_t$  in the model to capture the effects from external shocks on the Namibian economy which are generated by outside forces, for example the price of diamond, uranium and copper. These three minerals account for more than 20% of total output of Namibia. In addition, this represents the trade link in term of raw commodities export between Namibia and South African. Thus, the  $\Delta cmi_t$  equation will help to account for shocks that hit quarterly real GDP but are not attributed to innovations in Namibia's monetary policy. In SVAR, the Commodity Price

<sup>86</sup> Equation (2.11) in compact form is given by:  $AY_t = \delta_t + \sum_{i=1}^p A_i Y_{t-p} + B e_t$  with p-lags set equal to three.

<sup>87</sup> Since these variables after first differences in logs they can be interpreted as growth rates. Furthermore, we only write out the AB-model for the first estimation, while subsequent models as stated in a vector form. The techniques for imposing restrictions are the same.

<sup>88</sup> The sample starts from 1991:Q1 nine months after Namibia's independence and four months the establishment of The Bank of Namibia in July 1990.

Index is exogenously determined in relation to domestic variables. This means that its variation is determined by its innovations, which reflect sudden changes in commodity demand in South Africa or elsewhere and monetary policy shock in SA.

The second row represents the influence of the changes in foreign interest rate which in this case is represented by South Africa's repurchase rate (repo) as reported at the beginning of the this chapter. Namibia has maintained a fixed exchange rate peg with South Africa since the early 1990s. In theory, this bilateral arrangement makes it imperative that any change in South Africa's repo rate will be followed by a similar action in Namibia. In practice this has not always been the case as will be shown and explained later in this section. We assume that  $\Delta rs_t$  enters the model but it is only affected contemporaneously by  $\Delta cmi_t$  and its own lags.<sup>89</sup>

The third row represents the aggregate demand function which is the standard IS curve. Current output reacts to changes in South Africa's monetary policy and commodity prices; it depends further on its own lags and that of other variables. Interest rate lags in this equation indicate the direct effects of short term interest rate on aggregate demand which represents the so-called interest rate channel. It also captures the persistence of 'long and variable lags' associated with the monetary policy rate (Blinder, 1998). The New Keynesian economic theory suggests that there is an inverse relationship between aggregate demand and real interest rate. In addition, we include the commodity price index to capture the relative importance of commodity influencing the real economic activity in Namibia. This is expected to have a positive impact on real GDP. For example, a surge in the unit price of diamond or uranium gives mining companies incentives to reduce their inventories, and it therefore raises the volume of sales. Namibia is a mineral exporting country. This feature makes her subject to large swings in the prices of diamonds and uranium. The lags of real GDP in this equation represent the adjustment process as the economy moves towards equilibrium, while the lags of private credit show the adjustment from commercial banks that react only after monetary policy decisions. Practically, commercial banks do not immediately adjust their prime lending rates to reflect changes in official rates. The decision to adjust prime lending rates comes after banks have re-adjusted their portfolios; hence whatever happens to the current rates is only relevant to the GDP in the next period.

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<sup>89</sup> Furthermore,  $CMI_t$  and  $RSA_t$  are included to help the so called price puzzle observed in several studies on the topic (Favero, 2001; Westerway, 2002).

The equation in the fourth row represents the supply side of the economy. Inflation is determined by current output deviation and commodity inflation. The lags for inflation in this equation represent persistence and stickiness of domestic prices. Although current monetary policy emphasises the forward looking rule in setting monetary policy, in this model we have not included any expectation variable. This is based on the fact that the Bank of Namibia does not produce any inflation forecast, nor does it conduct surveys to generate inflation expectation variable. Thus, because of this gap, we assume that the best public guess for the next period of inflation is the last period of inflation. This is reflected by some form of backward looking inflationary process as captured by the lags.

The equation in the fifth row represents the total credit extended to the private sector. Domestic private sector credit is assumed to respond to contemporaneous changes in the repo rate in SA and monetary policy rate in Namibia. Theoretically the relation between prime lending rate and bank rate is directly proportional especially when financial sector is assumed efficient. In addition, we assumed that private credit responds to monetary policy in SA because three out of six commercial banks in Namibia are subsidiaries from SA. Thus, by this link, these commercial banks change the market rates even when the move in repo only happens in SA because their parent companies exert influence on their branches in Namibia. We further assume that private credit is also positively affected by current economic activity.

From the Post Keynesian perspective, the private credit equation illustrates the abilities of banks to create money which is driven by aggregate demand from creditworthy clients at prevailing costs of credit that is, market interest rates. This means that the credit variable represents our assumption of bank money in the system which is determined by demand in the economy.<sup>90</sup> This variable also serves as a broad measure for the credit channel through its responses to monetary policy shocks. Depending on whether the shocks are generated by aggregate demand or monetary policy, commercial banks will naturally accommodate these shocks by setting their terms of credit.<sup>91</sup>

The sixth row represents the central bank reaction function. We assume that the Bank of Namibia's monetary policy reacts to contemporaneous conditions in inflation, credit growth and to changes in South Africa's monetary policy stance. According to the current working document for the monetary policy framework, "the main policy tool that

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<sup>90</sup> Post Keynesians argue that it is credit that matters for the level of economic activity, see (French-Davis, Nayar, Ocampo, Spiegel, & Stiglitz, 2006).

<sup>91</sup> Commercial banks are quantity takers and price setters for spreads in the financial system.

the Bank of Namibia uses to influence monetary conditions in the country is the Repo rate, which is kept close to the South African Reserve Bank's repo rate. The Repo rate is the interest rate at which commercial banks borrow money from the Bank of Namibia, and this, in turn, affects other interest rates in the economy. Changes to the Repo rate usually take into account not only the SARB's decision about its repo rate, but also domestic economic conditions, international economic conditions, and future prospects'' (Bank of Namibia, 2008, p. 8).

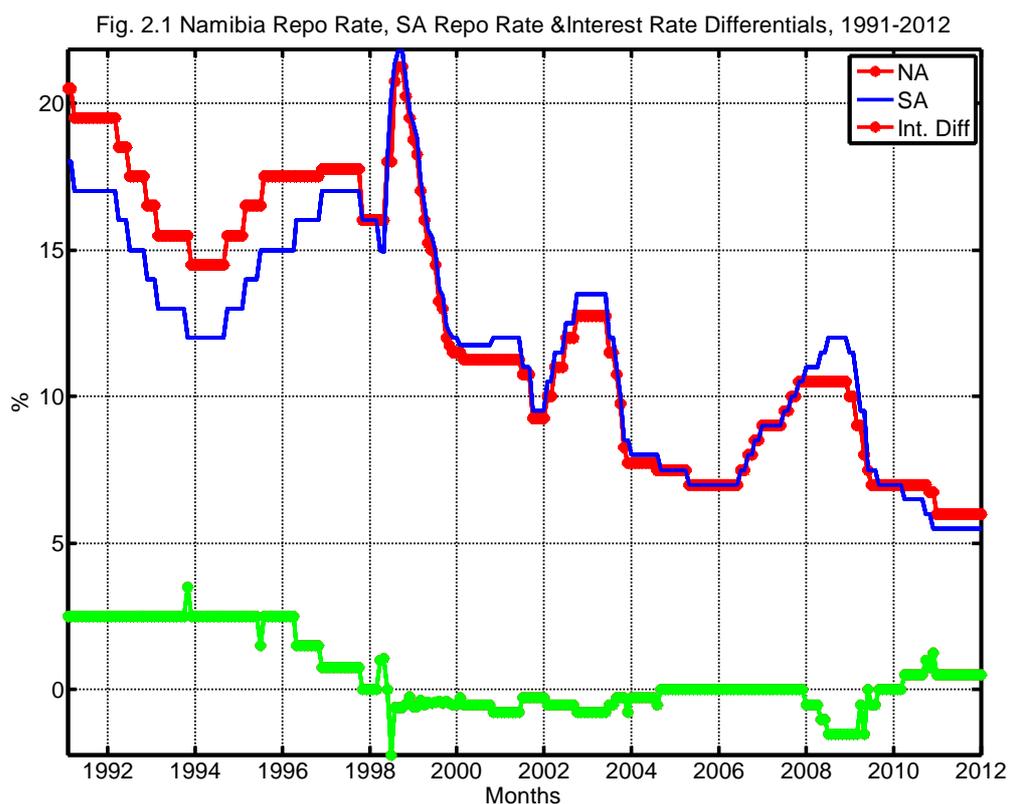
Thus, in this SVAR, monetary policy shocks are identified as the changes in the repo rate. Furthermore, we assume that BoN reacts to credit conditions in the domestic economy to improve domestic demand and promote economic growth.<sup>92</sup> In the fashion of a Taylor rule, central bank reacts to inflation rise from output and inflation gaps.<sup>93</sup> We note here that there are arguments against the claim of assuming a Taylor rule in fixed exchange rate regimes like Namibia (Al Raise et al., 2001). The general belief is that fixed exchange rate regimes do not have monetary policy independence and as a result they respond to and/or follow interest rate in the anchor country. However on many occasions BoN has chosen not to respond when the South African Reserve Bank changes its monetary policy stance. These occasional non-responses by the BoN are contrary to the doctrine of fixed peg in exchange rate theory. Many proponents argue that when a country fixes its currency to another country, it entirely loses 'monetary independence'. In practise, this is not entirely true as shown by the economic arrangement between Namibia and South Africa. This is because monetary independence is not only a function of the exchange rate, but also depends on other forms of capital arrangements that exist between the two countries. These may include capital control in the form of ownership of foreign investments in the domestic economy, and the degree of substitutability of financial assets between the two economies. When these arrangements are in place they can give some comparative advantages that allow fixed peg regimes to deviate from the level of interest rate in the anchor country. For example, in Namibia where capital controls exist between Namibia and South Africa, the BoN has on several occasions deviated from the repo rate in South Africa. The evidence is given by the interest rate differential graph below in Figure 2.1. In this figure we see that since 1998 to 2005 and 2007 to 2009, BoN has been able to

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<sup>92</sup> This is based on our analysis of various monetary policy statements issued by the Bank of Namibia for the last ten years. Records show that there is always a section dedicated to the development of credit extended to the private sector.

<sup>93</sup> Gottschalk (2005, p. 137) reveals that Taylor rule is important because 'it is consistent with optimal policy in Keynesian models', and it helps central bank 'to shape the expectations thereby making monetary policy effective.'

maintain the repo rate below SA's policy rate. The deviations of Namibia's repo from SA's repo, as shown by the graph indicate some form of freedom for BoN to pursue independent monetary policy, albeit perhaps for sometimes. Hence, in our view the question is not whether a fixed peg regime can deviate -because it can; but, it is about how far it can deviate, and for how long it can deviate from the level of interest rate prevailing in the anchor country.



#### 2.4.2 Identification Conditions: Short Run SVARs

How many variables should the SVAR model contain before it can be deemed as representative of the economy in question? Naturally, it depends on the purpose and question it meant to answer. However, some constraints such as data unavailability on important variables and the sample size will obviously affect the size of the SVAR model to be estimated. There have been many papers on the same topic, which applied SVAR and serve as the basis and yardstick in this area.<sup>94</sup> Some economists consider a system with seven variables large enough for economic analysis; however, with advances such as the Bayesian VAR (BVAR) method the issue of how large the system should be has become a minor issue. Our structural models estimated in this chapter are limited to six variables or

<sup>94</sup> See (Bernanke & Mihove, 1995; Brischetto & Voss, 1999; Kim & Roubini, 2000), and Sims (1991).

fewer because of limited observations available on most important macroeconomics variables in Namibia.

In identifying the SVARs, there are common ways to impose restrictions and estimate the SVAR model. On condition that the A and B are non-singular matrices, the identifying restrictions are placed on A, B or on both AB matrices. In our study, we use the AB-model while the A-model identification is set up and used as one of the robustness checks. This model imposes enough restrictions both on  $A_0$  and B matrices in (2.11). The matrix B is a diagonal structure, while the  $A_0$  companion matrix has a recursive or non-recursive structure as the identification is set up. After imposing the restrictions we write out the full structure of the identified structural VAR as follows: use the equation (2.5), which relates the structural shocks to residuals.

$$\begin{bmatrix} 1 & a_{0,12} & 0 & 0 & 0 & 0 \\ a_{0,21} & 1 & 0 & 0 & 0 & 0 \\ a_{0,31} & a_{0,32} & 1 & 0 & 0 & 0 \\ a_{0,41} & 0 & a_{0,43} & 1 & 0 & 0 \\ 0 & a_{0,52} & a_{0,53} & 0 & 1 & a_{0,56} \\ 0 & a_{0,62} & a_{0,63} & a_{0,64} & a_{0,65} & 1 \end{bmatrix} \begin{bmatrix} \Delta cmi_t \\ \Delta rs_t \\ \Delta gdp_t \\ inf_t \\ \Delta pcr_t \\ \Delta rn_t \end{bmatrix} = [const] + \begin{bmatrix} a_{1,11} & a_{1,12} & a_{1,13} & a_{1,14} & a_{1,15} & a_{1,16} \\ a_{1,21} & a_{1,22} & a_{1,23} & a_{1,24} & a_{1,25} & a_{1,26} \\ a_{1,31} & a_{1,32} & a_{1,33} & a_{1,34} & a_{1,35} & a_{1,36} \\ a_{1,41} & a_{1,42} & a_{1,43} & a_{1,44} & a_{1,45} & a_{1,46} \\ a_{1,51} & a_{1,52} & a_{1,53} & a_{1,54} & a_{1,55} & a_{1,56} \\ a_{1,61} & a_{1,62} & a_{1,63} & a_{1,64} & a_{1,65} & a_{1,66} \end{bmatrix} \begin{bmatrix} \Delta cmi_{t-1} \\ \Delta rs_{t-1} \\ \Delta gdp_{t-1} \\ inf_{t-1} \\ \Delta pcr_{t-1} \\ \Delta rn_{t-1} \end{bmatrix} + \dots + \\
 \begin{bmatrix} a_{3,11} & a_{3,12} & a_{3,13} & a_{3,14} & a_{3,15} & a_{3,16} \\ a_{3,21} & a_{3,22} & a_{3,23} & a_{3,24} & a_{3,25} & a_{3,26} \\ a_{3,31} & a_{3,32} & a_{3,33} & a_{3,34} & a_{3,35} & a_{3,36} \\ a_{3,41} & a_{3,42} & a_{3,43} & a_{3,44} & a_{3,45} & a_{3,46} \\ a_{3,51} & a_{3,52} & a_{3,53} & a_{3,54} & a_{3,55} & a_{3,56} \\ a_{3,61} & a_{3,62} & a_{3,63} & a_{3,64} & a_{3,65} & a_{3,66} \end{bmatrix} \begin{bmatrix} \Delta cmi_{t-3} \\ \Delta rs_{t-3} \\ \Delta gdp_{t-3} \\ inf_{t-3} \\ \Delta pcr_{t-3} \\ \Delta rn_{t-3} \end{bmatrix} + [d_{11} \quad d_{12}] \begin{bmatrix} D98_t \\ D0708_t \end{bmatrix} + B \begin{bmatrix} e_t^{cmi} \\ e_t^{rs} \\ e_t^{gdp} \\ e_t^{inf} \\ e_t^{pcr} \\ e_t^{rn} \end{bmatrix} \quad (2.12)$$

In this non-recursive SVAR or the so called ‘AB-model’, for a system to be exactly identified, it only needs  $2k^2 - k(k+1)/2$  exclusion restrictions on both  $A_0$  and B matrices. Since  $k = 6$  and B is a diagonal matrix, then it means the B-matrix requires  $k^2 - k$  or 30 exclusion restrictions and the remaining 21 restrictions are imposed on the  $A_0$  matrix. Next, as  $u_t$  are linearly related to structural shocks, the task is to impose enough restrictions so that they will enable us to separate the systematic component from structural shocks, which are unobservable from the structural shocks. Commodity price inflation and foreign interest rate block represents the external sector influence on the domestic economy with representing foreign monetary policy shock. The third, fourth and fifth rows represent non-policy variables block which aimed to capture the demand and credit shocks; and the sixth row captures the policy reaction function.

$$\begin{bmatrix} 1 & a_{12} & 0 & 0 & 0 & 0 \\ a_{21} & 1 & 0 & 0 & 0 & 0 \\ a_{31} & a_{32} & 1 & 0 & 0 & 0 \\ a_{41} & 0 & a_{43} & 1 & 0 & 0 \\ 0 & a_{52} & a_{53} & 0 & 1 & a_{56} \\ 0 & a_{62} & a_{63} & a_{64} & a_{65} & 1 \end{bmatrix} \begin{bmatrix} u_t^{cmi} \\ u_t^{rs} \\ u_t^{gdp} \\ u_t^{lnf} \\ u_t^{pcr} \\ u_t^{rn} \end{bmatrix} = \begin{bmatrix} b_{11} & 0 & 0 & 0 & 0 & 0 \\ 0 & b_{22} & 0 & 0 & 0 & 0 \\ 0 & 0 & b_{33} & 0 & 0 & 0 \\ 0 & 0 & 0 & b_{44} & 0 & 0 \\ 0 & 0 & 0 & 0 & b_{55} & 0 \\ 0 & 0 & 0 & 0 & 0 & b_{66} \end{bmatrix} \begin{bmatrix} e^{cmi} \\ e^{rs} \\ e^{gdp} \\ e^{lnf} \\ e^{pc} \\ e^{rn} \end{bmatrix} \quad (2.13).$$

This SVAR model is over identified because the numbers of exclusion restrictions exceed the 21 exclusion restrictions required for exact identification in  $A_0$ . The validity of these over-identifying restrictions will be tested using the log-likelihood test. This log-likelihood test indicates whether the over identification restrictions are supported by the data. In addition, it is required that  $A_0$  and B matrices are square and non-singular matrices. This implies that both  $A_0$  and B must first satisfy these conditions so that we are able to estimate the coefficients in  $A_0$  and B.

Our second, identification is the recursive identification. In the recursive identification we use a recursive order of the variables in the VAR system. This is whereby we restrict matrix  $A_0$  to a lower triangular matrix with zero above the diagonal line. Generally, the emphasis is the order in which variables enter the system with low frequency placed above the high frequency variable. Recursive identification requires that enough restrictions are place on A for exact identification.

$$\begin{bmatrix} 1 & 0 & 0 & 0 & 0 & 0 \\ a_{21} & 1 & 0 & 0 & 0 & 0 \\ a_{31} & a_{32} & 1 & 0 & 0 & 0 \\ a_{41} & a_{42} & a_{43} & 1 & 0 & 0 \\ a_{51} & a_{52} & a_{53} & a_{54} & 1 & 0 \\ a_{61} & a_{62} & a_{63} & a_{64} & a_{65} & 1 \end{bmatrix} \begin{bmatrix} u_t^{cmi} \\ u_t^{rs} \\ u_t^{gdp} \\ u_t^{lnf} \\ u_t^{pc} \\ u_t^{rn} \end{bmatrix} = \begin{bmatrix} 1 & 0 & 0 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 & 0 & 0 \\ 0 & 0 & 1 & 0 & 0 & 0 \\ 0 & 0 & 0 & 1 & 0 & 0 \\ 0 & 0 & 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} e^{cmi} \\ e^{rs} \\ e^{gdp} \\ e^{lnf} \\ e^{pc} \\ e^{rn} \end{bmatrix} \quad (2.14)$$

Finally, this section concludes estimation of short run SVAR with structural representation of three domestic variables –(see the equations (B.1) and (B.2) in the appendix B). This analysis aims to examine whether there is any significant difference in the impulse response functions obtained from the system with foreign variables. The results from the three-variable model and recursive identification will form part of the robustness checks. It helps to form a robustness check for our results in this estimation.

#### 2.4.2 Identification Conditions: Long Run SVARs

We evaluate the long run effects of monetary policy shock, demand and supply shocks on output. Many economists in the new consensus macroeconomics generally agree

that economic theory tells much more about the long run than the short run effects. For example, the new Keynesian monetary theory argues that monetary policy effects have significant effects on economic activity in the short run; however, in the long run monetary policy effects only matter for the consumers' price inflation.<sup>95</sup> Real output in the long run is largely affected by supply and technology shocks. In the case of demand shocks do not real output in the long run. From the long run SVAR model we derive the cumulative structural impulse response functions (CSIRF) with the identifying restriction given in equation (2.17) below. Our economic model to estimate long run structural impulse responses is given by the following identifications. We limit the system to three variables, excluding foreign variables and private credit for the reason that these factors are not directly considered as long-term objectives for central banks. In addition, this helps to maintain our focus on interaction between the demand and monetary policy shocks only. Consider a reduced form ignoring the deterministic component for the sake of space, we write as follows:

$$Y_t = A(L)Y_t + u_t \quad (2.14)$$

This model can be expressed in a moving average as follows:

$$Y_t = (I - A(L))^{-1}u_t ,$$

$$Y_t = (I - A(L))^{-1}A^{-1}Be_t \quad (2.15)$$

The variance covariance of the structural errors is the identity (i.e.  $VCV=I$ ), so that structural shocks are uncorrelated and have unit variances; and further we defined  $A^{-1} = C$ . The matrix  $C$  represents the cumulative effects from ( $t$  to  $\infty$ ) of a shock hitting in period  $t$ .

$$Y_t = \bar{A}^{-1}Be_t = Ce_t \quad (2.16)^{96}$$

$$Y_t = \begin{bmatrix} 1 & c_{12} & 0 \\ 0 & 1 & 0 \\ 0 & c_{32} & 1 \end{bmatrix} \begin{bmatrix} e_t^{\text{gdp}} \\ e_t^{\text{inf}} \\ e_t^{\text{rn}} \end{bmatrix} \quad (2.17)$$

The main focus in the long run SVAR model is the matrix  $C$  in equation (2.16). This is a sum of infinite orders of vector moving average from Wold decomposition. Using a three based endogenous variables method we assumed that the structural monetary policy

<sup>95</sup> Blanchard and Quah (1989) showed that demand side has no long run effects on real gross national product. See also Enders (Enders, 2010, p. 338).

<sup>96</sup> If  $VCV=I$ , then  $Be_t=e_t$ .

and demand shocks do not have significant long run effects on output, hence effects set to zero. Meanwhile, the supply shock in the third row is assumed to have long run effects on real quarterly GDP. Monetary policy shock is set to have cumulative effects on inflation in the long run.

Having set the SVAR system and adequately identified it, we now proceed to estimate the structural impulse response functions for quarterly real GDP, inflation rate and bank money to unanticipated shock monetary policy shocks, credit and demand shock.

## 2.5 Empirical Results: Data Presentation & Results

This section starts with graphs, summaries and diagnostics test results. In Section 2.5.2 we present the structural impulse response functions (SIRF) from the short and long run SVAR models. We discussed the SIRF to the SA and domestic monetary policy shock, followed by credit and demand shocks. In section 2.5.3 we present the structural forecast error variance decomposition (SFEVD) and the results from robustness checks. Section 2.5.4 presents cumulative impulse response function results from the long run SVAR model. Finally, Section 2.5.4 gives the conclusion, implications, and limitations of the results.

### 2.5.1 Data Presentations

The descriptions of these variables have been given in Section 2.3 under the description of the economic model given in equation (2.12) and the definitions are given in the Appendix. Figure 2-2 below gives the graphical presentation of variables in log level, while Figure 2-3 gives the changes in log, which represent growth rates. All variables are stationary after the first difference as shown in Figure 2-3 and this is confirmed by ADF test results in Table B.2-1 in the Appendix.

This study used two different time series for the quarterly GDP variable. These are labelled as QGDP and RTGDP in Figures 2-3 and 2.4. Figure B.2-6 in appendix shows the log level and changes of the RTGDP series, which represents the quarterly real GDP data reported by NSA in the national accounts publications. The QGDP in Figure 2-3 represents the quarterly real GDP series, which was obtained after transforming the annual GDP data into quarterly data through the Denton method<sup>97</sup>. The growth rate for QGDP was used in the estimation of SVAR and the impulse response functions. We find that the quarterly GDP data reported by NSA (i.e. RTGDP) is highly erratic and it produced nonsensical and inconsistent results in our estimations. Hence, we transformed the annual real GDP at constant price into quarterly real GDP. The weakness of the quarterly RTGDP reported by NSA may be attributed to the fact that Namibia quarterly GDP at constant prices is produced from sub-sample surveys and then benchmarked to the annual data. Thus, it is possible that this benchmarking method might have distorted the real behaviors captured by individual sectors that respond to monetary policy actions.

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<sup>97</sup> See Baum & Hristakeva on the link below on how to transform variables from low frequency to high frequency and vice-versa. <http://econpapers.repec.org/software/bocbocode/s422501.htm>

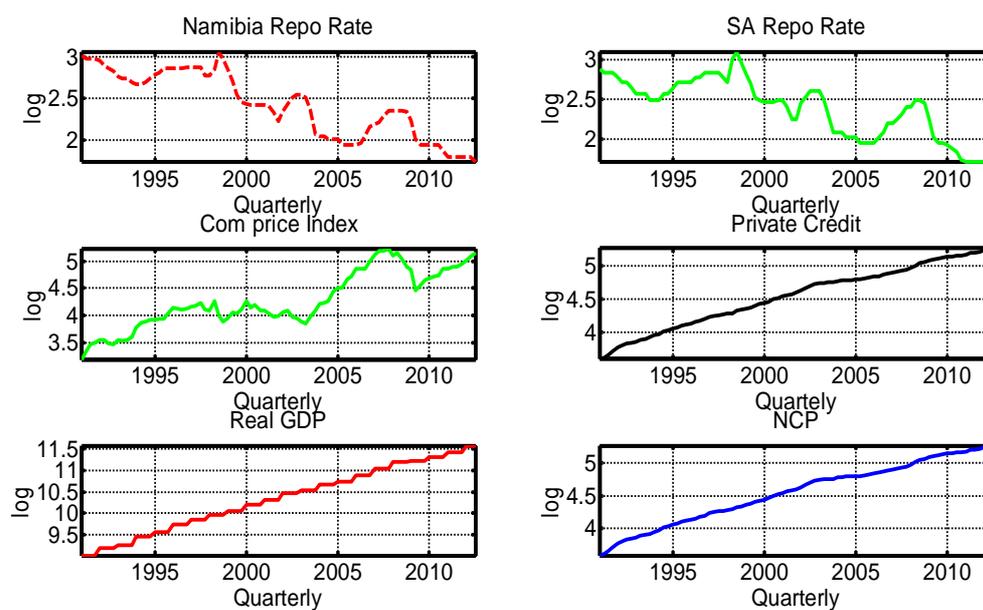
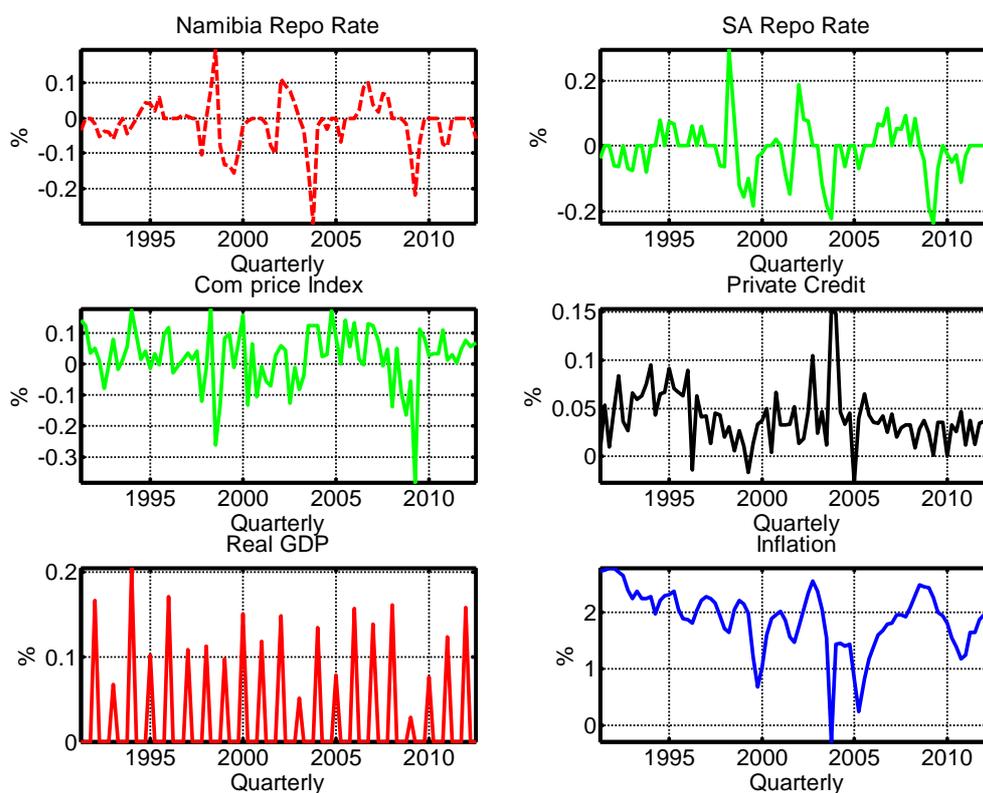
**Figure 2-2** Log level Namibian macroeconomic time series, 1991:Q1-2012:Q3**Figure 2-3** Changes in log Namibian macroeconomic time series, 1991:Q1-2012:Q3

Table B.2-4 shows the pair wise correlation between variables used to estimate the SVAR AB-models. It shows that the pair wise correlations between most macroeconomic variables are statistically significant. These correlations show that there is a significant

positive relation between private sector credit, output and consumer price level; and there is a significant negative relationship between policy rates, output, private credit and consumer price level. Table B.2-1 in the Appendix presents the results from the Augmented Dickey-Fuller tests. The results show that all time series in the SVAR AB-model (2.12) are stationary after the first difference at 5% significance level; that is, we reject the null hypothesis of non-stationary at 5% significance level.

The pre-estimation diagnostic test results are given in Tables B.2-2 and B.2-3 in the Appendix. First, the AIC and FPE statistics indicate the optimal lag length of  $p = 3$ . At this lag length the Lagrange-multiplier test shows that the null hypothesis of no autocorrelation is not rejected. Other models that exclude the foreign variables indicate five lags as an appropriate lag length. Similarly, Figure B.2-6 shows the graph plots eigenvalues from the reduced form VAR. All eigenvalues lie within the unit circle which means the VAR from which this SVAR AB-model is derived satisfies the stability conditions. In all, these statistics show that the system is stationary and stable.

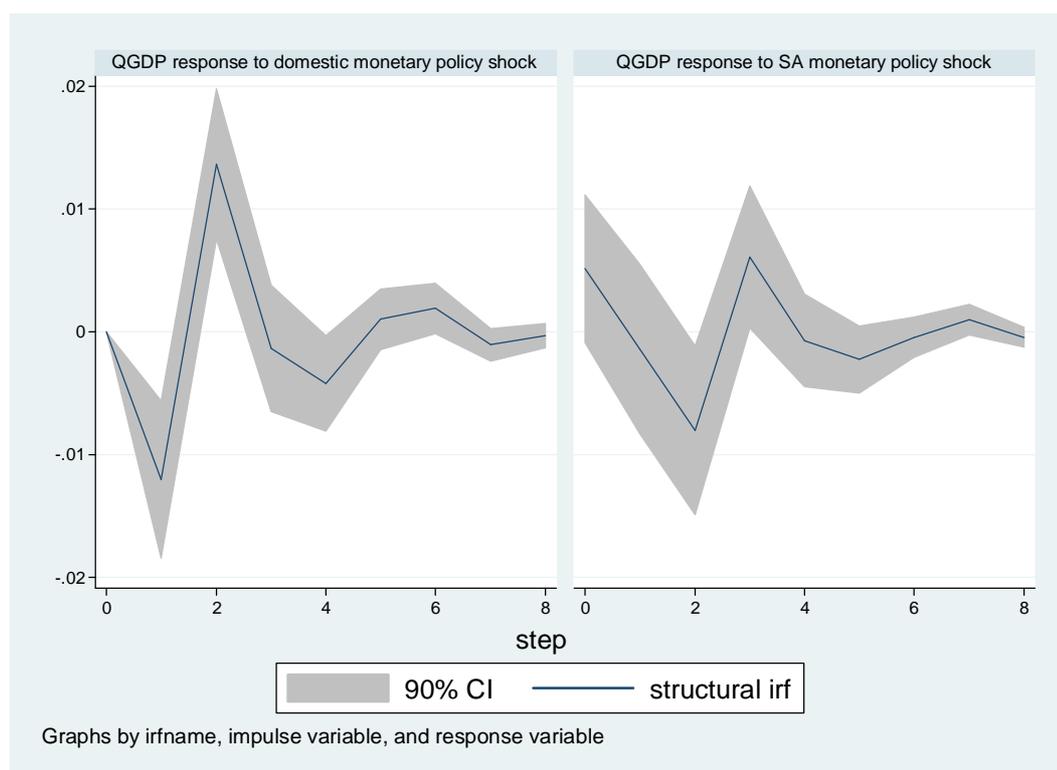
Table B. 2-2 presents the Granger causality test which shows the results that are consistent with the assumptions about restrictions used in the SVAR AB-model in (2.12). For example, we assumed that some domestic variables are non-Granger-causal to foreign variables. The results in Table B.2-2 show that the non-Granger causality null hypothesis is not rejected while the null hypothesis that foreign variables are non-Granger-causal to the domestic variables is rejected too. Finally, the log-likelihood test of identifying restrictions:  $\chi(4)=6.362$ ,  $p = 0.17$  shows that the linear restrictions in the SVAR AB-model are supported by the data.

### **2.5.1 Short Run Structural Impulse Response Functions: SVAR-AB Model**

Figure 2-4 (a) to (e) shows the panel of the simulated structural impulse response functions (SIRF) for QGDP growth, inflation, credit growth rate, commodity price inflation and changes in the policy rates, to a one standard deviation in domestic monetary policy and SA's monetary policy shocks. The dark line in-between represents the point estimates of SIRF within the two bands that show a 95% confident level.

#### **2.5.1.1 Effects of monetary policy shocks: domestic & SA's repo rate shocks**

**Figure 2-4** Structural impulse response functions of (a) QGDP, (b) Inflation, (c) private credit growth rate, (d) commodity price inflation, and (e) changes in the repo rates to domestic and SA's monetary policy shocks.

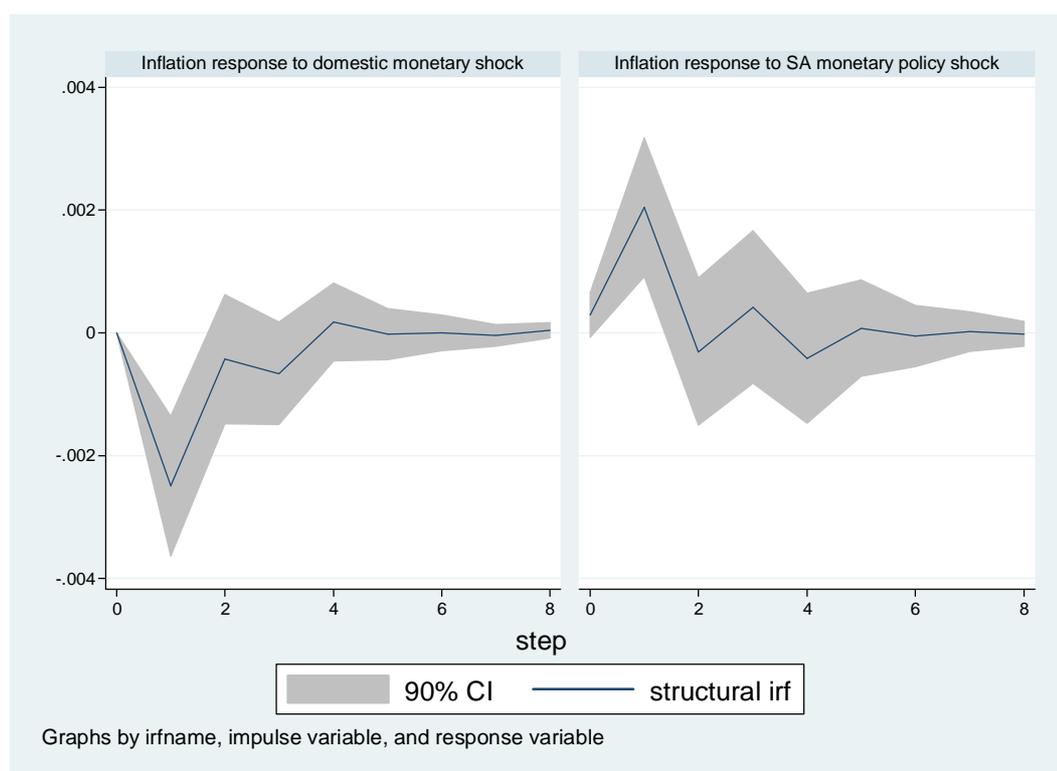
*(a) Structural impulse responses of Quarterly real GDP to monetary policy shocks*

We start with the structural impulse response functions to a shock in Namibia's repo rate. Figure 2-4(a) presents the SIRF, which shows how domestic and SA's monetary policy shock in Namibia affects the quarterly real GDP growth rate in the short term. A positive shock in Namibia's repo rate (NA, repo) causes significant contractions of more than 1.5% in quarterly real GDP with the significant effects lasting up to the fourth quarter, before real GDP returns to the initial level. SA's monetary policy (SA, Repo) produces positive effects at impact followed by a negative significant effect from the second quarter. Although monetary policy from SA produces a negative response in output, the SIRF shows that output response is less severe as compared to the response to domestic monetary policy shock. In addition, the responses to the monetary policy shocks last for less than six quarters before QGDP growth rate returns to the initial levels. Further, these SIRFs show volatile movements even after adjusting the lag length in the VAR from four to two quarters. Monetary policy tightening leads to a significant fall in quarterly GDP; thus, it confirms the empirical evidence of interest rate channel in Namibia. This result is consistent with the stylized facts about the theory of the monetary transmission mechanism. According to Favero (2001, p. 22) "aggregate output initially falls, with a j-shaped response and a long-run zero effect of monetary policy impulse". Further, we found

that the impulse response function of real GDP to domestic monetary policy shock is significant even when we reduce the SVAR to domestic variables only.

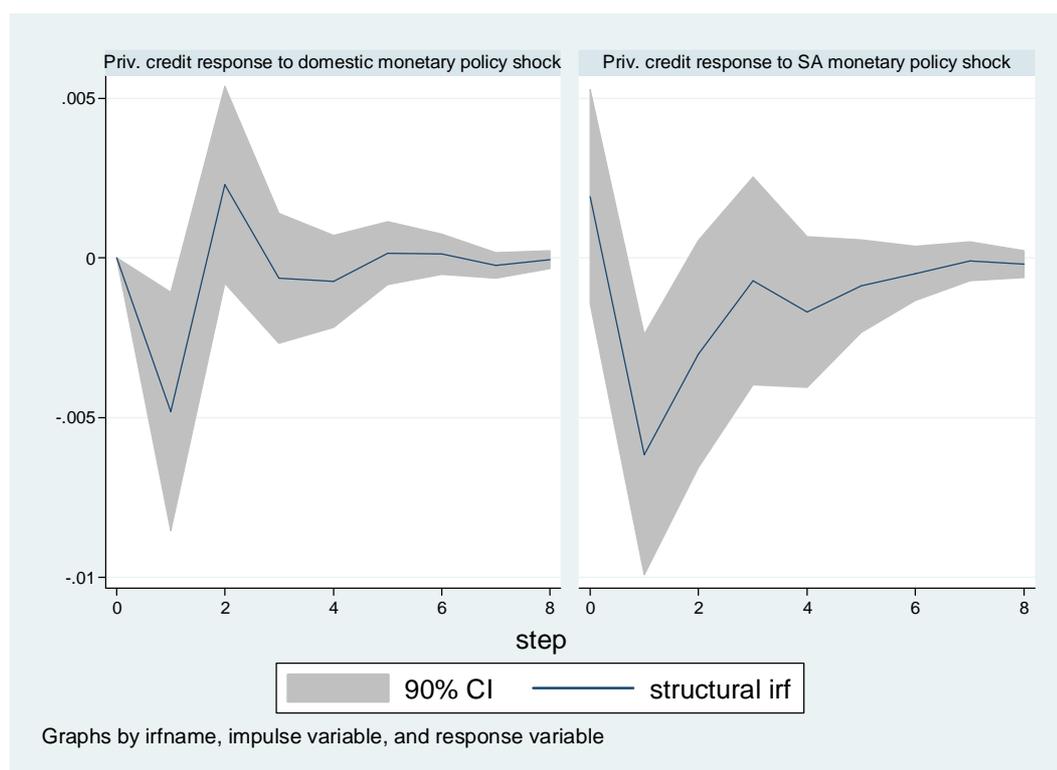
Further probing of these results seems to suggest that economic agents in Namibia respond rapidly to changes in the country's monetary policy. This quick adjustment may be attributed to the fact that when South Africa's Reserve Bank (SARB) changes its monetary policy stance, this propels high expectations in Namibia with anticipation that domestic monetary authority will respond by adjusting the repo rate upward too. In other words, a change in monetary policy in South Africa serves as a signal indicator to Namibian households and businesses that a similar action is on the way in Namibia. Consequently, many households and businesses scale down their borrowing and activity in anticipation of high borrowing costs. The slow response to SA's monetary policy is practically explained by the fact that it takes time for the effects to trickle down to Namibia through imports prices and interest rate spreads.

(b) *Structural impulse responses of inflation to monetary policy shocks*



Domestic monetary policy shock produces a significance negative response on inflation. Inflation declines by more 0.3% before for it returns to the initial level. Meanwhile the SIRF on the right shows inflation response to SA's monetary policy shock. This impulse response shows first a rise in inflation before a decline from the third and

fourth quarters. This positive response to monetary policy has been observed in the literature and is often called price-puzzle - see (Afandi, 2005; Favero, 2001). A positive surprise shock to monetary policy is followed by an immediate increase in the rate of inflation. Inflation increases in the first two quarters, followed by a fast decline in the next three quarters before it converges toward the initial level. In relation to the price-puzzle, although it is deemed unusual in the mainstream literature from a post-Keynesian perspective, this is not an unexpected result. Some post-Keynesians argue that if firms are able to pass on costs immediately to consumers then a rise in the general price level is expected in response to unanticipated shock in the cost of money. In the case of Namibia, this increase in the general price level in response to a monetary policy shock can be attributed to import prices from South Africa through the fixed peg. This is whereby exporters in SA revise their price on goods that forms parts of Namibian imports. This might put pressure on inflation before monetary policy effects trickle down to Namibia. However, we argue that import inflation is subject to how fast the prices are revised in South Africa so that a significant impact is imported into Namibia's inflation. Furthermore, although the initial responses of inflation present a puzzle, the subsequent movements in the rate of inflation follow a downward path as predicted by the theory. As a whole, the results show that output and inflation decline to reflect the responses to a tight domestic monetary policy in the short term, while in the long run, both variables tend towards their initial levels to demonstrate the evidence of zero effects. We examine the results from the long run SVAR in Section 2.6. This will show whether there is a long run negative impact on inflation and output.

(c) *Structural impulse responses of private credit growth to monetary policy shocks*

Next, the variable of interest in this study was to test how bank money i.e. private sector credit responds to a monetary policy shock and the relative strength of credit shock compared to interest rate channel through the SFEVD. Generally, bank credit is assumed to be inversely related to interest rate – meaning that as the cost of credit increases, the demand for credit falls. The structural impulse responses in Figure 2-4(c) above show that private sector credit declines by more than 1% in response to a positive shock in Namibia’s repo rate. Although these SIRFs are only significant for two quarters, the dynamic path of the SIRF, as shown by the point-base estimate in-between the confidence bands, shows that credit growth declines as from the first quarter to the fourth quarter before it converges to its initial level within six quarters. This evidence shows to some extent the support for the credit channel through the bank lending channel to the private sector in Namibia. Surprisingly, monetary policy effects from SA’s policy on private credit are quite large as compared to effects from domestic repo rate. This might be explained by the financial link between financial institutions in Namibia and SA. This result also illustrates that the growth rate of bank money is determined by the price of liquidity. However, it is not yet clear as to whether the decline in total lending is because the supply of loans shifts to the left or because the demand for loans from firms and households reduced and shifted leftwards.

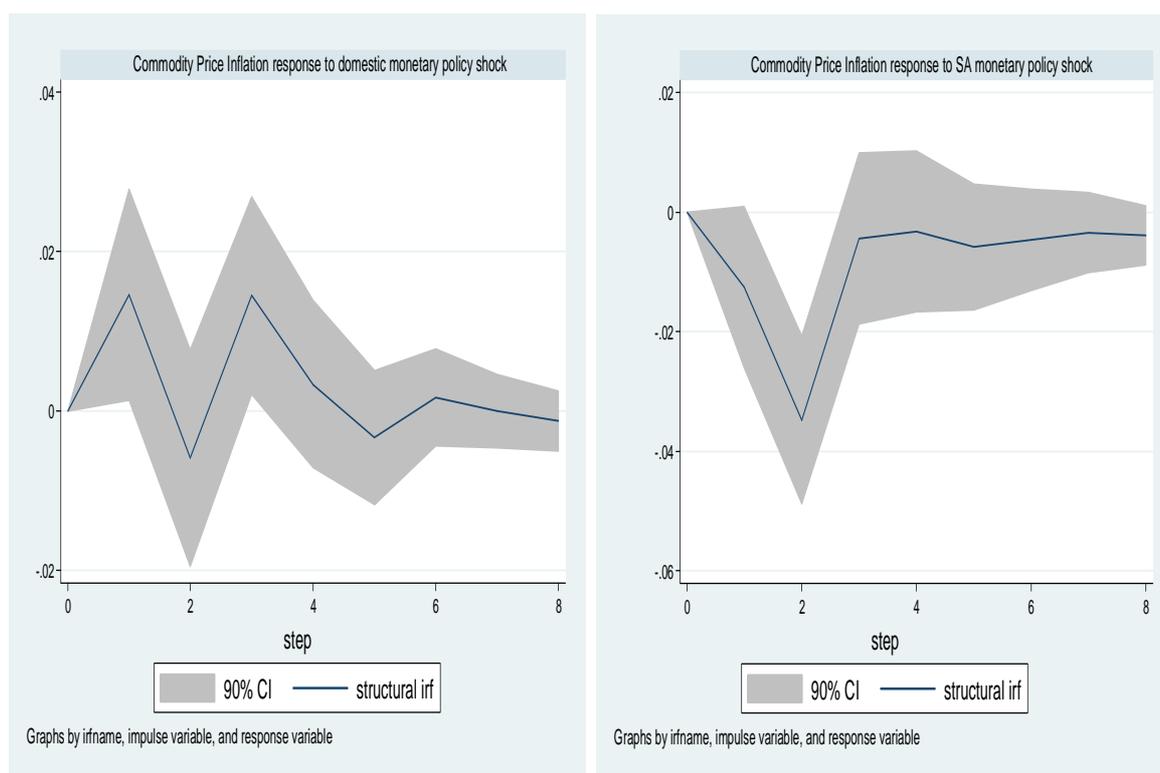
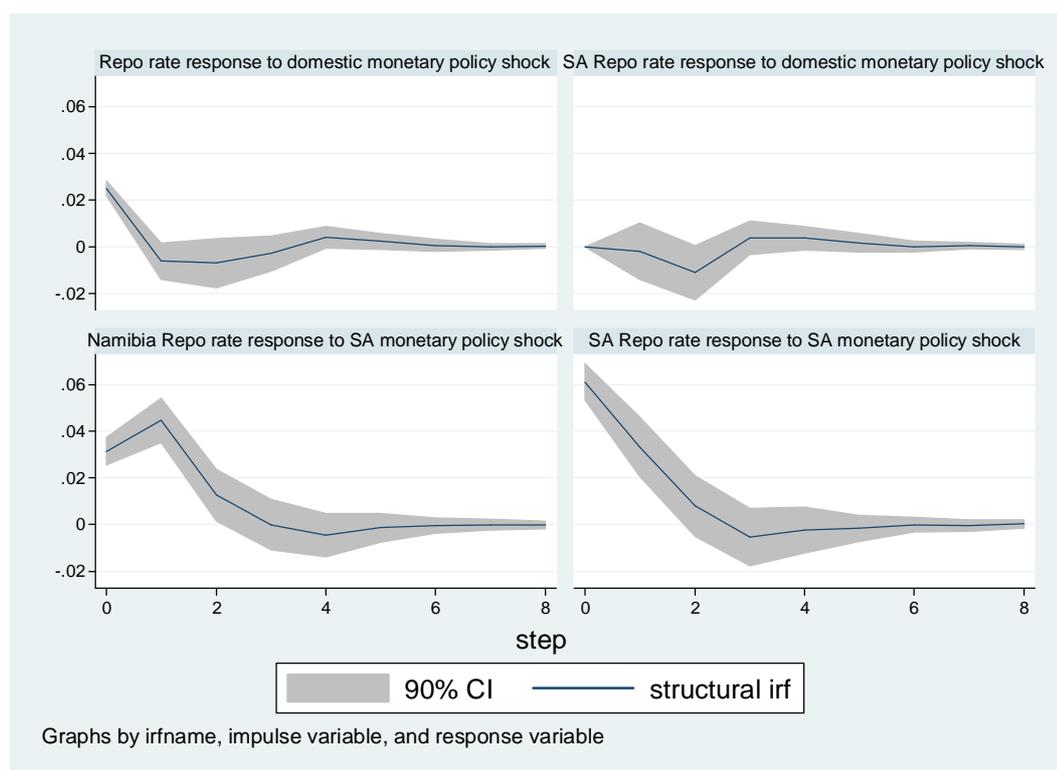
(d) *Structural impulse responses of commodity price inflation to monetary policy shocks*

Figure 2-4 (d) shows the SIRFs of commodity price inflation in response to Namibia and SA's monetary policy shocks. In our identifications restrictions for the AB-model we assumed that domestic variables do not significantly influence commodity growth and foreign interest rate. This SIRF in Figure 2-4(d) shows that Namibia's repo rate shock does not produce significant effects on commodity price inflation. Although there seems to be positive effects on commodity this is accompanied by large uncertainty around the impulse response function and the response is statistically insignificant throughout the sample horizon. Meanwhile the response to SA monetary policy shock is highly statistically significant until the third quarter. SA's monetary policy shock (SA repo) produces a statistically significant negative impulse response of more than 2.0% from commodity price inflation. This therefore indicates that the growth in commodity prices at Johannesburg Stock Exchange (JSE) is influenced by monetary policy actions in SA.

(e) *Structural impulse responses of monetary policy rates to monetary shocks*

Finally, Figure 2-4(e) shows the impulse response for Namibia & SA's repo rates to domestic and foreign monetary policy shocks. Namibia repo rate responds positively to the monetary policy shock from itself and SA's monetary policy. Again, these structural impulse responses are consistent with a prior expectation. Firstly, there is a positive response on the domestic policy rate to itself and the SA's monetary policy shock. This is reasonable since the central bank tries to maintain the same level of policy rate to anchor future inflation expectations of the fixed exchange rate mechanism. This manifestation shows why the interest rate provides clarity of monetary policy stance and good controllability, which is lacking in the money-growth targeting approach. Meanwhile, the structural response for SA's repo rate shows that the domestic monetary policy shocks do not significantly affect the changes in the level of SA's policy rate. This is in agreement with the results from the Granger-causality test, which shows that domestic variables do not have (contemporaneous and immediate) predictive information of foreign variables.

Taken together, these structural impulse response functions show that the interest channel through domestic repo rate (i.e. policy rate) to real output is statistically significant; secondly, domestic monetary policy clearly produced large and fast contractions in real quarterly GDP as compare to the effects from SA's monetary policy shock. In addition, domestic monetary policy produces negative response inflation in the

short run. SA's policy rate produced a somewhat positive response at impact in the first quarter after initial impact. Third, we find that domestic monetary policy shocks do not produce significant responses in foreign variables in the system. In all, this empirical evidence therefore supports the hypothesis that the policy of changing the repo rate in Namibia does have significant effects on output and inflation in the short run. It therefore provides the evidence of an effective interest rate channel in the short run. However, it also shows that although SA's monetary policy effects are visible in Namibia particularly on private credit development; our empirical results suggest lesser impacts compared to significant effects from the domestic monetary policy shocks. This evidence argues against the idea that BoN does not need to change the level interest rate independently from SA because such changes are not necessary and they do not significantly differ from the changes in the foreign interest rate in the anchor country.

#### **2.5.1.2 Structural impulse responses to aggregate demand shock**

Figure B.2-1 (in Appendix B) shows the SIRF for inflation, commodity price inflation and credit shock to one standard deviation shock in output in the short run. Firstly, there is a significant positive impact on inflation from demand shock. This is consistent with the fact that in the short run aggregate demand will lead to inflation as the supply factor will take time to respond to meet new demand. However, demand shock reduces commodity price inflation and credit growth in the short run. In addition, the impulse response of SA's repo rate is statistically insignificant. Meanwhile the impact of demand shock on the domestic policy rate, although insignificant, remains constant up to the first quarter and thereafter increases from the second quarter before it starts to decline to the initial level in the fourth quarter.

#### **2.5.1.3 Structural impulse responses to private credit shock**

Figure B.2-2 shows the sirfs for quarterly real GDP, inflation and private credit to one-standard deviation shock in private sector credit. Private credit shock produced a statistically significant contraction in the domestic repo rate at impact; however, this is followed by a sharp rise in the repo rate in the first quarter maybe as a response by the central bank to reduce credit growth. Credit shock leads to a considerable increase in the rate of inflation and the effects persist until the third quarter. Private credit induces a positive significant impact on real quarterly GDP of more than 1.5% in the second quarter after the initial impacts. As expected, private credit shock does not significantly influence the commodity price inflation in the model. These impulses show that after taking into account the systematic component of anticipated credit effects, the private credit shock has significant effects on output and inflation, which last for less than three quarters after

initial impacts. This evidence seem to suggests that inside money does matter in the short term for real economic activity and inflation. In the following section we examined the SFEVD to analyse the relative strength of individual shocks on real GDP, inflation and private credit growth.

## 2.6 Structural Forecast Errors Variance Decomposition (SFEVD) Analysis

Our results in the last section point to the empirical evidence of an effective monetary transmission mechanism through interest rate and credit channel in Namibia. In this section we analyse the relative importance of monetary policy and credit structural shocks at different horizons. For the sake of space we discussed the SFEVD for domestic repo rate and credit shocks. From the monetary policy statement issued by BoN it is clear that these two channels are always closely monitored for the effectiveness of monetary policy actions. The rest of the results for SFEVD attributed to other shocks are given in the Appendix. Tables 2.1 and 2.2 give the SFEVD, which describe the variation attributed to domestic monetary policy ( $e_t^{rn}$ ) and credit ( $e_t^{pc}$ ) shocks in equation (2.12). Structural forecast error variance decomposition analysis displays proportions at each point in time as caused by the shock in the variable itself and the variation attributed to others structural shocks in the system. The SFEVD statistic lays bare relevant information about the relative importance of each unanticipated shock as they affect all endogenous variables in the structural model. Hence, we use results from this exercise to compare the relative strength of individual channels of the transmission mechanism in Namibia. This approach allows us to establish the proportions of the variation in output, which is accounted for by credit and monetary policy shocks at different horizons.

In Table 2.1 the first column gives the horizon from period 0 to the eighth quarter. Columns two to six give the SFEVD for commodity price inflation, changes in SA policy rate, QGDP, inflation, private credit growth and changes in domestic repo rate. At each step SFEVD statistics indicate the percentage attributed to monetary policy shock ( $e_t^{rn}$ ) as in Table 2.1 and credit shock ( $e_t^{pc}$ ) in Table 2.2. Our main focus is the SFEVD for QGDP, which represents the percentage of variation accounted for by monetary policy shock.<sup>98</sup> In column three, the result shows that domestic monetary policy shock accounts for about 5.0% in the second quarter, 7.0% in the fourth quarter, and 8.0% in the seventh quarter after the initial impact. Meanwhile, column four shows that there is a significant influence of domestic monetary policy shock on inflation. Monetary policy shocks account for more

<sup>98</sup> The discussion about the SFEVD for CMI and SA repo is not of much interest because they do not form part of the objective and their impulse response functions to domestic monetary shock are not statistically significant.

than 11.0% of variation in the rate of inflation in the second and fourth quarter after initial impacts. In column six, SFEVD shows that 34.9% of variation in domestic policy rate shock is attributed to itself in the second quarter and less than 20.0% from five to eight quarters ahead. In other results not reported here we observed, SA's monetary policy shock accounts for more than 2.0% in SFEVD for QGDP over the same horizon. Similarly, Table 2.2 credit shock accounts for less than 1.8% of the variation in QGDP. This evidence indicates that the interest rate channel through Namibia's repo rate is relatively stronger than the credit channel. This is because the result for SFEVD from the short run SVAR AB-model shows that domestic monetary policy shock (i.e. repo) accounts for more variations in quarterly GDP and inflation in Namibia.

**Table 2.1** SFEVD, which describe the variation attributed to domestic monetary policy ( $e_t^{rn}$ ) shock

step	(1) sfevd	(2) sfevd	(3) sfevd	(4) sfevd	(5) sfevd	(6) sfevd
0	0	0	0	0	0	0
1	0	0	0	0	0	.349961
2	.037129	.000083	.050886	.113791	.026839	.152976
3	.03499	.014847	.082808	.105897	.024583	.149243
4	.057226	.02008	.079942	.114872	.027485	.145864
5	.058064	.024765	.065775	.11204	.028189	.148046
6	.058837	.027577	.071547	.111108	.028133	.147544
7	.058502	.027471	.080094	.111336	.028747	.148205
8	.058366	.027867	.079295	.110615	.028687	.147334

Note: (1)  $\Delta cmi_t$ , (1)  $\Delta rs_t$ , (3)  $\Delta gdp_t$ , (4)  $infl_t$ , (5)  $\Delta pc_t$  and (6)  $\Delta rn_t$  -i.e. (1) sfevd shows variation in  $\Delta cmi_t$  attributed to a shock in Namibia repo rate shock from 0 to 8<sup>th</sup> quarter.

**Table 2.2** SFEVD, which describe the variation attributed to private credit ( $e_t^{pc}$ ) shock

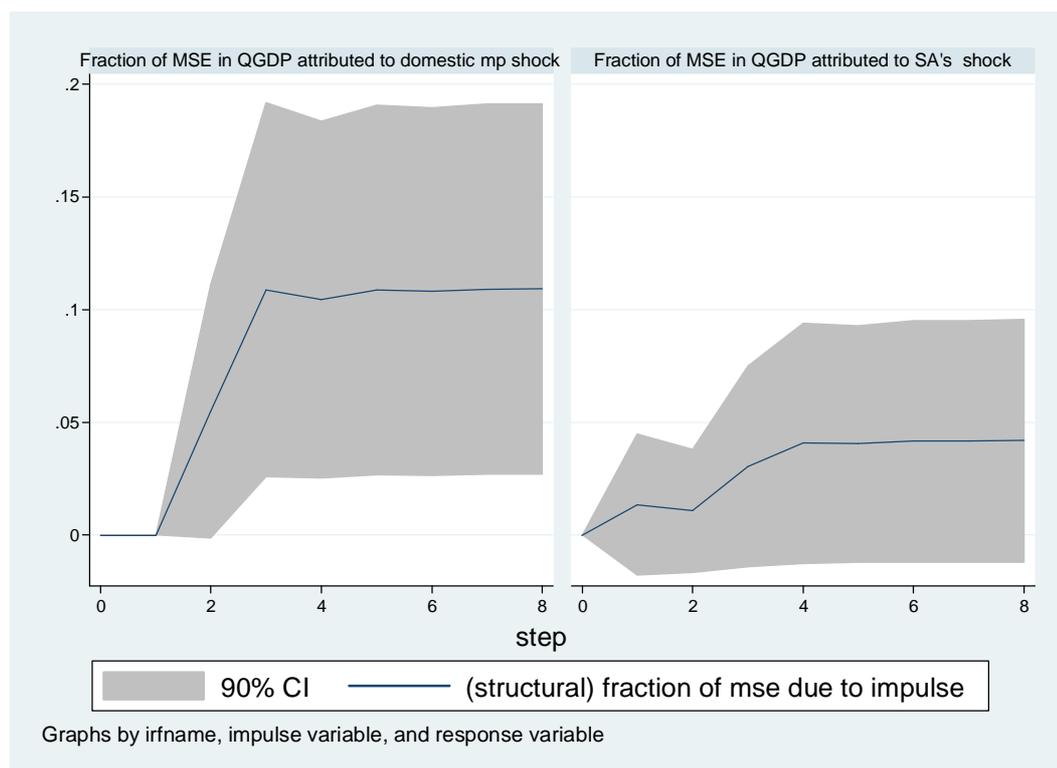
step	(1) sfevd	(2) sfevd	(3) sfevd	(4) sfevd	(5) sfevd	(6) sfevd
0	0	0	0	0	0	0
1	0	0	0	0	.97626	.003486
2	.001655	.049298	.011664	.02213	.852541	.048419
3	.003247	.048261	.013178	.020413	.78642	.048693
4	.015892	.046427	.012998	.021803	.767231	.048378
5	.019995	.045124	.011626	.029764	.756299	.04701
6	.021613	.04476	.018909	.029523	.744434	.046299
7	.025636	.046964	.01889	.03099	.742482	.046975
8	.026306	.048292	.018708	.030724	.740231	.049112

Note: (1)  $\Delta cmi_t$ , (1)  $\Delta rs_t$ , (3)  $\Delta gdp_t$ , (4)  $infl_t$ , (5)  $\Delta pc_t$  and (6)  $\Delta rn_t$  -i.e. (1) sfevd shows variation in  $\Delta cmi_t$  attributed to a shock in private credit ( $e_t^{pc}$ ) shock from 0 to 8<sup>th</sup> quarter.

Finally, we compare the structural fraction of mean squared errors SFMSE due to monetary shocks as derived from the short run SVAR. Figure 2-5 show the structural fractions of mean squared errors due to domestic and SA monetary policy shocks. These results show that significant

large fractions in the variation of output are attributed to domestic monetary policy while foreign monetary policy shock only accounts for less than 5% over four quarters. Thus, changing the level of domestic repo rate will result in more significant effects on real economic activity as compared to transmission effects from SA monetary policy rate.

Figure 2-5. Structural Fraction of Mean Squared Errors (SFMSE) due to monetary policy shocks  $\Delta rn_t$  and  $\Delta rs_t$ .



In all, this evidence from SFEVD and SFMSE show that domestic monetary policy shock repo rate produced consistent significant results regarding monetary policy effects in Namibia. Both structural impulse response functions and forecast error variance decomposition show that repo rate shocks have negative impacts on output, inflation and private credit. Although SA's monetary policy shocks have significant effects in Namibia the empirical evidence obtained is small relative to effects generated by domestic monetary policy shock.

### 2.5.3 Robustness Checks

In order to assess the internal validity of our results, we carried out the following three robustness checks. We made three main alternative estimations to the short run SVAR model in (2.12). We estimate the SVAR model with A-model identification restrictions. The main aim of this alternative estimate is to check whether our identification restrictions have shaped the pattern of behaviours portrayed by the structural impulse

response functions. In the second alternative estimation, we estimated the SVAR AB-model excluding the foreign variables commodity price inflation and SA's repo rate. We reduced the economic model by trimming the structural representation in (2.12) to three domestic variables: quarterly GDP, inflation and the repo rate. Finally, we present the trimmed model with SA's policy as the policy instrument. This alteration is necessary to assess the view that Namibia's policy rate is redundant; therefore, we need to model the transmission mechanism only with SA policy rate as the policy instrument.

In the first alternative specification, we start with exact identification of the three variables SVAR-AB model: QGDP, inflation and domestic monetary policy rate. This makes a lower triangular identification of the type AB-model. Figure B.2-3 present results from this alternative specification, which shows that all SIRFS are statistically significant with evidence of negative impact on inflation while QGDP remains volatile after the second quarter. The impulse responses show that monetary shock produces similar responses on output, inflation and repo rate. Meanwhile, demand shocks produce significant positive responses on inflation and the repo rate (i.e. the monetary policy rate). These structural impulse responses are consistent with results from six variable short run SVARs, therefore the size and order of the system do not significantly influence the responses from QGDP, inflation and policy rate.

Our second robustness check involved trimming the three variables in the SVAR by excluding the commodity price inflation and private credit, and replacing Namibia's repo rate with SA monetary policy rate. This robustness is aimed to test SA monetary policy effects in the model without monetary policy rate. Impulse responses from this alternative specification show that SA's monetary policy shock barely produced any statistically significant impulse response functions in quarterly real GDP and inflation. These results show that whether we exclude commodity price inflation and private credit the impacts from SA monetary policy shock are smaller compared to domestic monetary policy shock. Finally, although we used five lags in the structural estimation instead of the three lags suggested by the Akaike Information Criteria (AIC), this switch from four to two lags has not considerably changed the statistical significance of the impulse response functions. Impulse responses to SA's monetary policy are the same as in the six variables SVAR in equation (2.12). These findings thus indicate that the results from the SVAR models used are robust. Therefore, these results reflect the efficacy and transmission mechanism of monetary policy in Namibia. Finally, these empirical evidences are consistent with stylized facts as found in many studies both from developed and developing countries. In the new

consensus, an increase in monetary policy shock should always lead to a rise in policy rate, lower prices, and reduce real output.

## 2.6. Long Run SVAR Results

Finally, we examined whether the dynamic relationship among variables in Namibia display long run behaviours and dynamic responses as observed in the literature. Many studies find that monetary policy shocks affect the price levels in the long run while effects on other variables die out after the fourth quarter. Literature shows that there are significant effects on economic activity from supply shock while demand shocks are statistically insignificant in the long run. Figure B.2-5 shows the long run cumulative impulse response functions to monetary policy shock in Namibia, followed by demand shocks and supply shocks. Firstly, monetary policy causes a significant decline in GDP up to the fourth quarter and then it returns to the initial level. This implied response is similar to what we have obtained in the short run. This result is the same as in the short run and it shows that there is no long run lasting monetary policy effect on QGDP, while there is a significant long run impact on the rate of inflation. Inflation level remains below the initial level even in the seventh quarter after the initial shock has taken place. This shows that domestic monetary policy shock i.e. the policy of changing the level of repo rate in Namibia has a long run effect on the consumers' price inflation. Furthermore, figure B.2-5 presents the rest of the cumulative impulse response functions showing that the monetary policy shock does not produce significant effects on most variables in the long run in line with economic theory. In the long run monetary policy stabilizes inflation that is achieving the goal of price stability. In the case of SA's monetary policy shock the results are similar with the exception that monetary policy increases or raises inflation in Namibia permanently at a high level.<sup>99</sup>

The next figure presents the long run structural impulse response function to the demand shocks (GDP). Demand shocks have permanent effects in the long run on itself and negative long run effects on credit growth. For policy rate increases in response to demand shocks however these cumulative impulse response functions (CIRF) are statistically insignificant.

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<sup>99</sup> These results are the same even when SA's repo rate is used in the SVAR alone as an exogenous monetary policy function in Namibia. See the discussion on the robustness check for the short run exercise.

## 2.7. Conclusion

Starting with the literature review, we assert that many studies indicated that the monetary policy transmission mechanism is a very important topic and its relevance is timeless (Gerdesmeier, 2013, p. 140). This study estimates the efficacy of monetary policy and the transmission mechanism of monetary policy in Namibia. We applied the methodology of structural vector auto-regression with short run and long run identifications restrictions based on the new macroeconomic consensus. This consensus argues that a country's economy can be analysed on the basis of three fundamental equations: aggregate demand, price developments and the monetary policy instrument that is used to manage demand and supply. Hence, we designed SVAR with endogenous variables representing foreign sector and policy variable blocks. The SVAR approach is highly useful in policy evaluation because it has the following unique advantages.

Firstly, this method produces structural impulse functions, which depict the expected time paths of variables in response to a structural shock; for example, monetary policy, and demand and supply shocks. In addition, SVAR provides the structural forecast error variance decomposition aid to explain the relative importance of each structural shock in the economic model under study. Thus, using this method, we have established the following results concerning the effects of monetary policy and credit shocks in Namibia.

First, the results show that monetary policy through repo rate is effective in stabilizing real economic activity in the short run and consumers' price inflation in the long run in Namibia. The structural impulse response functions obtained show that the impacts of monetary policy shocks are statistically significant, more than 2.0% contraction in quarterly real GDP, 4.0% inflation and 0.3% private credit fall in response to one-standard deviation shock in the repo rate in the short run. Second, our empirical results show that Namibia's monetary policy shock induces more direct negative impact on output, inflation and private credit than foreign monetary policy shock. This evidence is therefore contrary to the argument that monetary policy in Namibia is subordinate to monetary policy in the anchor country. Based on the sample data used in this study we assert that there is little evidence to suggest that SA's monetary policy accounts for more variation in output than domestic monetary policy.

Thirdly, the results show that monetary policy contraction improves price stability in Namibia in the short run. Although there is large uncertainty around the impulse response to monetary policy shock in the long run, we find that the domestic monetary

policy shock significantly affects the inflation path as the impulse response remains below the initial level from the first quarter until the eighth quarter before it returns to the initial level. Meanwhile, SA's monetary policy shocks seem to generate the so-called price-puzzle, which contributes to the inflation rate in Namibia. In the first two quarters, we find that the response for inflation rate displays the so called price-puzzle response which means that the general price level rises instead of falling up to the third quarter in response to a positive shock in monetary policy. Qualitatively, this implies that a positive monetary policy shock on average increases the borrowing cost which is passed on to the consumer before the effects are transmitted to the overall aggregate demand. However, this response declines as from the fourth quarter, which shows that inflation stabilizes after a decline after a year in Namibia.

Furthermore, our results show that private credit negatively responds to monetary policy shocks. In the short run aggregate demand significantly increases when shocked by one-standard deviation shock from private sector credit. This evidence reinforces the assumption that bank money is endogenous and credit significantly influences economic growth in the short run.

Structural error variance decomposition analysis reveals that a large share of fluctuations in the quarterly GDP growth rate and changes in the repo rate in Namibia is mainly attributed to innovations to domestic monetary policy shock, while variation attributed to SA's monetary policy accounts for less than 5.0% in the third quarter. Therefore, the results show that the direct transmission mechanism from domestic interest is relatively stronger as compared to the mechanism from credit and SA's monetary policy shocks. Thus, this empirical evidence shows that the policy of changing the level of repo rate in Namibia is effective in stabilizing output and inflation.

In addition, this result implies that the interest rate channel is relatively stronger than the credit channel in Namibia. This result holds even when compared with the variation attributed to monetary policy shock in SA's repo rate. There are several implications that follow from these results. First, the size of fluctuations in QGDP and inflation attributed to domestic monetary policy rate illustrate the importance of domestic monetary policy actions in the process of macroeconomics stabilization in Namibia. Although there is a fixed exchange rate arrangement, domestic monetary policy should proactively respond to important economic factors without waiting for similar action to happen first in the SA. Secondly, these results show that Namibia's repo rate is a good and effective instrument to regulate monetary and financial factors in the short run in order to

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achieve long run monetary stability. Thus, such an instrument should be clear in the monetary policy framework to enhance monetary policy communication to the public at large.

## Appendix B

### Appendix B.1 Definitions and Data Sources

Data used in this thesis are obtained from various sources. These are Bank of Namibia Quarterly bulletins, Central Bureau of Statistics in the Namibia Statistic Agency (NSA), South African Reserve Bank Data Base, and International Financial Statistics (IFS) published by International Monetary Fund (IMF). The sample period is the period 1991:Q1 to 2012Q4.

Gross Domestic Product (GDP) at constant price 2004=100 base year: These are seasonally adjusted quarterly real GDP, time series taken from the National Planning Commission/ Central Bureau of Statistics of Namibia.

Namibia Consumer Price Index (**NCPI**) with December 2001=100 as the base year. NCPI covers both rural and urban households living in Namibia; prices are collected from more than 650 retailers in 8 localities.

Namibia Inflation Rate (*infl*). Quarterly Inflation rate is derived from NCPI and expressed annually as follows:  $infl = 400 * [\log(\text{NCPI}) - \log(\text{NCPI}(t-1))]$ .

Repurchase Rate (*repo*) ( $rn_t$ ): This is the official rate charged by the Bank of Namibia on advances on specific collateral to commercial banks. The Repo rate is the cost of credit to the banking sector and therefore eventually affects the cost of credit to the general public. This is sourced directly from the Bank of Namibia.

Repurchase Rate ( $rs_t$ ) (South Africa): SA's central bank defines repurchase rate as the 'rate at which the private (sector) banks borrow Rand from the SA Reserve Bank'. This rate was formally called the bank rate until February 1998 and repurchase rate thereafter. It is directly sourced from the database as SA reserve bank.

Commodity Price Index (CMI): This is a South African commodity index that includes mineral commodity exports traded on the Johannesburg Stock Exchange. This series is sourced from the International Financial Statistics/IMF database.

Private sector credit (*pcr*): This time series reflects the amount of credit extended to the domestic private sector. The data are obtained from the Bank of Namibia.

**Appendix B.2 Pre-estimation Tests:** Summary statistics and diagnostic tests**Table B.2-1** Augmented-Dickey-Fuller and Philip-Perron Tests for Unit root.

Series	ADF Test (Obs. =86)		Max. lag	PP Test (Obs. =86)	
	Level ( <i>p</i> -value)	1 <sup>st</sup> Diff. ( <i>p</i> -values)		Level ( <i>p</i> -value)	1 <sup>st</sup> Diff. ( <i>p</i> -value)
CMI	0.62	0.00	4	0.59	0.00
Infl	0.01	0.00	4	0.00	0.00
Priv.Cr	0.15	0.21	4	0.26	0.00
QRGDP	0.86	0.15	4	0.83	0.00
Nam Repo	0.68	0.00	4	0.79	0.00
SA Repo	0.57	0.00	4	0.73	0.00

**Table B.2-2** Granger-Causality test results. H<sub>0</sub>: variable (k) along the column is non-causal for variable (x), H<sub>1</sub>: Variable (k) is Granger cause for variable (x). P-values are given in the table.

Var. (x)	CMI (k=1)	SA Repo	QRGDP	NCPI	Priv. Credit	Nam Repo
CMI	-	<b>0.02</b>	0.39	<b>0.00</b>	0.71	<b>0.01</b>
SA Repo	<b>0.02</b>	-	0.32	<b>0.00</b>	0.46	<b>0.00</b>
QRGDP	<b>0.00</b>	0.11	-	0.12	<b>0.04</b>	<b>0.01</b>
NCPI	0.68	0.27	0.89	-	<b>0.00</b>	0.27
Priv. Credit	<b>0.02</b>	0.05	0.51	<b>0.00</b>	-	<b>0.00</b>
Nam Repo	0.48	0.49	<b>0.01</b>	0.12	0.61	-

Notes: The p-values less than 5% are shown in bold face -this means that we reject the null hypothesis.

**Table B 2-3** Selection criteria: AIC, HQIC, SBIC

Selection-order criteria								
Sample: 8 - 87								
Number of obs = 80								
lag	LL	LR	df	p	FPE	AIC	HQIC	SBIC
0	873.185				1.5e-17	-21.6796	-21.608	-21.501
1	958.566	170.76	36	0.000	4.5e-18	-22.9141	-22.4128*	-21.6636*
2	996.41	75.688	36	0.000	4.4e-18	-22.9602	-22.0291	-20.6378
3	1048.76	104.7	36	0.000	3.0e-18*	-23.3689*	-22.008	-19.9746
4	1083.21	68.914	36	0.001	3.4e-18	-23.3304	-21.5397	-18.8641
5	1117.42	68.409*	36	0.001	4.0e-18	-23.2855	-21.065	-17.7473
6	1140.98	47.128	36	0.101	6.7e-18	-22.9746	-20.3244	-16.3644

**Table B.2-4** Pair Wise Correlations at log-levels, sample 1991Q1-2013:Q3

```
. pwcorr lcmi lsarepo lp2 lqgdp rtgdp1 lpc2 lrepo, sig star(5)
```

	lcmi	lsarepo	lp2	lqgdp	rtgdp1	lpc2	lrepo
lcmi	1.0000						
lsarepo	-0.6841*	1.0000					
lp2	0.8746*	-0.8072*	1.0000				
lqgdp	0.9000*	-0.8098*	0.9952*	1.0000			
rtgdp1	0.9197*	-0.7906*	0.9817*	0.9787*	1.0000		
lpc2	0.9135*	-0.8038*	0.9929*	0.9941*	0.9868*	1.0000	
lrepo	-0.7589*	0.9735*	-0.8932*	-0.8922*	-0.8693*	-0.8876*	1.0000

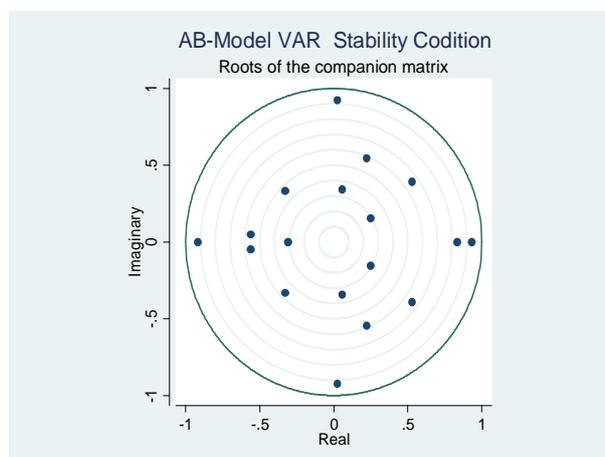
\*show significance at 0.05 percent significance level.

**Table B.2-5** Lagrange Multiplier test for autocorrelation

## Lagrange-multiplier test

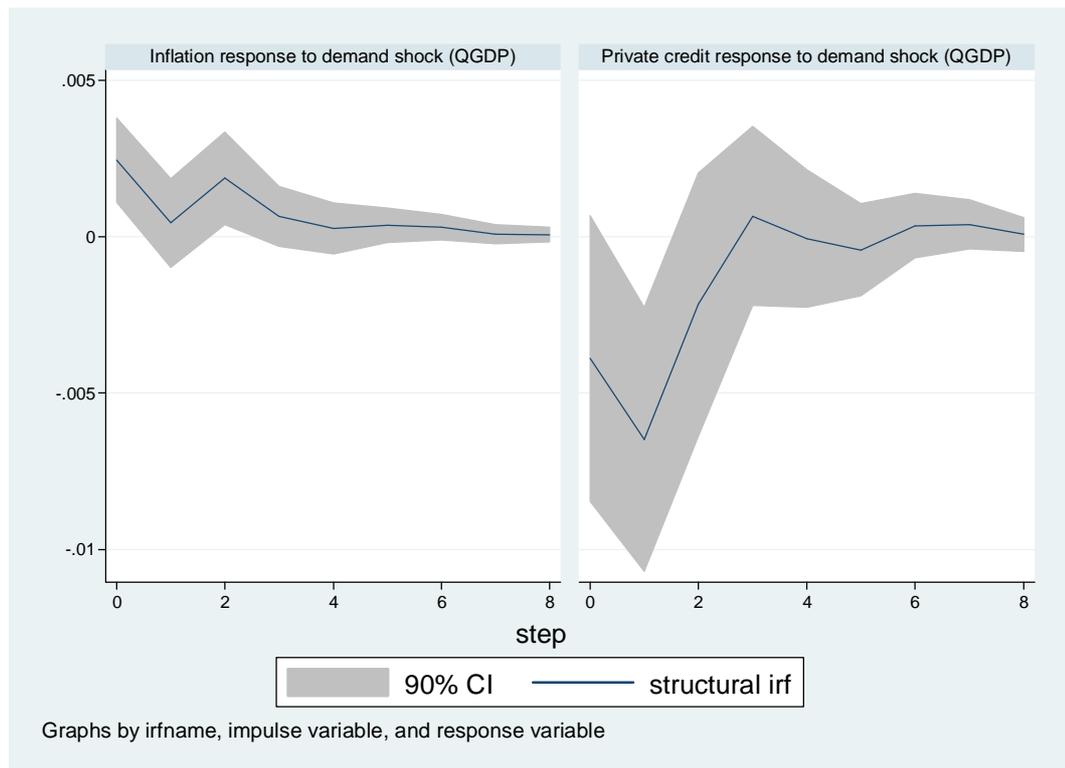
lag	chi2	df	Prob > chi2
1	50.3011	36	0.05713
2	39.8892	36	0.30125
3	44.9802	36	0.14493

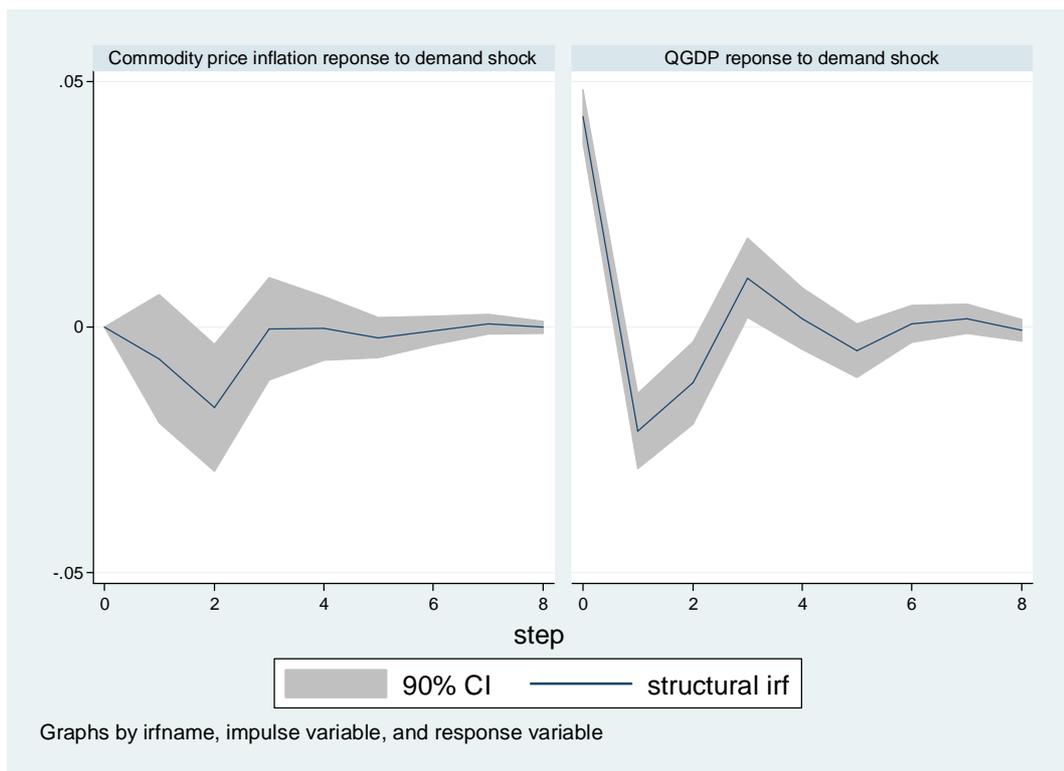
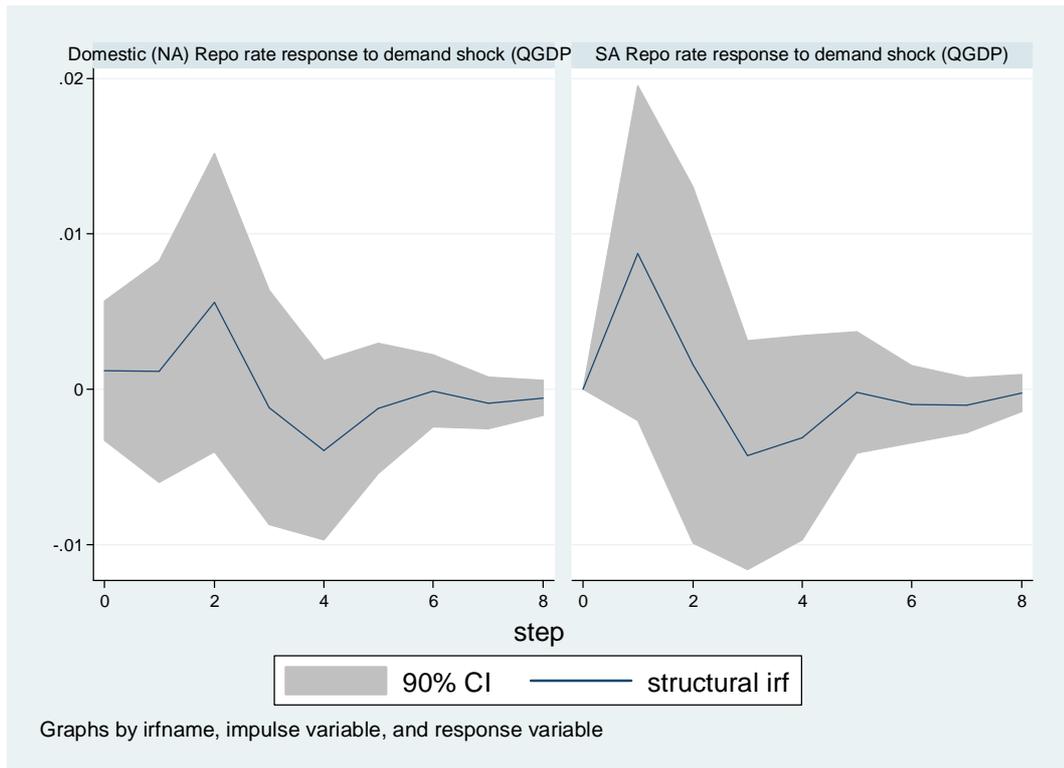
H0: no autocorrelation at lag order

**Figure B.2-6** Stability condition test with eigenevalues plot in the unit circle

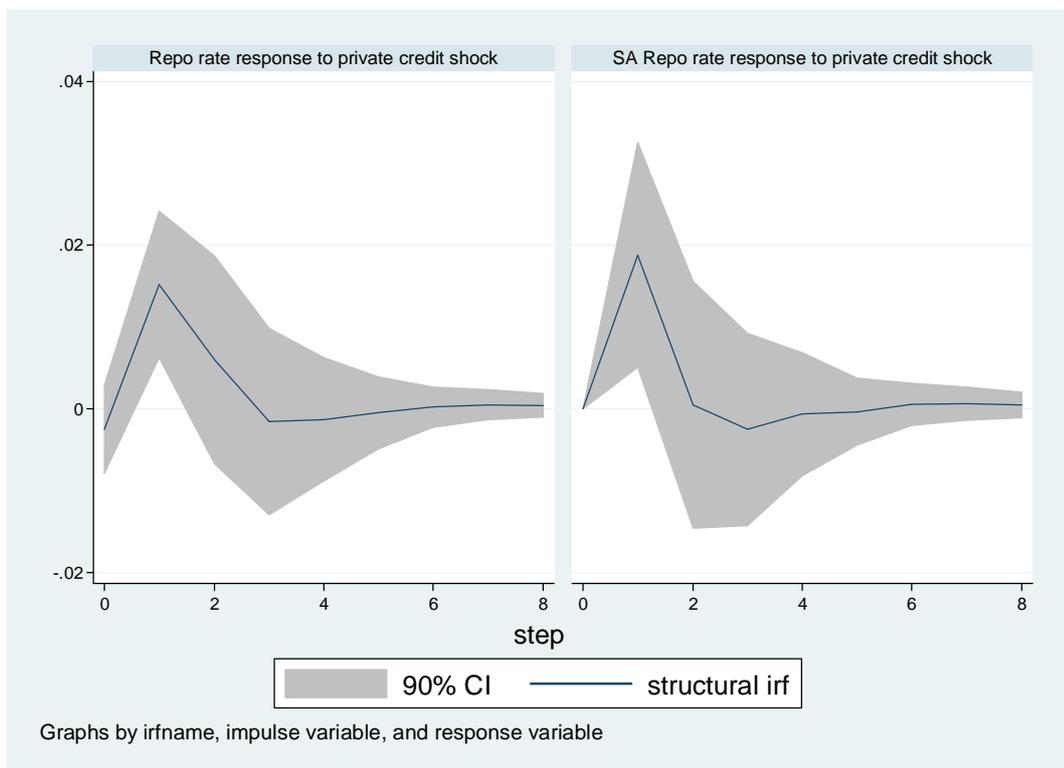
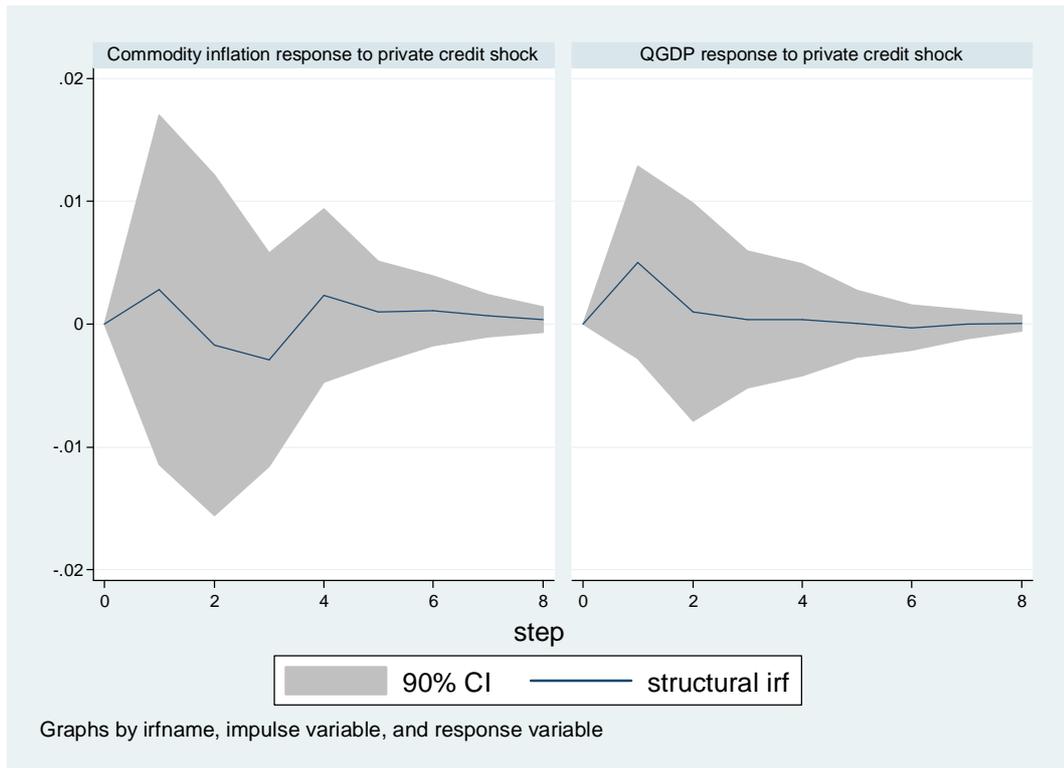
**Appendix B.3** Structural impulse response functions (sirtf) for demand and credit shocks in SVAR AB-model equation.

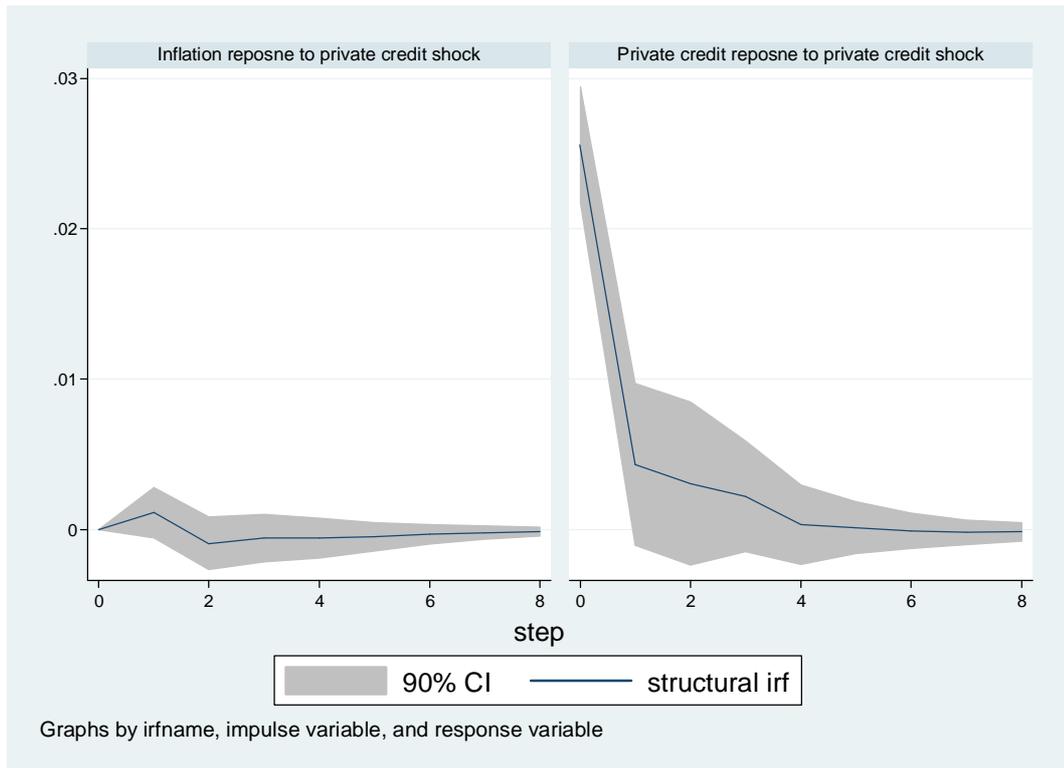
**Figure B.2-1** Structural Impulse Response Functions for inflation, private credit, repo rate, SA repo, commodity price inflation and growth rate of QGDP to a one-standard deviation on the demand shock.



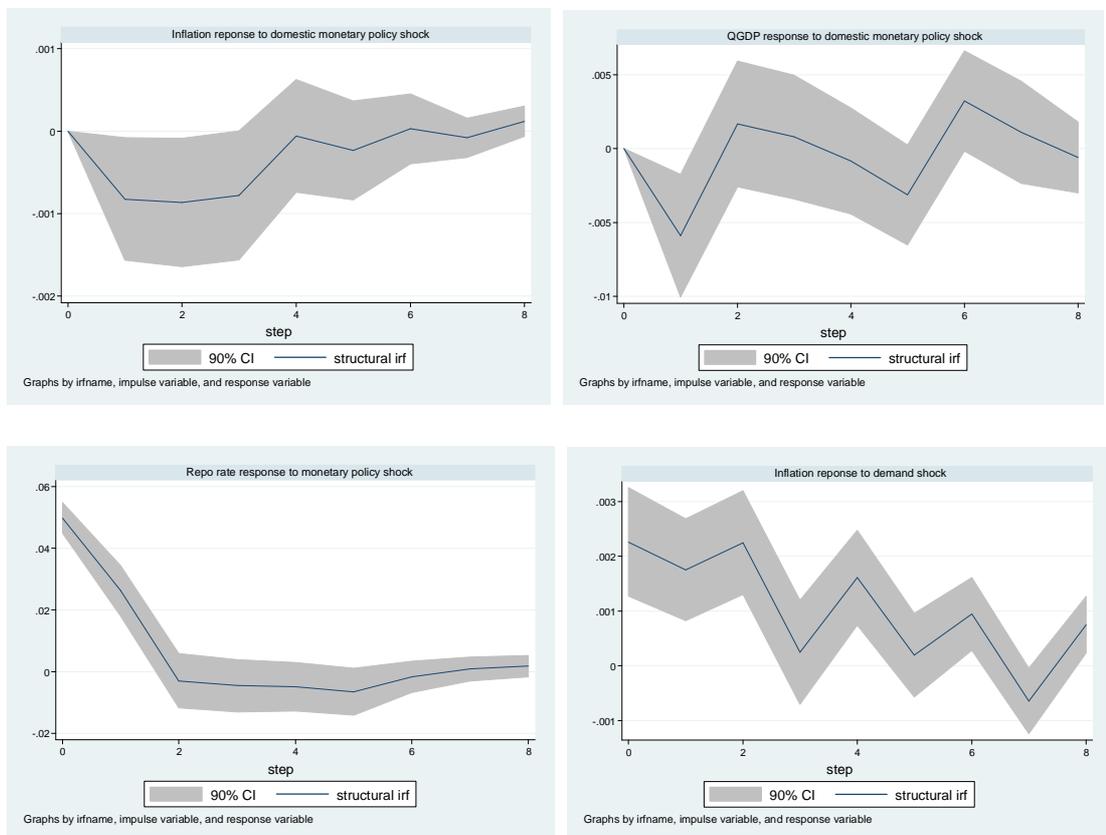


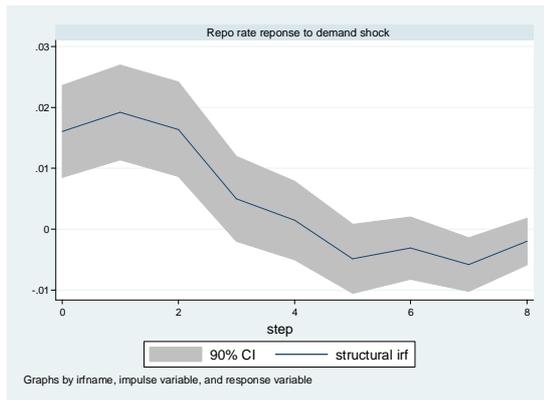
**Figure B.2-2** Structural impulse response functions for commodity price inflation, QGDP, domestic repo, SA repo, inflation, and private credit to a one-standard deviation of private credit structural shock.



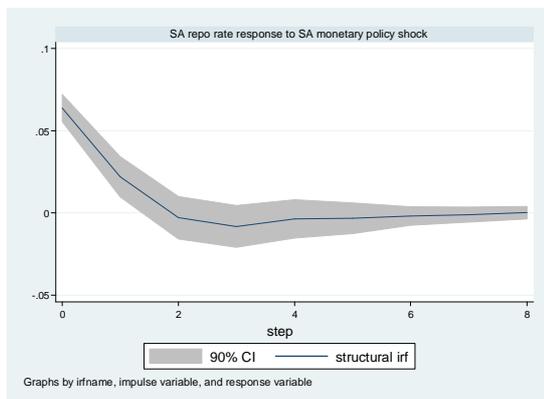
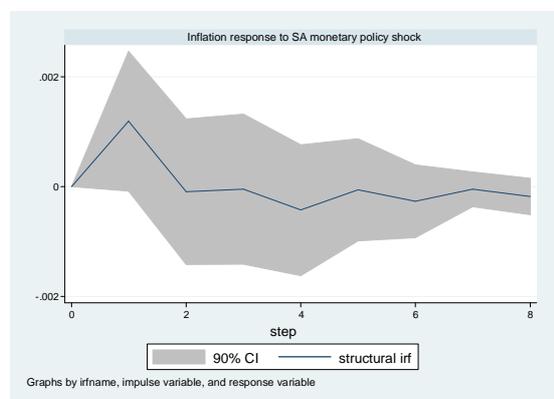
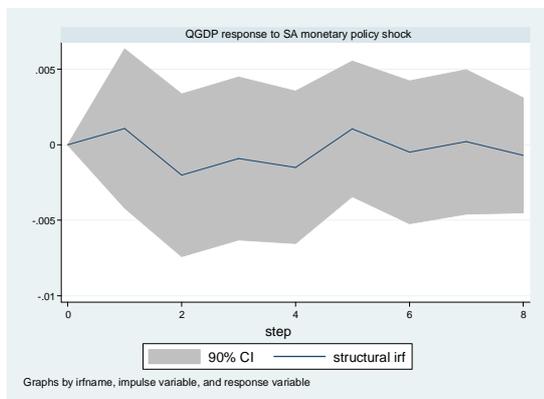


**Figure B.2-3 AB-model 3-variables for robustness checks: Sirfs for QGDP, inflation and repo rate to a one-standard deviation in domestic monetary policy shock.**

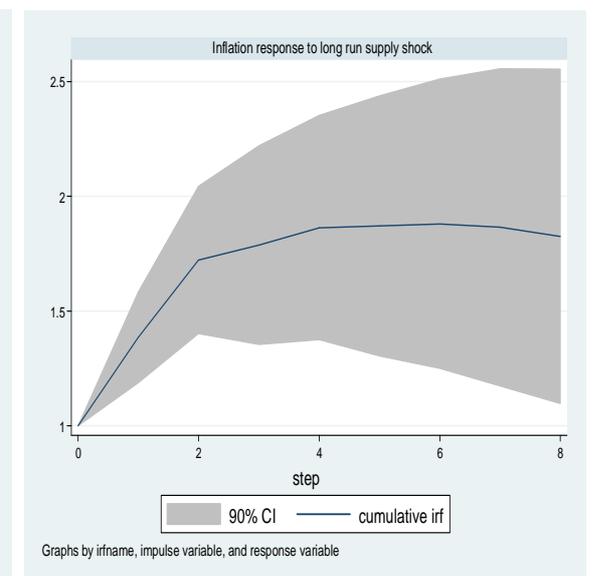
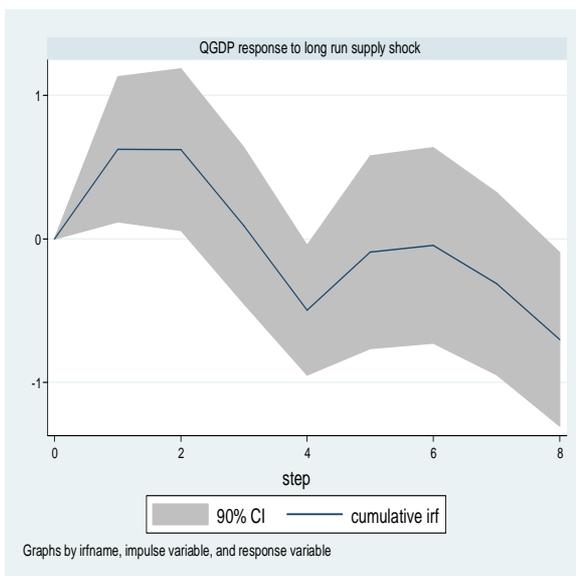
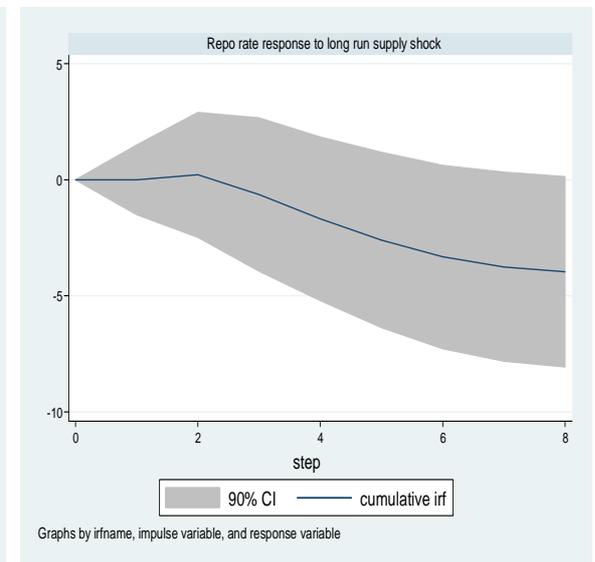
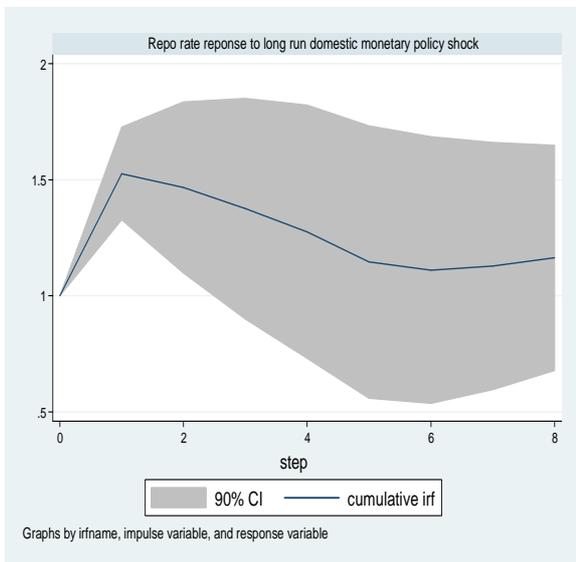
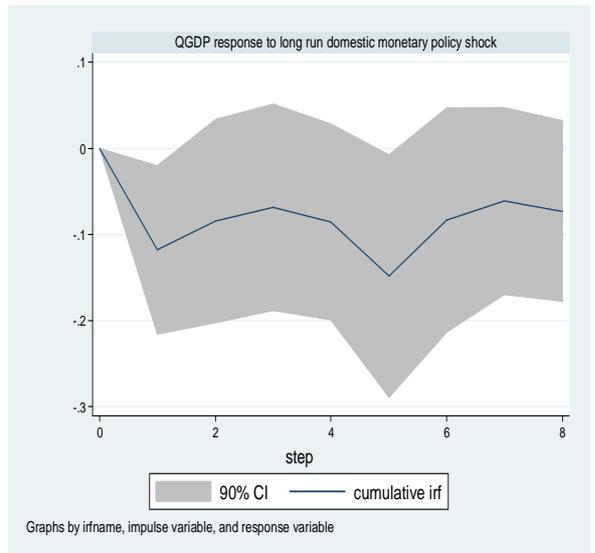
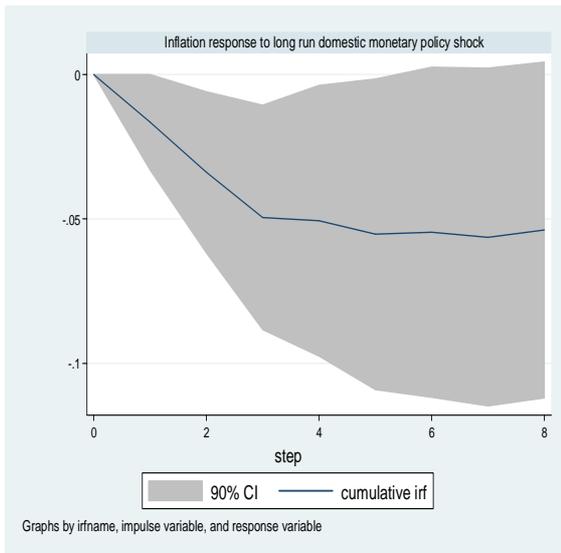


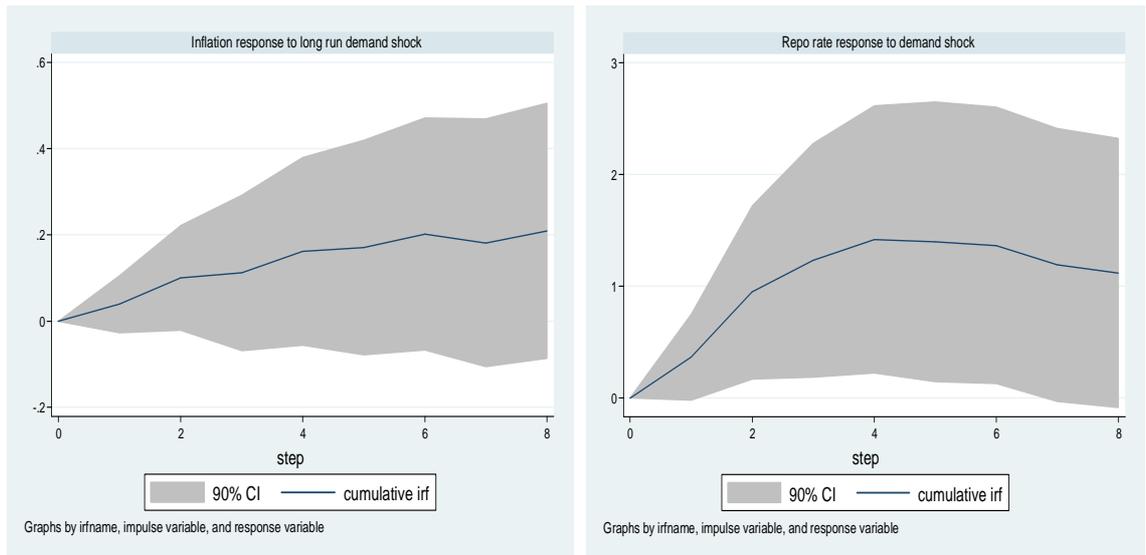


**Figure B.2-4 AB-model 3-variables for robustness check** Sirfs for QGDP, inflation and repo rate to the SA monetary policy shock.

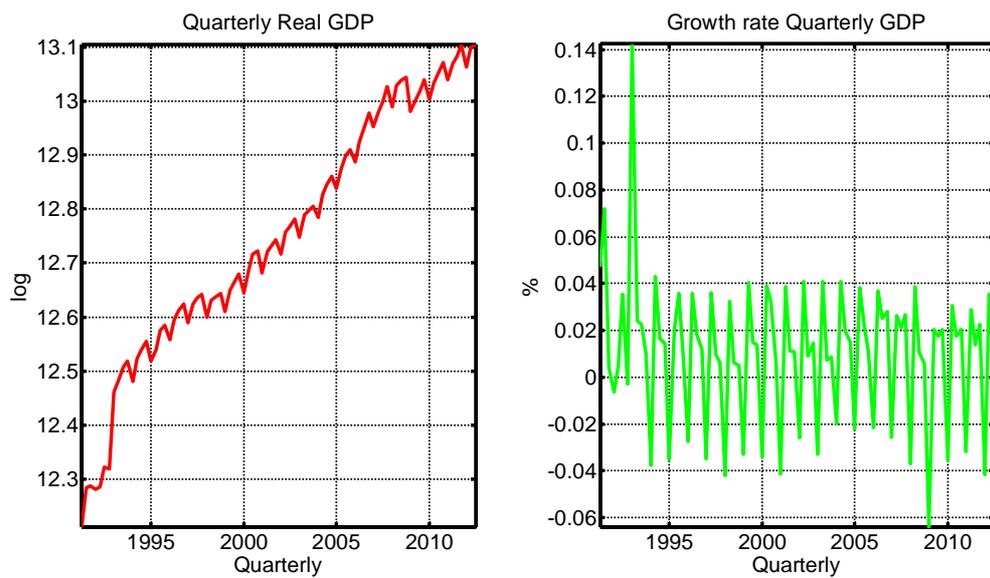


**Figure B.2-5 Long-run cumulative impulse response functions for QGDP, inflation and repo rate to a one-standard deviation in domestic monetary policy shock.**





**Figure B.2-6** Quarterly GDP and growth rate reported by the Namibia Statistics Agency (NSA)



**Robustness Checks: Three Variables short run SVAR recursive identifications**

$$\begin{pmatrix} 1 & 0 & 0 \\ a_{21} & 1 & 0 \\ a_{31} & a_{32} & 1 \end{pmatrix} \begin{bmatrix} u_t^{gdp} \\ u_t^{Inf} \\ u_t^{rn} \end{bmatrix} = \begin{pmatrix} b_{11} & 0 & 0 \\ 0 & b_{22} & 0 \\ 0 & 0 & b_{33} \end{pmatrix} \begin{bmatrix} e_t^{gdp} \\ e_t^{Inf} \\ e_t^{rn} \end{bmatrix} \quad (B.1)$$

$$\begin{pmatrix} 1 & 0 & 0 \\ a_{21} & 1 & 0 \\ a_{31} & a_{32} & 1 \end{pmatrix} \begin{bmatrix} u_t^{gdp} \\ u_t^{Inf} \\ u_t^{rs} \end{bmatrix} = \begin{pmatrix} b_{11} & 0 & 0 \\ 0 & b_{22} & 0 \\ 0 & 0 & b_{33} \end{pmatrix} \begin{bmatrix} e_t^{gdp} \\ e_t^{Inf} \\ e_t^{rs} \end{bmatrix} \quad (B.2)$$

## CHAPTER THREE

### Understanding Interest Rate Spreads (IRS): An investigation of macroeconomic and financial determinants of Interest Rate Spreads in Namibia

“When spreads ‘blow out’ (as market professionals put it), borrowing becomes prohibitively expensive, credit dries up, and economies are brought to their knees. Huge spreads often connote few transactions –markets are drying up” (Blinder, 2013, p. 241).

#### 3.1 Introduction

Interest rates spreads are primary features of every bank-based and market-based financial system. They are the conduits through which monetary and financial policies are transmitted to the economy. Generally, under the influence of central bank’s policy and financial institutions’ market powers, interest rate spreads when properly aligned, they can improve economic and productive efficiency which enhances welfare gains for households and businesses. However, interest rate spreads are double-edged swords. This is because persistently large interest rate spreads impede the very basic aims of monetary and financial policies which they suppose to serve in the first place. In crises times, large spreads amplify the effects of credit crunch and economic crises thereby increasing the magnitudes of business cycles.

Most often, higher and disequilibrium interest rate spreads indicate inefficient and uncompetitive financial systems which are a cause of concern in developing countries.<sup>100</sup> As a result, interest rate spreads have become a major central issue that dominates public debates in developing countries. Many researchers and policymakers are interested to find out causes and consequences of large spreads on economic development. In fact, (Taylor, 2008) has suggested that current monetary policy should be augmented with the spread to address financial instability. Blinder (2013, p. 242) argues that spreads and their consequences were not understood until the recent financial crisis which shows that ‘it is all [i.e. *all relevant information needed to discern the impending dangers in the financial system*] in the spreads’. Spreads are important because they determine the actual costs of

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<sup>100</sup> For example, Fuentes and Basch (2000) and Birchwood (2004) assert that interest rate spread impede savings and investments decisions. Beck and Hesse (2009) reveal that although large spreads have been expected after liberalization, their persistently high levels have been a major concern for policy-makers in developing countries.

borrowing. In Namibia, large interest rate spreads have been a cause of concern and a controversial issue. Specifically, the central bank and general public have expressed enormous interest particularly to understand the (i) main determinants of interest rate spreads; (ii) the dynamic behaviours of interest rate spreads; and (iii) the consequential effects of large changes in interest rate spreads on households and business credits. It is high time we address these concerns about interest spreads while both parties are interested to find out what can be done to reduce the large size of interest rate spreads. In this chapter we examine the underlying macro and financial fundamentals that seem to explain changes in interest rate spreads.<sup>101</sup> In the working paper (Kamati, 2013) examined the dynamic behaviours and consequential effects of changes in the spreads.

In the literature review, we established that there are many different definitions of interest rate spreads; and the selection of what are major spreads is subjective. Despite this caveat, spreads show significant links between the base rate in the hand of monetary authority and different market rates. The base rate we can think of is the central bank policy rate or government treasuries – risk-free rate. One important interest rate spread is given by the difference between the benchmark rate (often referred to as the repo rate) and the prime rate (the price at which most banks will lend to each other and to other prime institutions in the domestic economy). In this study, we call this difference the based spread.<sup>102</sup> This is the base spread on which other interest rate spreads in the financial markets anchor. Another spread is given by the difference between average lending rates and average deposit rates. This difference, for the sake of identification is called the retail spread. Finally, we have the risk premium spread which is the difference between prime lending rate and the short term risk-free rate (three-month T-bills). There are many interest rates in the financial sector; similarly there are also many definitions of interest rate spreads. For example, Brock and Rojas-Suarez (2000) identify six definitions of interest rate spreads in their study on interest rate spreads in Argentina. In this study we limit our

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<sup>101</sup> Banerjere (2001) argues that the problem is not that there is a difference between lending and deposit rates i.e. spread exists; but it is about the size of the spread which is a major concern in many financial systems. Generally, interest rate spreads must exist because intermediation is very costly; banks borrow on short term and lend on long term thus, exposing themselves to interest rate and credit risks and maturity mismatch.

<sup>102</sup> For convenience purposes and easy identification when analyzing the dynamic behavior of interest rate spreads, we have attached short names on various spreads. We called the *base spread* in the sense that it is a bench mark (with the bank rate as a virtually riskless base rate) for other spreads in the economy, while we used the expression *retail spread* because it primarily covers differences of prices in the banking sector (for exapmle see Hall & Lieberman, 2010, pp. 808-809). Curdia and Woodford (2010) used the term credit spread instead of interest rate spread while other definition of spreads includes: risk premium, yield spread, and the retail bank's spread. Blinder (2013, p. 238) assumed risk free rate as the base rate, therefore the margins over Treasury Bills will form the base spreads.

investigation to the base spread, retail spread, and risk premium because they are most recognizable and relevant in Namibia.

### **3.1.1 Objectives of the study**

In this study, we first investigate the unit root process and structural breaks in the base and retail spreads; secondly, we investigate macroeconomic and financial factors that determine changes in the interest rate spreads in Namibia. Under these objectives, we use two definitions of interest rate spread - base spread and retail spread - to identify empirical factors that significantly explain interest rate spreads in Namibia.<sup>103</sup> What are the macroeconomic and financial fundamentals that explain the changes in level of spreads in Namibia? Is there a significant relationship between ex ante base spread, retail spread and the macroeconomic fundamentals achieved in the country? We find the following empirical results concerning unit roots with structural breaks and the determinants of spreads.

Firstly, descriptive statistics show that on average the unconditional mean of spreads was statistically different from zero over the sample period. Secondly, the unit root test with endogenous breaks shows that the base spread, retail spread and risk premium have unit root process with structural breaks. The most common significant endogenous structural breaks were identified in the months 1998M06 and 1998M08. These structural breaks represent the structural changes caused by the 1997/98 East Asia financial crisis shocks on equity and commodities through South Africa to Namibia. For a commodity exporting country, the financial crisis had significant impact through commodity and equity prices that fell by more than 40% in Asia. Further, our unit root test results show that the order of integration in spreads is not influenced by the presence of endogenous structural breaks in the data. Thirdly, empirical results show that underlying fundamentals such as inflation, unconditional inflation volatility, changes in bank rate, perceived risk as measured by changes in the risk premium, economic growth, interest differential and South Africa's spread are some of the statistically significant macro and financial factors that explain changes in interest rate spreads in Namibia. However, our measure for financial instability did not perform well as this was statistically insignificant. Whether we use changes in the retail spread or changes in base spread, empirical results indicate that

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<sup>103</sup> Owing to unavailability of data on many important bank specific variables and fewer observations on micro level data, this analysis is based to a large extent on macroeconomic time series data. Although we made efforts to use the Bank scope database, we found that the annual observations available span a period of five years. Results from these observations are given as indicative on the appendix.

macroeconomics and financial fundamentals play significant roles in the determination of interest rate spreads in Namibia.

### 3.1.2 Motivation and Contributions of the Study

It is worth noting that the issue of higher interest spreads is not only confined to Namibia, but is also a contentious subject in many countries, including both emerging and developing economies. Folawewo & Tennant (2008) and Crowley (2007) view that higher interest rate spreads are a major problem in Sub-Saharan Africa countries, Beck and Hesse (2009) identify particularly Uganda. Brock and Rojas-Suarez (2000) also analyze determinants of spreads in Latin America, Birchwood (2004), and Craigwell and Moore (2001) investigated it in the Caribbean and Pacific nations. It seems that issue of interest rate spreads only catches the attention during crises time in advanced economies (see De Grauwe & Ji, 2013, p. 1). The situation is different when it comes to developing and emerging economies. It is clear from empirical studies that the problem of interest rate spreads generally become particularly more noticeable immediately after financial sector liberalization. Thus, not surprisingly, within the first ten years of independence, this sensitive topic has also generated a heated debate about the roles of financial intermediaries in Namibia. Some headlines that appeared in the print media about interest rate spreads are as follows:

- (1) “Bank rate showdown looms: Bank of Namibia (BoN) Governor Tom Alweendo has given commercial banks until year-end to reduce the interest rate spreads, or the difference between the central bank’s repo rate and banks’ prime lending rates, to 375 basis points” (Duddy, 2009); (2) “Rates war heats up: with only 12 days left to the Bank of Namibia deadline for the narrower interest rate spread of 425 basis points, the central bank and the commercial banks remain at odds about the controversial demand” (Duddy, 2009).<sup>104</sup>

Apart from these quotes, at other occasions, the Bank of Namibia (BoN) has expressed its main concerns about the magnitude of the spread between the repo rate and prime lending rate of commercial banks. The Central bank asserts that the size of base spread and many others are unjustifiable (see the Annex in the Appendix C.2).<sup>105</sup>

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[http://www.namibian.com.na/index.php?archive\\_id=55015&page\\_type=archive\\_story\\_detail&page=3581](http://www.namibian.com.na/index.php?archive_id=55015&page_type=archive_story_detail&page=3581)

<sup>105</sup> (i) For example, Paul Hartman the deputy govern of the Bank of Namibia argues that “The bank (BoN) views it as undesirable that the differential [5.00 percent] between the bank rate (10.25 percent) and the prime rate of commercial banks (15.25 percent) remains substantial, despite the fact that the bank rate is 50 basis points lower than that of the South Africa repo rate.” The Namibian, 01 February 2008. (ii) Rates drop

On the one hand we have central bank, businesses and households expressing concerns that interest rate spreads have negative effects on spending decisions. On the other hand, we have retail banks which seem adamant to defend their position that the size of interest spreads between bank rate and prime lending rate are justified. Thus, their independence as private institutions that is, individual rights to independently set prices according to market conditions is threatened by undue influences from the Central bank interventions. Some proponents that support large spreads argue that they are better than thin margins which make the financial system susceptible to collapse in the face of financial crisis. Therefore, it is desirable that interest rate spreads are large enough to sustain financial institutions when times are hard and profit margins are squeezed for a long period of time. Large spreads will also help financial institutions to sufficiently cover business costs such as staff, management, and infrastructure for payment services as well as financial intermediation costs. Furthermore, free marketers argue that higher interest rate spreads are therefore a reflection of high costs of doing business in Namibia.

This study and the next chapter are motivated by the quest to find empirical evidence about any significant economic relationship between large changes in spreads and fundamentals realized in the country over the past two decades. These empirical evidences contribute immensely to the redevelopment and revision of Namibia's financial charter and the monetary policy framework. These documents guide the execution of monetary policy by the Bank of Namibia and the financial charter of the ministry of finance in Namibia. As in other mixed economies, the mode of implementing monetary policy in Namibia does not permit the central bank to give direct instructions to retail banks on how they should price their financial products and services. This feature as in any market economy is left to financial intermediaries to make their own decisions as they view the demand and supply of funds in the financial markets. However, it is now recognized that this arrangement has some drawback because it leaves limited options for policymakers to influence interest spreads into a desired level (see also Hall & Lieberman, 2010, p. 808).<sup>106</sup>

Secondly, in our view, some empirical evidences about the significant roles fundamentals in spreads and the behaviours of interest rate spreads are essential for

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at 'own peril' BoN warned. Duddy (2009), reported that according to FNB CEO Vekuii Rukoro, 'The financial impact of the Bank of Namibia's push to narrow the gap between the repo and the prime lending rates to 425 basis points by month-end and 375 basis points by next October, will be "profound, and very profound"', and he added that 'the Namibian economy will be hit profoundly too,'. The Namibian, 21 October 2009. See also the Annex 1.1 in the appendix.

<sup>106</sup> Hall and Lieberman (2010) discussed the challenges of using the conventional tools (e.g. federal fund rate) to correct interest rate spreads in the US.

designing the monetary policy that takes into the importance of spreads. These evidences are necessary to guide the central bank and other financial regulators in addressing the problem of large interest rate spreads in the financial sector. For example, in the past decade, the Bank of Namibia has been persuading all banks to narrow their spreads in order to ease the burden of repaying debts by businesses and households. However, these persuasions were not based on any empirical research showing that the size of interest rate spread is unjustifiable and thus, poses a threat to overall welfare (see the directive from BoN on the Appendix C.3.3). Additionally, despite the importance of this topic we are not aware of any comprehensive empirical study so far that examines the causes of spreads and effects of changes in interest spreads in Namibia. The lack of empirical evidence as to what significantly explains interest rate spreads, and how interest spreads affect businesses and households is obstructing the efforts to device appropriate policies that could help address the problem of large interest rate spreads. Thus, we hope this study will help policy makers to make well-informed decisions about this central issue in Namibia's financial sector.

In order to fill this gap, we document the empirical evidence about the bank-specific and macroeconomic determinants that significantly explain changes in spreads in Namibia. This empirical chapter is followed by the last chapter that examine how spreads can be integrated in the current monetary policy framework. However, we do not expect to answer all questions related to the issue of interest rate spreads in Namibia. Thus, we hope this study will serve as a starting point for constructive debates and will provide the necessary foundation for further studies related to this topic. It is a fact that interest rate spread is a complex topic and touches many technical areas of financial intermediaries which require independent studies. Hence, we admit that some factors can only be fully examined at micro level as they are either too 'bank' specific or too 'geographical' specific. We point out here that while this was one of the main goals, to have complete analyses both at macro and micro levels; we were not able to extend to the micro level because of our inability to get enough bank level data. Even at the macro level, some variables do not have enough observations.

Finally, this study aims to complement the current *Namibia Financial Strategy 2011-2021* (NFSS).<sup>107</sup> This strategy aims 'to develop a more resilient competitive and dynamic financial system with best practices in order for the sector to realize its full potential in respect to the growth of the economy'. The key areas of focus in the NFSS which relate to our study are: to increase financial markets deepening and development as

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<sup>107</sup> Namibia Financial Sector Strategy 2011-2021 is available at: <https://www.bon.com.na>

well as financial inclusion. Financial inclusion aims to raise the standard of consumer financial literacy and improve access to financial services and products.

### **3.1.3 Organization of the study**

Following this introductory section, this study is structured into three sections. Section 3.2 discusses the literature review about the roles of banks and models of interest rate spreads and empirical studies of determinants of interest rate spreads. Section 3.3 starts with methods, descriptive statistics and unit root test with structural breaks and regression results, and finally, conclusion and policy implications.

## 3.2. Literature Review: Roles of financial intermediaries, and interest spread models

As a matter of fact, interest rate spreads are a basic feature of financial intermediation. The movements of these spreads affect the supply and demand of financial intermediation services in the financial sector. This is because, as part of their main activity, banks accept deposits as liabilities and issue loans; hence a difference between the lending and the deposit rate or any other rate is bound to occur in the market economy. Intermediation allows banks to borrow from surplus units and lend to deficit units at a higher premium. Thus, it is logical that interest rate spreads should make provision for the cost of originating loans, risks of extending credit and returns for the owner's capital and costs for other financial services rendered. Therefore, to understand the subject of interest rate spreads better, we need to examine some theoretical underpinnings for supply and demand of financial intermediation. To start with, we explained the main roles of banks; this is followed by a review of theoretical and empirical models about financial intermediation. We derive theoretical lessons that will help us to explain factors that determine intermediation spread in theory and to illustrate how this can be applied from the context of industrial organization theory. As there is no specific theory or generally agreed framework to model interest rate spreads, this review is aimed to help us formulate the econometric method that we will use to estimate and analyze fundamentals that explain interest rate spreads in Namibia.

### 3.2.1 Roles of Financial Intermediaries in the financial system

Traditionally, banks exist to facilitate allocation of resources from surplus units to deficit units. Banks, as financial firms, play a critical role in the economy as they provide liquidity and payment services. The main fundamental roles of banks are listed as follows: to provide liquidity and payment services; to transform deposits into assets; to manage risks; to process information and to monitor borrowers. According to (Machiraju, 2008) banks exist to provide packages of financial services which individuals cannot offer. Individuals find it very costly to search out, produce and monitor financial products and services.<sup>108</sup> These costs include searching, transaction and contracting, and evaluation and monitoring costs. Therefore, banks exist to offer these essential financial services at more competitive costs than households would.

*Liquidity and payment services:* One of the most important processes of financial intermediation is to provide liquidity and payment services in the financial system. Banks

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<sup>108</sup> See Machiraju (2008)

collect deposits and other short term funds from surplus units and channel them to deficit units in the economy. Irrespective of the level of development of financial markets in the country, banks provide both funding liquidity and market liquidity. For example, in developing countries, banks deal with the public at large as lenders and depositors or vice-versa, providing banking services such as salary payments for government employees, and making contract payments to firms. These roles are amplified by the absence of deep financial markets in many developing countries. The role of payments by banks is also reinforced by people's preference to exchange goods for money rather than goods for goods, as was the case in the barter system. Hence, financial intermediaries' existence enables the smooth running of the economy. Banks provide saving facilities which help consumers to smoothen their consumption over time, while allowing businesses to access trade credit for imports and exports, see (Strahan, 2010).

*Maturity Transformation:* Another important role of banks in the economy is the process of maturity transformation. Banks collect a pool of deposits from households and firms, and short term funds from money markets and transform them into large securities with long term maturity. This intermediation role creates a link in the economy through banks, as various economic agents such as households and firms- become lenders or borrowers of funds from banks.

However, the process of maturity transformation attracts and exposes financial intermediaries to a myriad of risks in the longer term. These risks are systemic, political or economical in their origin.<sup>109</sup> The immediate role of financial intermediaries is to minimize risks by maintaining competitive interest rate spreads on main financial products and services. It is for these reasons that the average banks' margin should implicitly reflect the fixed and variable costs of services provided and the return to equity capital, and the provisions to generate internal capital through returned earnings.<sup>110</sup>

*Risk Management:* As mentioned above, another role of the bank is to manage risks which they assume when they accept public deposits and further invest it in illiquid assets. Financial intermediation exposes banks to myriad risks such as: maturity mismatch risk, interest rate risk, default risk, liquidity risk, and credit risk and other exogenous risk. Banks are well endowed with the technology to manage large assets and liabilities and the risks

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<sup>109</sup> For example, a decline in government revenues can generate a systemic problem in the form of liquidity problem in the economy. When there is a liquidity problem, some banks will be unable to meet their commitments in the short term. Liquidity problem is particularly a major problem in financial markets that are dominated by government bonds. This liquidity problem may trigger panic among the public and result in what is called a bank run.

<sup>110</sup> See Ennew, Watkins, and Wright (1995) and Eyster (2010).

that come along with them. Through the technology, many banks are well placed to mitigate these risks as opposed to individuals who are exposed to the risks associated with direct lending. Thus, banks allow interest rate spreads to freely adjust to account for risks associated with liabilities and direct lending.

*Monitoring and Information Processing:* Banks also act as delegated monitors and information processors on behalf of borrowers and lenders. The role of monitoring and information gathering is made possible by the special ‘borrower-lenders’ relationship which is peculiar to banks. Banks aim to establish a relationship with their customers through which they can collect information. The probability of a long relationship over time puts banks in a better position to accumulate information about households and firms. As more information is collected, this can be used to evaluate any application from households or firms, which results in an economy of scale for the banks.

### 3.2.2 Theoretical models of interest rate spreads

In this section we briefly point out some of the theoretical and empirical models used to investigate determinants of and consequences of changes in interest rate spreads in the literature. We discussed the model’s specifications and their applications to interest rate problem. We left out mathematical derivations of these models which are not necessary for this chapter. Firstly, we start with Woodford and Curdia (2009) who describe the relationships between the macroeconomics and financial intermediation. They introduced financial frictions in the form of credit spread within a new-Keynesian model. This illustrates how changes in the credit spread affect the supply of financial intermediation given the level of income, interest rate and the perceived riskiness of borrowers in the economy. As Groth (2012, p. 1) puts it, “the essence of the ‘story in the Woodford paper’ is an account of the determination of and the consequences of changes in the wedge” that is, credit spread between deposits and lending rates. Woodford’s model contains all necessary equilibria; however, here we start with the equilibrium of financial intermediation which specifically gives the implicit function of credit spread.

In this model, there is supply and demand of new loans with supply upward sloping and demand downward sloping. Supply of new loans in the short run is constrained by rising marginal cost because some input are fixed for example, human capital. The supply also increases with the size of credit spread (interest rate spread) as it is more profitable for financial intermediaries to provide credit when the spread is large. Woodford and Curdia assert that given the size of credit spread  $\omega$ , the supply of financial intermediation increases with income and decreases with the perceived riskiness of borrowers. This will

allow banks to carry out their role of intermediation in the economy. Let loans supply be  $L^s(Y, \omega; \sigma)$ , demand for new loans  $L^d(Y, \omega)$ , the credit spread is denoted by  $\omega$  and  $\sigma$  represents the perceived riskiness of supplying loans to borrowers and  $Y$  is gross national income. In equilibrium, supply and demand for new loans are equal.

$$L^s(Y, \omega; \sigma) = L^d(Y, \omega) \quad (3.1)$$

The credit spread  $\omega$  can be written as an implicit function of  $Y$  and  $\sigma$ ,

$$\omega = \omega(Y, \sigma). \quad (3.2)$$

Overtime, the total changes in  $\omega$  can be shown by taking the total differential of (3.1) with respect to  $Y$ ,  $\omega$  and  $\sigma$  on both sides which results in the following equations<sup>111</sup>:

$$L_Y^s dY + L_\omega^s d\omega + L_\sigma^s d\sigma = L_Y^d dY + L_\omega^d d\omega \quad (3.3)$$

$$d\omega = \{(L_Y^d - L_Y^s) dY - L_\sigma^s d\sigma\} (L_\omega^s - L_\omega^d)^{-1} \quad (3.4)$$

Suppose we let  $\alpha = (L_Y^d - L_Y^s)(L_\omega^s - L_\omega^d)^{-1}$  and  $\beta = L_\sigma^s (L_\omega^s - L_\omega^d)^{-1}$  then (3.4) becomes

$$d\omega = \alpha dY - \beta d\sigma. \quad (3.5)$$

The equation (3.5) suggests that the total change in interest rate spread  $\omega$  is ambiguously related to changes in income, and unambiguously related to the perceived riskiness of supplying loans to the ultimate borrowers.<sup>112</sup> The model therefore offers some lights on what should contain the set of determinants of interest rate spread. Some of these are real income growth and the risk premium or risk perceptions.

Classens et al. (2006) in their effort to identify determinants of interest rate spread in Brazil used the following linear model. This is specified as follows:

$$r_i - r = \alpha + \beta r + \text{other factors} + u \quad (3.6)$$

Whereby  $r$  is the base interest rate and the  $r_i$  is the lending rate for bank  $i$  while other factors include variables that are deemed to influence interest rate spreads and  $u$  is the stochastic term. This simple linear model above is nothing else than the rearrangement and modification of the first order conditions derived from the Monti-Klein model of a

<sup>111</sup> See more about the IS-LM model with financial intermediation in Groth (2012, pp. 5-12).

<sup>112</sup> The partial effects of  $\Delta Y$  are ambiguous because the term  $\alpha$  in (3.5) can take any signs depending on the difference of partial derivatives inside the parentheses.

monopolistic bank. These first order conditions give the usual Lerner index which shows the price of a loan ( $r_i$ ) minus the costs of deposit ( $r$ ) which include the marginal cost of an additional loan all equal to inversely related elasticity.<sup>113</sup> This reflects the market power of the firm (bank) as it shows the price distortion between price of a loan and the marginal cost. Young (1996) clearly points out that the spread resulting from these conditions is the same as the product price in industrial theory using loans as output of the firm.<sup>114</sup> Thus, interest rate spread of bank  $i$  is determined by  $\alpha$ , which can be regarded as the industry marginal cost of raising an additional loan,  $r$  which is the level of base interest rate (policy rate) and other factors represent the macroeconomic and financial factors that explain variation of interest rate spreads in the banking sector.<sup>115</sup> For simplicity,  $\alpha$  is a constant term which represents firm's average marginal cost rate if we assume that all firms have the same level of technology. The general challenge of the Monti-Klein model is that it is based on the much criticized theory of industrial organization (IO) of the firm. Although IO theory offers some of intuitions about financial intermediation, it has been proven that banking firms are very different from industrial firms. For example, when we apply IO theory to study financial intermediation, one has to contend with issue of firm's classifications that is, deciding whether banks should be classified and examined as monopolistic, oligopolistic or perfectly competitive, and the challenge of costs allocation when there are non-financial institutions (e.g. the post office saving bank) that also provide intermediation service. Furthermore, banks are different because the banking business is a confidence business while this is not necessarily the case to the same extent for industrial firms.

Another important point about Classens et al. (2006) model is that, the model over-emphasizes the level interest rate above other variables. This might be because the first order conditions from the profit maximizing monopolistic bank clearly gives the interest rate as one of the explanatory factors of the interest rate spread. Although the level of the interest rate plays a significant role in the determination of interest rate spreads, many researchers have shown that this alone cannot fully explain why the interest rate spread is much higher in some countries such as Brazil, the Caribbean community and sub-Saharan Africa. In addition, it is exposed in the literature that competition in banking goes beyond price and therefore there are many fundamentals that extensively influence the wedge

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<sup>113</sup> Lerner Index =  $\frac{r_i - mc(q)}{r_i} = \frac{1}{\varepsilon}$ , mc=marginal cost and  $\varepsilon$  is the price elasticity of demand.

<sup>114</sup> Young (1996) used a theoretical model to analyze how bank behaviors affect total lending to household and business. The results from the theoretical model illustrate that higher costs, tighter external lending control, balance sheet control, and less competition can reduce lending through the interest rate.

<sup>115</sup> Rochet and Xavier (2008, pp. 8-10) gave derivations about the Monti-Klein model.

between return on deposits and prime lending rates. Furthermore, in the recent financial crisis 2007/08, it has been shown that although most interest rates were close to zero, a dramatic spike in the spread reinforced and prolonged the effects of the credit crunch.

Gertler, Hubbard, and Kashyap (1991) use a linear model to examine the relationship between interest rate spreads and investment fluctuations. They started from the premise that the interest rate spread reflects ‘the payoffs’ or ‘default risk’ in the economy. Hence, the problem of identifying the determinants of the interest rate spread is about identifying these factors that shift the ‘payoffs’ or ‘default risks’ in the economy. They implicitly specified the interest rate spread equation as follows:  $\text{Spread} = f(\text{GNP}, \text{investment}, \text{other factors})$ . The model combines both micro level and macroeconomic factors which are assumed to shift default risks and payoffs. The theoretical result shows that the current changes in interest rate spread are partially explained by financial variables through business cycles. Additionally, the empirical result of Gertler, Hubbard, & Kashyap (1991) shows that a shock such as an immediate rise in wealth increases capital and consequentially lowers the interest rate spread.

### ***3.2.2.1 Interest rate spreads the likelihood function***

What interest rate spreads are, and how to effectively model them, are some of the challenges that have been recognised by many authors on this topic.<sup>116</sup> For example, Birchwood (2004) and Brock and Franken (2002) acknowledged this problem and all expressed dissatisfaction at the lack of an agreed general framework in the literature on how to model interest rate spreads. We find that empirical analyses based on the theory of the firm had skewed micro level analysis while neglecting the role of macro and financial fundamentals in interest rate spreads. For example, the Marshal-Lerner condition equation emphasised the microeconomic factors without accounting for the contribution of macroeconomic fundamentals realised. Another common definition used to model interest rate spreads covers the interest earned and interest rate paid accounting identity – this is called net interest rate. Net interest rate spread is the difference between interest earned on loans, securities and other interest-earning assets and the interest paid on deposits and other interest-bearing liabilities. We disagree with the use of accounting identity on the following grounds. Firstly, because it is an identity, therefore it implies that the identity conditions must hold at any time irrespective of whatever is happening.<sup>117</sup> Thus, modelling this as an equation without formulating the assumptions that turns the identity into a

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<sup>116</sup> It has been recognised that both *ex ante* and *ex post* definitions of interest rate spreads have their weaknesses.

<sup>117</sup> Identity is an equation that is true no matter what number is plugged in for the unknown variable.

stochastic equation is methodologically wrong. Secondly, the interest rate earnings minus interest rate income identity emphasises the balance sheet variables more than relating it to other factors that do not feature directly in the balance sheets of financial firms. Thus, it is very difficult to relate variables that do not directly link firm balance sheets to this accounting identity. Taking into account all these challenges we decided to use the implicit formulation by Woodford and Curdia (2009) and the linear model used by Classens et al. (2006) to come up with the likelihood function of how to model interest rate spreads. As in Curdia and Woodford (2009) and Classens et al. (2006) we proposed that interest rate spreads is a function of the average cost of originating the loan, the price of credit from central bank, perceived risk, income, and other macroeconomic and financial fundamental realised in the country under study. This relation should also include structural dummies to take into account structural changes and transitions from one regime to another over sample period. We expressed this economic relation as follows:

$$\Delta(r_i - r) = \text{constant} + \Delta\text{income} + \Delta\text{perceived risk} + \Delta(\text{macro\&financial fundammentals}) + \text{interest differential} + \text{structural dummies} + \text{error term}$$

(3.8).

In order to take into account the unit root process and endogenous structural breaks manifested in some of the spread variables we will start from the first difference with pulse dummy variables. It is important that we highlight some of the challenges usually encountered in estimating a single equation such as this and how we propose to overcome them. The first immediate challenge relates to uncertainty around the true functional form of interest rate spreads. This refers to whether the true relationship between changes in the spreads and the determinants should be treated as a linear or non-linear relationship. Similarly, since the dependent variable is a time series the functional form should take into account the dynamic structure of the dependent variable and the length of memory in the average spreads; that is, the lag length to address autocorrelation. The next challenge concerns how to deal with regime shifts and the unit root process with structural breaks as has been observed in some of the interest rate spreads in Namibia. Lastly, we need to determine the list of covariates to include in the model while avoiding over fitting.

Firstly, the issue of linear or non-linear functional form can be handled very well by using a Generalised Method of moments while other tests such as the reset test can be used to check the adequacy of the model. Holly and Turner (2012, p. 21) pointed out that

‘the main advantage of GMM estimator is that we don’t have to write down a conventional regression relationship. Instead we can specify an implicit relationship between variables.’ In addition, this allows techniques to minimise the problem of multicollinearity through instruments while bearing in mind that the model is less restrictive on the data generating process. However, we must highlight other methods that are adequate in analysing the problem of interest rate spreads. These methods include the Stepwise least squares method, the smooth transition auto-regressive (STAR) model and the logistic smoothed transition model (LSTAR). STAR and LSTAR methods estimate simultaneously estimate the linear and non-linear part of the dependent variable with the ability to identify whether the non-linear part is statistically significant. In addition, the STAR model accounts for structural breaks and the transition function, and whether the transition is governed by logistic or exponential functions from one regime to another. However, STAR models do fail when both linear and non-linear parts exhibit the unit root process with structural breaks. This seems to be the case with the interest rate spreads in Namibia whereby even after identifying and including the endogenous structural break in the dependent variables (i.e. spreads) these still do not pass the unit root test with structural breaks. This implies that augmenting the process with structural breaks does not make the time series variable stationary. Thus, we differenced the variables involved in the regression and used the impulse dummy rather than the level shift dummy.<sup>118</sup>

Further we adjust the single equation to account for the timing effects and the memory of the dependent variable. It is therefore essential to append some macroeconomic fundamentals to lags the in the list of independent variables. The long memory in the dependent variable will require the use of the Auto-regression Integrated Moving Average model with exogenous variables (ARIMAX). However, the ARIMAX model is limited to how many exogenous variables should enter because too many with their lags make it very difficult to establish which should be in or out even with a Granger causality test. In the case of GMM and related estimators this task is simplified by omitted variables and redundant variable tests to avoid over fitting the model. After establishing that there is no serial correlation, insignificant independent variables can be assessed jointly and individually in regard to whether they are redundant in the final regression. Finally, we used two unconditional inflation and interest rate volatilities measures, which summarise the factor effects of macroeconomic and financial instability on interest rate spreads. Other

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<sup>118</sup> Another alternative method for regime shifts is the stepwise regression method. Although this method may partially address the problem of regime shift, it is argued that it is too subjective and the outcomes are either over fitted regressions with less optimum results.

factors such as the changes in income, interest rate, financial depth and perceived risk are theoretically suggested by Woodford and Curdia (2009) and Groth (2012, p. 1) as factors that contribute to the variation of interest rate spreads.

In all, we aimed to overcome the quandary about modelling spreads as we opt for the Generalised Method of Moments to investigate the factors that seem to explain interest rate spreads in Namibia. GMM requires less information about the exact mathematical relations of the problem that needs to be examined. Therefore, in a situation whereby we have less information about the likelihood functions (that is, an explicit linear or non-linear function that describes interest rate spreads), the GMM approach is an appropriate tool to estimate the partially specified economic models and the results from a single equation can be examined for consistency when results from two closely related estimators OLS and TSLS are estimated alongside.<sup>119</sup>

### **3.2.2.2 OLS, TSLS and GMM estimators**

This section gives a brief discussion about the econometric methods we used to estimate the coefficients of the two dynamic models. There are many excellent materials which offer more details about how the OLS, TSLS and GMM estimators are derived.<sup>120</sup> These three methods are closely related and somehow produced results that are closely comparable.<sup>121</sup> Here, we only highlight some important aspects that are necessary for the interpretation of our results. We start the discussion with OLS, TSLS and GMM estimators, followed by essential requirement for instrument variables and weights, and the motivation for the robust-standard errors from heteroscedasticity and autocorrelation consistent covariance (HAC). This is also known as the Newey-West standard errors.

The general representation of OLS is as follows:

$$\mathbf{y} = \mathbf{X}'\boldsymbol{\beta} + \boldsymbol{\varepsilon}, \quad (3.9)$$

<sup>119</sup> See further support for GMM in Hansen (2010) and Heij, De Boer, Franses, Kloek and Van Dijk (2004).

<sup>120</sup> See for example, Green (2003) chapter 3 & 18, Hayashi () chapter 3 & 7..

<sup>121</sup> For example, GMM usually have large standard errors as compared to OLS and 2SLS. Secondly, it is possible that some coefficient estimates that are significant under OLS and TSLS can become insignificant in GMM. However, it is recommended that one pays attention to the following observations. When the estimated coefficient switches signs or explodes in size and/or significance, these observations signal that there might be problem with the estimated result. Our main drive is to use OLS and TSLS are benchmarks for GMM results.

$$y = \begin{pmatrix} y_1 \\ \cdot \\ \cdot \\ y_N \end{pmatrix} X = \begin{pmatrix} x_{11} & x_{12} & \cdot & \cdot & x_{1k} \\ \cdot & \cdot & \cdot & \cdot & \cdot \\ \cdot & \cdot & \cdot & \cdot & \cdot \\ \cdot & \cdot & \cdot & \cdot & \cdot \\ x_{N1} & x_{N2} & \cdot & \cdot & x_{Nk} \end{pmatrix}, \beta = \begin{pmatrix} \beta_1 \\ \cdot \\ \cdot \\ \beta_k \end{pmatrix}, \varepsilon = \begin{pmatrix} e_1 \\ \cdot \\ \cdot \\ e_N \end{pmatrix}. \quad (3.10)$$

Using the assumption of no correlation and multicollinearity .i.e. (i)  $\hat{X}\varepsilon = 0$  and (ii)  $rank(X) = k$ , the OLS estimator is derived as follows:

$$\begin{aligned} X'\varepsilon &= X'(y - X'\hat{\beta}) = X'y - X'X\hat{\beta} = 0 \\ \hat{\beta}_{ols} &= (X'X)^{-1} X'y. \end{aligned} \quad (3.11)$$

The regression results from OLS estimator are consistent as long as the fundamental assumption for consistency is fulfilled i.e.  $E[X\varepsilon] = 0$ . For many regression results, this is not always the case, and thus an alternative estimator that is robust to the problem of endogeneity is necessary. Generally, the violation of ordinary least squares assumptions is occurs because the error term is related to regressors, or because the presence of heteroscedasticity all lead to an inconsistent and bias OLS estimator. In the presences of problem the OLS results are inefficient and valid inferences should be drawn taking into account the biasedness in the estimator. The problem of heteroscedasticity and autocorrelation can be addressed through HAC-robust standard errors; and the endogeneity problem requires a different estimator that produces consistent and efficient point estimates.

The first port of call to solve the problem of endogeneity is the so-called Instrument Variables methods (IV). Instruments variable methods provide consistent estimators under the strict condition that they exist and correlate with regressors in the model. For this analysis we have used two IV estimators: Two Stage Least Square and Generalized Method of Moments estimators. Our choice is based on the fact that that these estimators are closely comparable to OLS estimator.

TSLs or IV method is aimed at removing the dependency between endogenous explanatory variables and the error term. This endogeneity problem violates the OLS assumption of no correlation between explanatory variables and the error term. As a result, OLS coefficient estimates are inconsistent that is, the estimated parameters are not close to the true values of the regression even when the sample size increases. TSLs is applied to

isolate that part of  $X$  which is not dependent on the error in order to obtain consistent estimates. TSLS estimator is given by

$$\hat{\beta}_{2sls} = (\hat{X}'X)^{-1} \hat{X}'y \quad (3.12)$$

The difference between TSLS and OLS is that  $\hat{X}$  is new matrix of regressors which is obtained by first stage regression of  $X$  on  $Z$  to obtain the fitted values of  $\hat{X}$ . The matrix  $Z$   $dim(z)$  is called the instrument variables set which helps to solve the classical problem of endogeneity in the least squares regression results. The required conditions are that  $Z$  should satisfy: (i) orthogonality/validity conditions  $E[Z\mathcal{E}] = 0$ ; and, (ii) Relevance/rank condition i.e.  $E[ZZ']$  has a full rank. TSLS provides a most efficient estimator when the errors are independent and homoskedastic. Although TSLS estimates are consistent in the presence of heteroscedasticity, the standard errors are inconsistent when these strict conditions are not fulfilled, thus pose a problem in making valid inferences. This problem can be addressed through heteroscedasticity and autocorrelation consistent (HAC) standard errors. As Hansen (2010) argue this solution is only possible if we know the exact form of heteroscedasticity, which we usually do not know. The GMM estimator deals with these problems.

The GMM approach begins from the fact that some regressors in  $X$  are correlated with errors. In other words some of the regressors are endogenously determined hence; they do not stand for independent effects on dependent variable. Although this problem can be addressed with TSLS and other closely related IV estimators, there are some weakness within their formulation. For example, Green (2003) points out that the short comings of these estimators are that they require strong assumptions about the distribution and the data generating process. However, in the case of GMM estimator there is less information required about parametric assumptions such as the normality and data generating process.

The criterion function of GMM estimator that solves  $\hat{\beta}$  for  $\beta$  is given as follows:

$$\hat{\beta}_{GMM} = (X'ZWZ'X)^{-1} X'ZWZ'y, \quad (3.13)$$

Whereby  $W$  is a full-rank symmetric-weighting matrix. An important point to emphasize here is that there are different kinds of weights  $W$  and so, the results too are weight dependent. Cameron & Trivedi (2009) reveal that weights depend on data and on unknown parameters. Unlike other IV estimators, the GMM estimator does not require the explicit specification of the likelihood function and probability distribution. This estimator fits our

estimation for the determinants of spreads because we do not have a specific theory to derive the likelihood function. Harris & Matyas (1998) point out that the main difference between GMM estimator and other estimators lies in what must be specified of the model as in other estimators we begin with much less information about the data generating process. Although this has some advantages for estimation, it comes with some costs too. For example, Heij, De Boer, Franses, Kloek, & Van Dijk (2004) argue that assuming less information about the data generating process comes with loss of efficiency as compared to other estimators like the Maximum Likelihood estimator. Additionally, the GMM estimator can also perform poorly in finite samples.

As Cameron & Trivedi (2009) point out, these IV estimators have the same starting point. IV estimators start with the so-called instrument variables ( $\mathbf{Z}$ ), the choice and evaluation of these instruments vary. After establishing the set of instruments, the next task is to evaluate statistically whether these instruments are good instruments. Good instrument should fulfil the following conditions: the relevance and validity conditions. There are three conditions required to implement TSLS and GMM methods which are: (i) there must be at least as many instruments as the number of parameters; this means that the  $\dim(\mathbf{z}) = \dim(\mathbf{x})$  for a just identified case. When the  $\dim(\mathbf{z}) < \dim(\mathbf{x})$  this under-identified case means there are fewer instruments than the regressors. When the  $\dim(\mathbf{z}) > \dim(\mathbf{x})$  this is the case where there are more instruments than the regressors. In (ii) and (iii) the instruments must be relevant and exogenous. The latter two conditions imply that the correlation between instruments and independent variables is not zero, while the correlation between the instruments and the error term must be equal to zero. The common approach to select instruments is therefore to treat the predetermined and exogenous variables as instruments, and add lags of endogenous-independent variables to the list of instruments. This implies that the constant and dummy variables enter the set instrument variables by virtue that they are exogenous. To establish the validity of these instrument variables, we checked whether the value of criterion function in TSLS and GMM is positive. This value is given by the J-statistic and its associated p-value which indicates the significance level. This weighting matrix helps to ensure the positive definiteness of estimated co-variance matrix and the heteroscedasticity autocorrelation is consistent standard errors.<sup>122</sup>

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<sup>122</sup> Choosing the weighting matrix is of the important aspect solving the TSLS and GMM estimators.

### 3.2.3 Review of Empirical Studies about Determinants of Interest Rate Spreads

The literature on the topic of ‘interest rate spread’ is extensive and most studies address the question of what the determinants of the interest rate spreads are. In many studies authors have shown that there are many determinants of interest rate spread. These determinants are either peculiar to a region or a country. For example, while some authors identified lending in dual currency as one of the cause of higher spreads in some of the Latin American countries; it is good to point out that this factor is not relevant in sub-Saharan Africa. This is with exception to countries such as Angola and Zimbabwe where multiple currencies are still in operation. Hence, the underlying fundamental factors responsible may vary from country to country. The common thread is that higher intermediation spreads are a significant political and economic issue in the Latin American countries, the Caribbean, some Asian and the Sub-Saharan Africa. Some of the main macroeconomic factors identified in the literature portray high economic risk profile of the country (persistent deficit and government debts), persistent high inflation volatility, and lack of financial depth and the use of multiple currencies for lending in the domestic economy. At micro-level many researchers identified micro factors such as overhead costs, abuse of market power through market concentration, and restrictive financial regulations. The common approach in the literature is to differentiate between macroeconomics, market structure variables, and bank-specific factors. For example, Crowley (2007), Beck & Hesse (2009), and Folawewo and Tennant (2008) argue that small developing countries tend to exhibit higher interest rate spreads in comparison to large economies or economies with larger economies of scales.<sup>123</sup> Therefore, these fundamentals are examined as time-varying macroeconomic factors which include economic growth, inflation and inflation volatility, the level of bank rate, interest rate and interest rate volatility. Other researchers investigate vectors of market structure and time-varying bank-specific factors together which generally include: the degree of market concentration, bank regulations, bank size, inter-bank market liquidity, operation costs (e.g. overhead costs), taxes, and non-performing loans.

Beck and Hesse (2009) examine the determinants of interest rate spreads and margins in Uganda. They used the fixed-effects panel data model to estimate determinants based on four broad-based views: risk based view, small financial system view, market structure view and macroeconomic view. The risk based view emphasizes the risk that banks take in extending loans and the compensation for ameliorating these risks that should be accounted for in the margins and spreads. The small financial system view

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<sup>123</sup> See also (Hossain, 2012)

emphasizes the size of financial system. Beck and Hesse argue that smaller financial systems are not able to realize economies of scale and scope because of high fixed transaction costs and thus, they are prone to charge higher interest rate spreads. Another argument that supports the small financial system view is that, banks that operate in smaller financial systems with shallow financial markets are limited as to the number of financial products and services they can offer. This argument partially justifies why interest rate spreads are very high in the Caribbean nations.<sup>124</sup> The third view is the market structure which emphasizes the degree of competition in the banking sector and the impact of foreign banks' entry in the domestic banking sector. The proponents that support this view argue that higher interest rate spread is due to lack of competition, thus lower spread can be achieved by permitting foreign banks to participate in the domestic banking sector. On the other hand, the macroeconomic view emphasizes that interest rate spreads are driven by macroeconomic factors such as inflation, monetary and exchange rates policies. Hence, macroeconomic instability is the main source of higher interest rate spread. Beck and Hesse (2009) find that the size of the banking sector is relevant in explaining bank margins in Uganda. They conclude that the results for Uganda show that there is a relationship between higher interest rate spreads in smaller market place and the high cost of doing business.

In this section, we will discuss empirical literature under five major determinants of interest rate spreads. These are: economic growth, competition, risk factors, institutional factors and other time varying bank-specific variables.

#### *Economic activity –the growth rate of real GDP*

Economic growth is one of the macroeconomic variables that are hypothesized as determinants of interest rate spreads. According to Antelo, Crespo, Cupe, Ramirez, and Requena (2000) assert that economic activity is an important macroeconomic variable, and its instability leads to high interest rates and consequently, interest rate spreads too. It means instability generates uncertainty which makes banks charge higher risk premium as a result of higher interest rate spreads. The theoretical expectation about expansion of economic activity or national income per se is that, it is positively related to the expansion of banks' profits; this suggests that it is one of the determinants of interest rate spreads. As the economy grows, it raises peoples' confidence and their future prospects which encourage financial institutions to increase lending at lower rates. As deposit interest rates

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<sup>124</sup> See Randall (1998) and Robinson (2000).

are rarely decreased, lower lending rates reduce the size of the interest rate spreads in the economy. In addition, banks lower the lending rates because of good economic prospects, and as result, there will be low default rates and an increase in deposit rates to attract more income. However, we argue here that economic growth only matters when it generates enough bank deposits and raises banks' confidence, which helps banks to lower the prime lending rate. Hence, if the rates at which new credit and deposits grow are lower than economic growth, many banks will keep their average prime lending rate higher. This implies that interest rate spread will remain higher too. Banking is a confidence business, thus economic growth can only make a significant impacts on spreads if it raises banks' confidence to lend at lower rates. Furthermore Woodford and Curdia (2009) show that effects of changes in real income are ambiguous on interest rate spreads.

Requena et al. (2000) also examined the determinants of interest rate spreads in Bolivia, after liberalization of the financial sector. Defining the spread as the difference between lending rate and deposit rate in their study, they observe the following results. Using random-effects and fixed-effects models with variable intercepts, their results show that macroeconomics variables such as money supply and fiscal deficit are positively related to interest rate spread and significant in explaining interest rate spread. Similarly, microeconomic factors such as capital adequacy and banks' earnings also increase interest rate spread in Bolivia. They conclude that interest rate spread in Bolivia is better explained by macroeconomic factors such as monetary and fiscal policies; however, their conclusion is different from other studies that emphasize microeconomic factors. In a similar study, Basch and Fuentes (2000) explore the determinants of interest rate spreads in Chile and conclude that bench mark interest rate and inflation rate are the main determinants of her interest rate spreads. However, they find that the relationship between interest rate spread and monetary policy is bi-causal as the central bank impacts the interest rate spread, but also responds to interest rate with monetary policy.

### *Competition*

Several studies indicate that the lack of competition in the banking sector in some countries is one of the main factors that cause higher interest rate spreads.<sup>125</sup> Proponents of this view argue that the fewer the numbers of banks in the economy, the higher the likelihood that these banks will operate in a cartel-like form. Lack of competition may also occur when there are too many banks concentrated in one geographical area. Those who

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<sup>125</sup> These studies include: Hossain (2012), Young (1996) and Craigwell and Moore (2001).

seem to support high spread in a less competitive environment justify it on the following grounds. The argument is that fewer banks in large populated economies or large geographical areas operate with higher fixed, overhead and variable costs. Higher operation costs limit the products and financial services that banks can offer to generate revenues. Thus, banks in sparsely populated countries will charge higher interest rate spreads to cover additional costs.

Analysis about the impact of competition in financial sector is examined by various authors using different models. The common hypothesis is that increase in the level of competition reduces inefficiency in the banking sector. On the one hand, some empirical studies argue that increase in the number of banks will help to improve level of efficiency and thereby reduce interest rate spreads in the banking sector. This position is supported by theoretical evidence particularly based on perfect competition models. According Rochet and Xavier (2008) perfect competition model whereby banks are price takers and quantity setters, this free competition will reduce interest spread. However, in this perfect competition model, they also show that free competition leads to too many banks in the economy.

On the other hand, there are those who disagreed and identified contrary results which show that increasing competition in the banking sector does not improve interest rate spreads. Research evidence shows that increasing the population of banks does not always result in lower interest rate spreads but rather produces negative results such as low profit, unstable banking sector, and the increase in risk-taking activities by banks.<sup>126</sup> For example, Ennew et al. (1995) pinpoint that, before increase in competition, banks' profits are usually stable and secure, but after a new wave of competition, banks' profits are reduced through pressure of competitive pricing. Thus, high competition affects the returns on assets for banks in equilibrium. Competition creates many banks with lower assets quality and weak balance sheets and eventually a fragile financial system. It may also reduce the profitability of banks as margins are kept small as many banks attempt to remain competitive to remain in business. Dell'Ariccia and Marquez (2004) argue that competition also affects relationship lending by making banks focus their lending only on captured borrowers.<sup>127</sup> On this basis Rochet and Xavier (2008) argue for a limited competition with restrictions on entry, branching, charting fees, and capital requirements.

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<sup>126</sup> See Rochet and Xavier (2008).

<sup>127</sup> This is contrary to Boot and Thakor (2010) who find that competition increases relationship lending.

Allen and Galle (2004) explore wide ranges of models of competition and financial stability. They produce mixed results about the effects of competition. It is mixed in the sense that models like the perfect competition support competition in banking sector. They argue that increasing the number of banks in the perfect competition model improves efficiency in that it lowers spread. Thus, if you believe in the perfect competitive model then you will support the view that competition may be good because it reduces the cost of intermediation in the economy. However, the results also indicate that there is some trade-off between competition and financial stability. For example, they indicate that competition may generate financial instability as suggested by the result from other models. Beck (2008) argues that competition and financial instability are positively related from the study of cross country empirical studies. This confirms the idea that competition can be harmful to the health of the financial system. He further reveals that the incompatibility between competition and financial stability is caused by financial regulation and supervision of financial institutions. Hence, Allen and Galle (2004) also conclude that bank competition can produce unwanted consequences such as excessive risk taking which increases financial instability.

Podpiera, Weill, and Schobert (2007) investigates the relationship between competition and efficiency. These authors reject the hypothesis that bank competition increases or improves efficiency. The result shows that interest spreads may not narrow when we increase the number of banks in the domestic economy. The reason competition does not translate into lower interest rate spreads is because competition increases monitoring costs for banks hence increases in the cost of intermediation. Crowley (2007) examines factors that influence interest rate spread in the Caribbean countries. The results show that the size of the economy, size of the banking sector, and concentration measures do not considerably determine the interest rate spread. In a related study, Demirguc-Kunt, Laeven, and Levine (2004) investigates the impacts of banks' regulation and market structure on net bank margins and overhead costs. These authors find that tighter regulation on banks' entry increases the interest rate spreads and other overhead costs of banking. In addition, they find that concentration as a measure of competition is positively related to interest rate spreads. These results support the fact that competition seems only to matter in some cases.

However, there is a problem about the appropriate measure of competition. There are different measures of competition which make it difficult to conclude about the real effect of competition on interest rate spreads. Hence the result about the significance of

competition depends on the variable used to capture the influence of competition in the model. Favero (2002) examines the impacts of foreign banks' participation on interest rate spreads and establish that foreign banks' participation results in lower spreads as compared to domestic banks, but it is not clear whether this improves welfare gains in domestic economy. Foreign participation is not an entirely a welcome solution to the problem of large spreads when it makes the banking sector fragile through weak margins and thin profit for banks. Thus, it argued that foreign participation does not necessarily imply lower interest rate spreads but rather, a decline in overall cost in the banking system.

### *Risk factors*

Requena et.al (2000) identify two types of risk that affect banking activity and interest rate spreads. These are market risk and systemic risk. The former consists of macroeconomic risks such as inflation and interest rate volatilities, fiscal deficit and country risk, which is the difference between domestic interest rate and foreign interest rate. The systemic risk in the banking system is expressed as the difference between short term interest rate and the deposit rate. They assert that deterioration of the country risk profile increases lending rates and the cost of intermediation and further creates uncertainty in loan transactions. In the same vein, Hossain (2012) and, Oreiro and de Paula (2010) also reveal that other major determinants of interest spread include the risk factors such as inflation, debts (public, private, and foreign), market risk, liquidity and credit default rate. These variables explain why interest spread is higher in countries such as Brazil, Argentina and Sub-Saharan Africa.<sup>128</sup> The fact is that inflation rate increases risk premiums and this is because banks try to prevent loss of revenue from weaker currency value or as they revalue balance sheets. Mujeri and Yunus (2009) explore the factors that determine interest rate spread in Bangladesh with a sample of 48 banks over 2004-2008. They show that inflation as risk factor helps to explain interest rate spreads in Bangladesh. Mujeri and Yunus claim that Bangladesh has a long culture of default in the banking system; thus this unobserved factor contributes to the level of higher interest rate spread. Inflation factor is complemented by other factors such as operating cost and concentrated market share all of which; comprehensively explain spreads in Bangladesh.

Other risk factors that significantly elucidate the interest rate spreads include the inflation and interest volatilities, exchange rate volatility and change in the risk aversion of banks or households. For instance, Classens et al. (2006) examine the issue of interest rate

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<sup>128</sup> Some of the factors common to these countries are such as: higher inflation rate, higher bank rates (e.g. Brazil), risk perception political uncertainty, and lack of formal financial services beyond urban areas.

spread in Brazil. This study addresses three main questions about the spread: why interest spread is so high, what the effects of high interest rate spread are, and what kind of policies should be implemented to reduce interest rate spread. Classens et al. (2006) study highlights, among others, the impacts of risk factors such as inflation volatility, interest default and leverage as main causes of higher interest spread. It also reveals that high interest rate (bank rate) is one of the main determinants of high interest rate spread in Brazil. Similarly, Beck and Hesse (2009) show that high treasury bills rate, inflation and exchange rate appreciation explain a large proportion of fluctuation in interest rate spreads and margins in Uganda. Other studies on Brazil, such as Aronomivch (1994) also indicate that inflation helps to explain the spread. This evidence justifies why inflation and interest rate volatilities should be included in the model that identify determinants of interest rate spread. Furthermore, Oreiro and de Paula (2010, p. 577) assert that “the greater the variation in the inflation and exchange rates, the greater the volatility in interest rate and as a consequence, the larger the spread.” Beruments, Killinc, and Ozlale’s (2003) study identifies inflation rate as one of macroeconomic determinants of interest rate spread. This paper analyses how three types of inflation uncertainties affect interest rate spread in the UK. It defines interest rate spread as the difference between the overnight rate and lending rate, with the hypothesis that inflation uncertainty helps to explain the behaviour of interest rate spread. Their results show that inflation uncertainty increases interest rate spread while random shocks in inflation produce inconclusive results. Young (1996) argues that when there is a decline in the risk appetite of investors and bank managements, this may increase the cost of bank capital which raises the spread and thus lending falls. This also implies that when bank institutions in the country are risk averse, this will translate into higher persistent interest rate spreads.

### *Institutional Factors*

Many economists assert that institutional factors also play a major role in determining the interest rate spread.<sup>129</sup> Non-regulation of deposits and credits and other law enforcement on debt recovery for banks increase the intermediation costs. It also includes binding constraints on balance sheet and tighter controls on external lending; these constraints often prompt banks to target optimal rates in order to increase returns on lending. Thus, it results in higher spread which reduces lending to households and businesses. The legal framework that enables customers to choose and change banks has a major role in influencing banks’ decisions on the interest rate spreads. For example,

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<sup>129</sup> See Antelo, Crespo, Cupe, Ramirez, & Requena (2000) and Demirguc-Kunt, Laeven, and Levine (2004).

Demirguc-Kunt, Laeven, and Levine (2004) study provides empirical evidence which shows that tighter regulations on banks' entry and bank activities raise interest rate spreads which, naturally increases the overall costs of intermediation.<sup>130</sup> Hossain (2012) examines the interest rate spread in Bangladesh using a dynamic panel method of 43 banks over 1990 -2008. Hossain's study shows that high administrative costs, non-performing loans, and other macroeconomic factors are significant in explaining high persistent interest rate spread in Bangladesh. In addition, a large share of public debts to private loans shows public sector dominance in the credit market which may lead to crowding out through high interest rate spreads, because government offers good rates. However, regulation also has negative impacts on interest rate spread, because it limits the competition pressure which keeps the interest rates close to equilibrium in the competitive market. Siddiqui (2012) examines the issue of interest rate spread in Pakistan over a 2000- 2008 sample period. Using a panel data from 14 banks, he finds that overhead costs and non-performing loans are significant factors that explain interest rate spread in Pakistan.

In all, the list of possible factors that influence interest rate spreads vary from one country to another and individual studies on the topic have used different methods too. However, there are common factors such as economic growth, inflation, perceived risk, volatility, nominal bank rate and micro level factors such as operation costs, competition, and regulations that should form part of independent variables. From these empirical literatures we found that many use single linear or a panel fixed effects model to examine the determinants of spreads. However, we did not find studies that account for endogenous structural breaks in the dependent variables.

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<sup>130</sup> Non-competitive environment as result of restrictive regulation increase the cost of intermediation Bernink and Llenwly (1995).

### 3.3. Data, Estimation and Results

#### 3.3.1 Descriptive statistics Analysis, and Unit root test with endogenous structural breaks

This section discusses descriptive statistics and unit root of interest rate spreads and volatility as observed over the last two decades.<sup>131</sup> We highlight some stylised facts on interest rate levels, examine any statistical correlation between interest rate spreads and unconditional volatility, and finally, determine the unit root with endogenous structural breaks. These initial summary statistics give the mean, range and the variation of spreads over the sample period. We also present the z-test on the hypothesis in regard to whether these average spreads were significantly different from zero over the sample period. To put our analysis into context we provide a brief summary about events that shaped the trends for interest rate and interest rate spreads over the last two decades. The summary statistics are presented in comparison with statistics in the Southern Africa Custom Union (SACU), with members consisting of Botswana, Lesotho, Namibia, South Africa and Swaziland.<sup>132</sup> For the unit root test we provided results for ADF with and without structural breaks and graphical results for shift and impulse dummy in the first difference variables.

Globally, interest rate levels have been falling across many countries. This overall decline is more pronounced in countries where restrictions on financial market rates have been removed after the waves of financial liberalisation. In the same vein, as shown in Figure 3.1, interest rates in Namibia have been falling too for the past two decades in many countries.<sup>133</sup> Namibia's repo rate closely but not exactly follows the SA (South Africa) repo rate. The difference between the two is given by the interest rate differential in Figure 3.2. As shown in Figure 3.1 the movements of the prime lending rate follow the trend of the Namibia repo rate, which mimics SA's repo rate. After independence, the policy rate (repo rate) trended above 10.0 percent and then remained below 10.0 percent from the year 2000 onwards. Similarly, the prime lending rates, which indicate benchmark lending to prime customers in Namibia, have been falling but hardly went below 10.0 percent until April 2010.

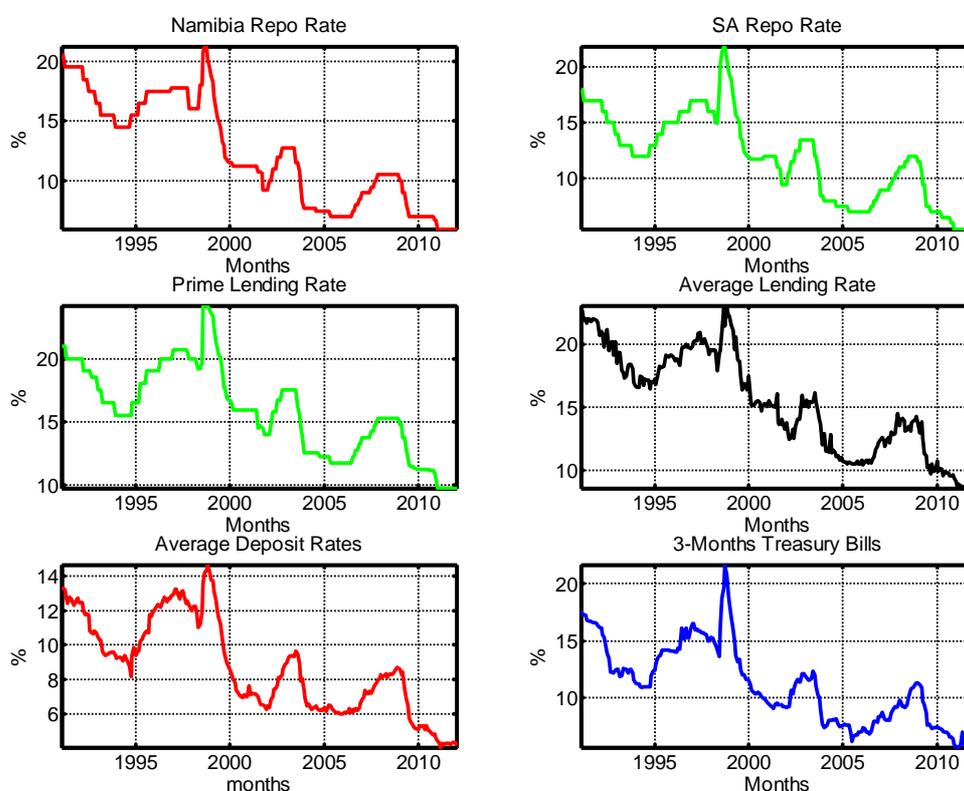
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<sup>131</sup> For additional information we have given a brief overview of the Namibian financial system in the Appendix.

<sup>132</sup> In the Southern Africa Custom Union (SACU), we have a common monetary area (CMA) which is made up of Lesotho, Namibia, South Africa and Swaziland. The South African Rand is the anchor currency on which other members currencies are pegged one to one.

<sup>133</sup> See Hossain (2012) and Classens et al. (2006).

**Figure 3-1** Interest Rates: Namibia Repo Rate, SA Repo Rate, Prime Lending Rate and 3-Months Treasury Bills 1991 -2011.

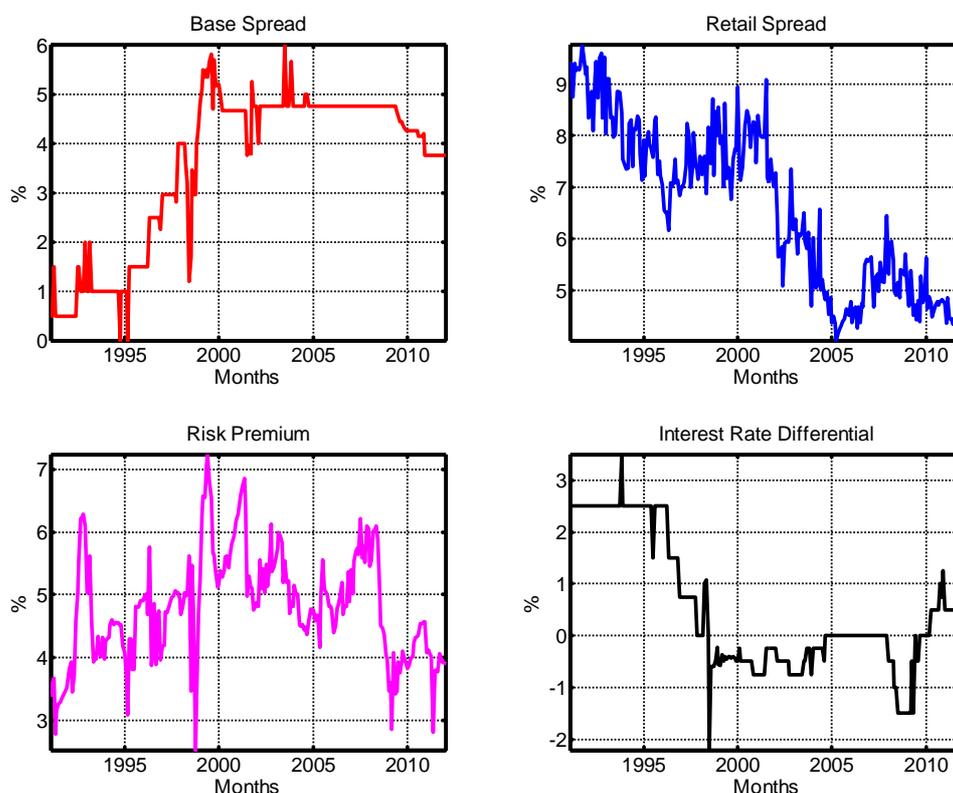


Higher interest rate levels in the first decade seen above reflect the climate of political instabilities and uncertainty that prevailed in Namibia and South Africa in the 1990s (see also the persistent volatility in figure 3.4). They also reflect a financially liberalised environment compared to the pre-independence era, where parallel systems operated.<sup>134</sup> The main factors that shaped the trend of interest rates include economic uncertainty that ensued after political independence in March 1990 in Namibia; the political uncertainty that prevailed within South Africa after the release of Nelson Mandela from prison in February 1990; the eventual fall of the apartheid regime in South Africa in April 1994; the East Asia financial crisis in 1998 and the great financial crisis of 2008. In addition, there were economic and financial reforms too, such as Liquid Asset Requirements and Domestic Asset Requirements in 1995; and new institutions were introduced, which encompassed the introduction of the central bank (Bank of Namibia); the Namibia Stock Exchange 1992; the joining of the common monetary area (CMA), and the fixed exchange rate system with the new currency, the Namibia Dollar pegged to the South African Rand.

<sup>134</sup> Before 1990, in Namibia we had a dual system in the financial sector whereby a formal financial scheme mainly catered for commercial and urban areas while an informal financial system served the majority of subsistence and communal rural areas.

In all these important changes, Vollan (2000) reveals that liquid and domestic asset requirements helped the development of financial markets in Namibia.

**Figure 3-2** Interest Rate Spreads: Base spread, Retail Spread, Risk premium & Interest rate Differential 1991-2011.



**Notes:** (1) Base spread is the difference between the Namibia repo rate (policy rate) and prime lending rates (the price at which most banks will lend to each other and to other prime institutions in the domestic economy). (2) Retail spread is the difference between average lending rate and average deposit rate. (3) Risk premium spread is the difference between prime lending rate and the three month Treasury Bills (risk-free rate). (4) Interest rate differential is difference between Namibia's repo rate and South Africa's repo rate.

Although these new reforms and institutions may have contributed to the overall decline in interest rate levels and the volatilities, they did not reduce inefficiency, as indicated by the rise in interest spreads in the banking sector, as can be seen in Figure 3.2. While interest rate levels have been falling, as shown in Figure 3.1 above, in the base spread the difference between the repo and prime lending rates has been steadily widening from as small as 1.0 percent to as high as 6.0 percent with an average of 3.45 percent over the sample period. Base spread hovered around 4.75 percent level until late 2009, when a directive was given to all commercial banks to reduce their spreads by the end of

November 2009.<sup>135</sup> The retail spread, which is the difference between average lending and average deposit rates, has been falling from as high as 10.0 percent annually to 6.0 percent average. Some other stylised facts about these two interest rate spreads are that they diverged in the 1990s; however, these series converged and tracked each other well over the last decade.

**Figure 3-4** Retail Spread, Risk premium & Unconditional Volatility 1992-2011

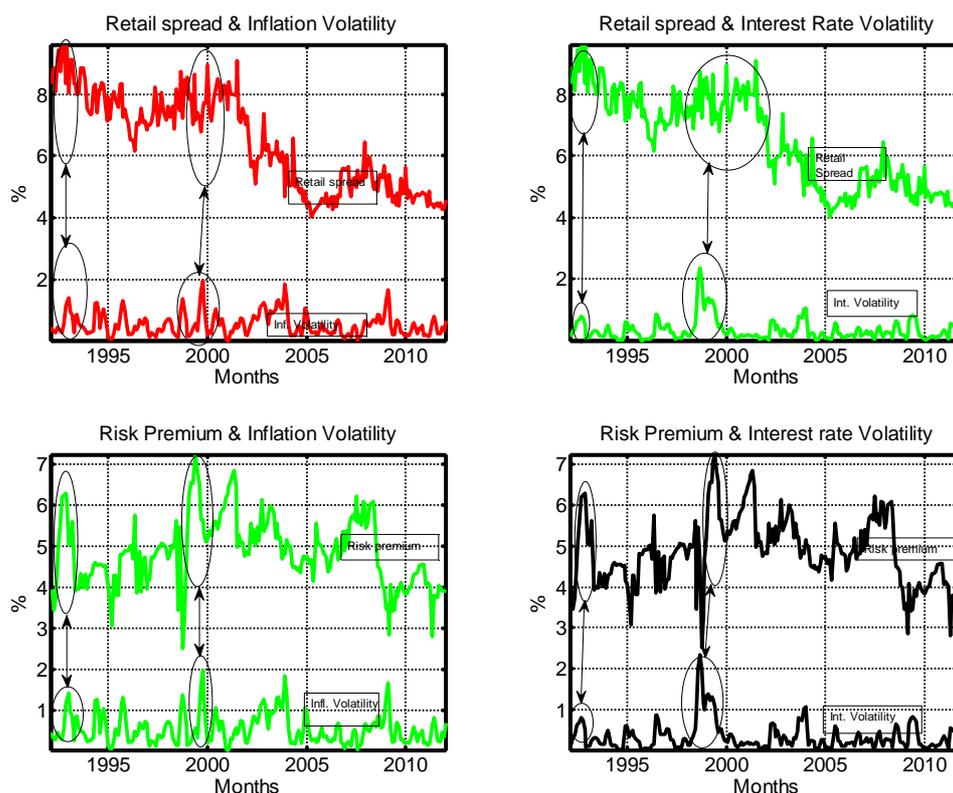
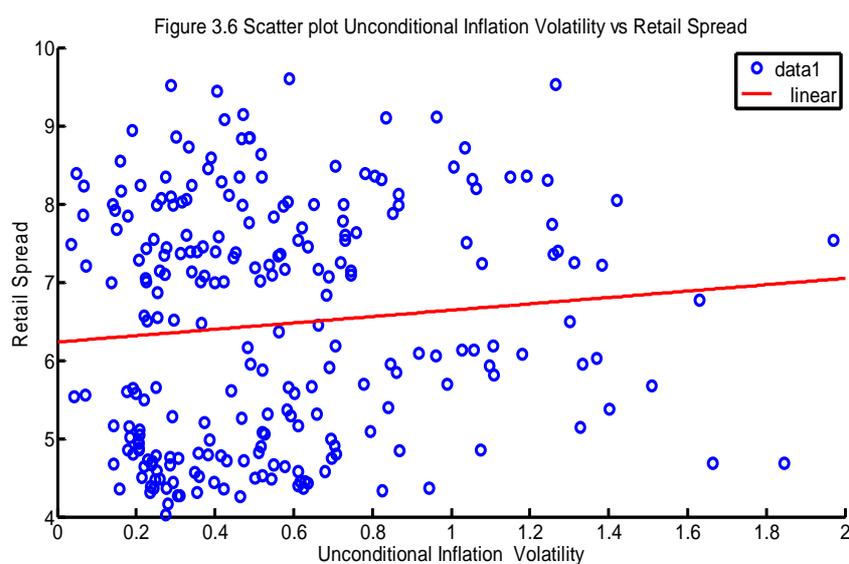
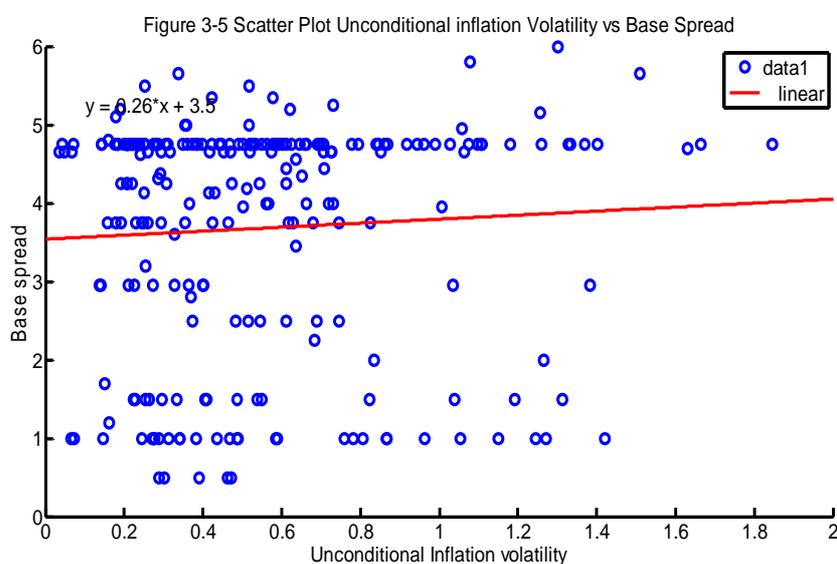


Figure 3.4 illustrates the trends of inflation and interest rate volatility, as they match the movements of retail spread and risk premium. As shown by ellipses superimposed on the graphs it is apparent that high volatility (as shown by inflation and interest rate volatilities) is associated with the persistently rising interest rate spreads. Of course, we understand that this relationship does not rule out that the reserve might be true until we examine the results from a multi-steps Granger causality test. For example, we see that the rising inflation volatility in the early 1990s and between 1998 and 1999 is associated with persistent rising retail spread and risk premium. We may deduce from these patterns that macroeconomic and financial instability conditions are linked to large

<sup>135</sup> A fall in interest spread from 4.75 to 3.75 came after the Bank of Namibia decided to intervene by ordering all commercial banks in Namibia to reduce the spread by November 2009. See the Bank of Namibia Directive in the Appendix.

spreads; therefore, stabilising these fundamentals is important for lower spreads in the long run. Hence, finally we used a scatter plot with linear graph fitted in order to illustrate the relationship between the unconditional volatility measures and spreads in Namibia.



Figures 3-5 to 3-8 present the scatter plot of unconditional volatility measures against base and retail spreads. First, 3-5 and 3-6 show that there is a moderate positive relationship between base spread, retail spread and inflation volatility. These scatter plots also show that there are outliers possible that result in structural breaks over the sample period. The relationships seem to confirm that large spreads are positively related to real sector instability, as measured by unconditional inflation volatility. In figures 3-7 and 3-8 we show the scatter plot of the same base and retail spreads against interest rate volatility. Similarly, these relationships show a positive association between spreads and interest rate volatility. Although these scatter plots do not show one-to-one linear relationships, all fitted linear graphs have positive slopes and intercepts above zero. This results suggest that we priori expect a positive parameter to capture the moderate effects of volatility on spreads in the single equation model. Finally, we examined the strength of the

relationships among variables both at level and first difference with the pair wise correlation coefficient.

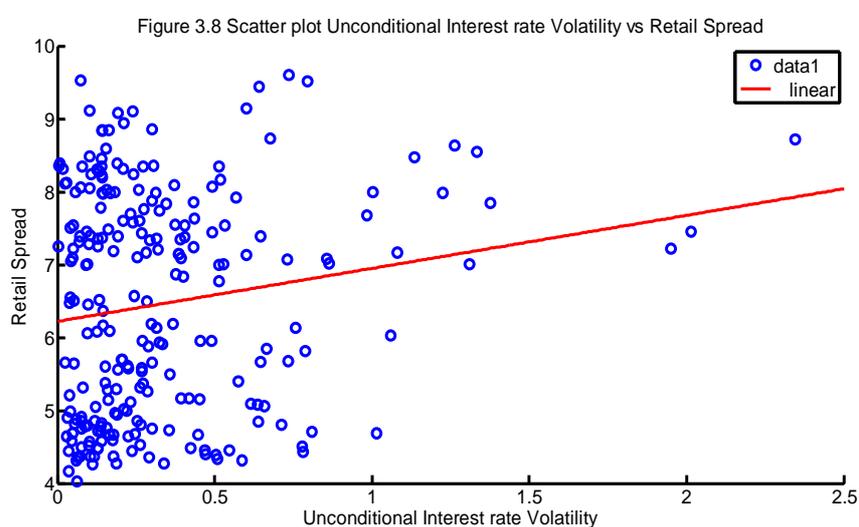
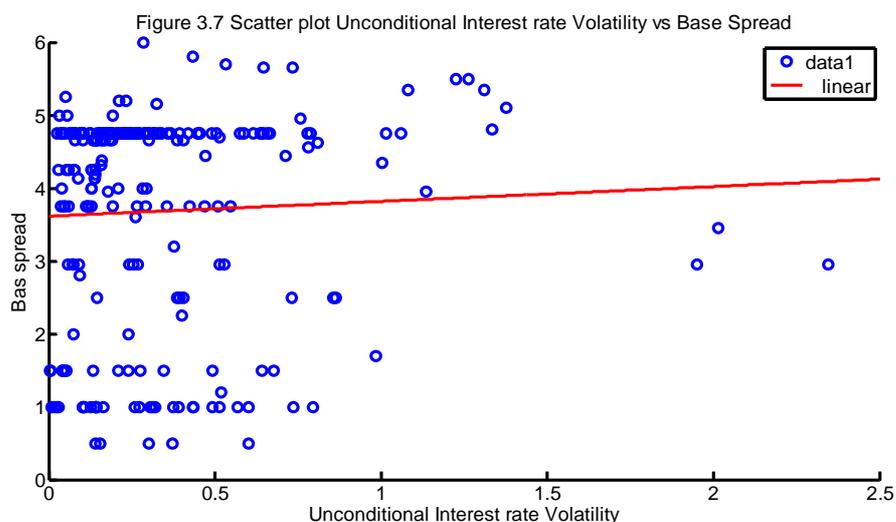


Table 3-1 below presents the pair-wise correlations between spreads and macroeconomic fundamentals realised in Namibia over the sample period. Firstly, correlations between base spread and inflation, interest differential M2/GDP, risk premium, and bank rate (repo rate) are statistically significant; however, the correlations with unconditional volatilities, although positive, are statistically insignificant. Similarly, the correlations of these macroeconomic fundamentals with retail spread are significant with the exception of unconditional interest rate volatility. In Table C.3-4 in the appendix we give the correlation statistics of the first difference of the same variables; however, the results show that some of the correlation statistics are weaker and statistically insignificant at first difference.

Table 3-1 Pair-wise correlation statistics, sample 1992:01 – 2011:12

	Inf	Base sprd	Retail sprd	Int. Diff	M2/ GDP	GDP	Risk pr.	Vol. Inf.	Vol. Int.	Bank rate
Inf.	1									
Base spr	-0.50* (0.00)	1								
Retail spr	0.47* (0.00)	-0.57* (0.00)	1							
Int. Diff	0.33* (0.00)	-0.89* (0.00)	0.45* (0.00)	1						
M2/GDP	-0.29* (0.00)	0.46* (0.00)	-0.76* (0.00)	-0.40* (0.00)	1					
GDP	-0.38* (0.00)	0.66* (0.00)	-0.87* (0.00)	-0.58* (0.00)	0.90* (0.00)	1				
Risk pr.	-0.006 (0.91)	0.35* (0.00)	0.22* (0.00)	-0.26* (0.00)	-0.31* (0.00)	-0.13* (0.04)	1			
Vol. Inf.	0.07 (0.27)	0.62 (0.33)	0.09 (0.13)	-0.10 (0.09)	-0.10 (0.09)	-0.13* (0.03)	0.06 (0.63)	1		
Vol. Int.	0.11* (0.07)	0.04 (0.47)	0.16* (0.01)	-0.15* (0.00)	-0.13* (0.04)	-0.14* (0.02)	0.02 (0.65)	0.14* (0.02)	1	
Bank rate	0.59* (0.00)	-0.64* (0.00)	0.81* (0.00)	0.49* (0.00)	-0.75* (0.00)	-0.86* (0.00)	0.08 (0.19)	0.11* (0.07)	0.32* (0.00)	1

\*indicates the 5% significance level.

Table 3.2 on the following page displays a summary of descriptive and relative dispersion statistics for interest rate spreads in the SACU area. We present the mean, standard deviation, coefficient of variation and the z-statistic to evaluate the hypothesis about the mean over the sample period. The z-statistic in the last row is used to evaluate the hypothesis that the averages ( $\bar{x}$ ) of these spreads are equal to zero. A z-test is generally preferred when the sample is large enough, that is  $n > 30$ . We set the hypothesis as follows:

$$H_0: \mu = 0$$

$$H_1: \mu \neq 0 .$$

Our sample contains 251 observations; thus, the sampling distribution of the mean is approximately normal and we can use the sample standard deviation as an estimate of the population standard deviation. The z-value corresponding to the mean ( $\bar{x}$ ) is given by:

$$z = \frac{\bar{x} - \mu_0}{s/\sqrt{n}}$$

Meanwhile the coefficient of variation ( $cv$ ) statistics shows the extent to which a variable varies about its mean (Lewis, 2012). This statistic is calculated as follows:

$$\text{Coefficient of variation (cv)} = (\text{Standard deviation} \div \text{mean}) \times 100.$$

Coefficient of variation statistics enables us to compare the relative dispersion and volatility of interest rate spreads among entities within the sample. Unlike the standard deviation,  $cv$  can be compared even when the entities in the sample have different means.

**Table 3-2** Relative Dispersions of Interest Rate Spreads among SACU Member's states.<sup>136</sup>

	Botswana		Lesotho		Namibia		South Africa	
	Base Spread	Retail Spread	Base Spread	Retail Spread	Base Spread	Retail Spread	Base Spread	Retail Spread
Mean $\bar{x}$	1.27	7.87	1.04	9.42	3.53	6.60	3.36	4.41
Maximum	2.38	10.34	6.50	15.00	6.00	9.77	4.50	6.50
Minimum	0.00	5.00	-2.50	4.50	0.00	4.03	0.25	2.30
Std. Deviation ( $s$ )	0.45	1.03	1.49	2.50	1.62	1.61	0.38	0.86
Coef. of Variation ( $cv$ )	35.40	13.07	144.14	26.59	46.07	24.36	11.25	19.52
z-statistic	44.76	121.3	10.99	59.59	34.3	65.02	140.8	81.15

Source: Author's own construction. The number of observations is 251.

The summary of statistics in Table 3.2 shows that Namibia has the highest average base spread within the custom union. Over the sample period, base spread had a mean of 3.53 percent and standard deviation of 1.62; and this is compared to South Africa with an average of 3.36 percent and standard deviation of 0.38. Among the SACU members, Lesotho had the lowest average interest rate spread of 1.04 percent and the standard deviation of 1.49. However, Lesotho also had a higher coefficient of variation, which is about 144.1 percent within the custom union. This higher coefficient of variation indicates that interest rate spreads in Lesotho were more volatile as compared to base spreads in other members of the custom union. If we use South Africa as the benchmark (on the basis that it is the largest economy in the custom union), the base spread in Lesotho was about

<sup>136</sup> This comparison here is only restricted to the members of the Southern Africa Custom Union (SACU) and Common Monetary Area (CMA). SACU members consist of Botswana, Lesotho, Namibia, South Africa and Swaziland; and the CMA members are: Lesotho, Namibia, South Africa, and Swaziland. The South African Rand is a legal tender in the all the member of CMA and it is pegged one on one. The statistics for Swaziland are excluded from the Table 3-1 because of incomplete data for interest rates.

thirteen times more volatile than the interest rate spread in South Africa. Namibia had average interest rate spreads about four times more volatile than the interest rate spreads in South Africa. The main points from this statistics are that base and retail spreads were very high in Namibia.

Second, the average mean for spreads is not zero across the custom union. Apart from this mere observation, we tested the hypothesis that average spread is equal to zero. Although these differences exist, it is possible that statistically they are actually not significantly different from zero. As can be seen from the table, the z-statistics are greater than  $\pm 1.96$  critical values, which imply that we reject the null in favour of the alternative hypothesis. In addition, Figure 3.3 seems to suggest that intermediation spreads always exist and gravitate around a mean above zero. The short-term persistence in the crises period might be due to panic, the fear factor and market sentiments (De Grauwe & Ji, 2013). However, in the long run, spreads are tied to prevailing macroeconomic fundamentals in the country. After establishing these stylised facts, we examine the unit root process in the spreads and variables used in this study.

### **3.3.2 Unit root test under structural changes**

Lastly, before we estimate the relationship between changes in spreads and the proposed determinants we examined two important issues: the unit root process and endogenous structural breaks in variables of interest for this estimation. Our primary focus in this section is the two dependent variables: the base spread and the retail spread. It is well acknowledged in applied research that the presence of unit root and structural breaks in the data generating process influences the decision about the method that needs to be used for estimation and the treatment of variables before estimation. In Figure 3.2 we showed that spreads and macroeconomic fundamental variables exhibited some forms of structural shifts over the sample period. Therefore, first we determined the order of integration of each variable through the ADF test, and further examined whether this order was affected by the presence of structural breaks in the time series. Harris and Sollis (2003), and Andrew and Zivot (1992) assert that it is common that most macroeconomic variables possess unit root and structural breaks. Generally, structural breaks emanate from changes in government policies, changes in the definition of variables and improvement of statistical methods collection and the compilation of data. Furthermore, some structural breaks are created by economic and political shocks, e.g. oil shock, economic and financial crises. Thus, it is important first to determine whether there is a unit root process and structural breaks in each variable so that we can avoid spurious regression and inconsistent

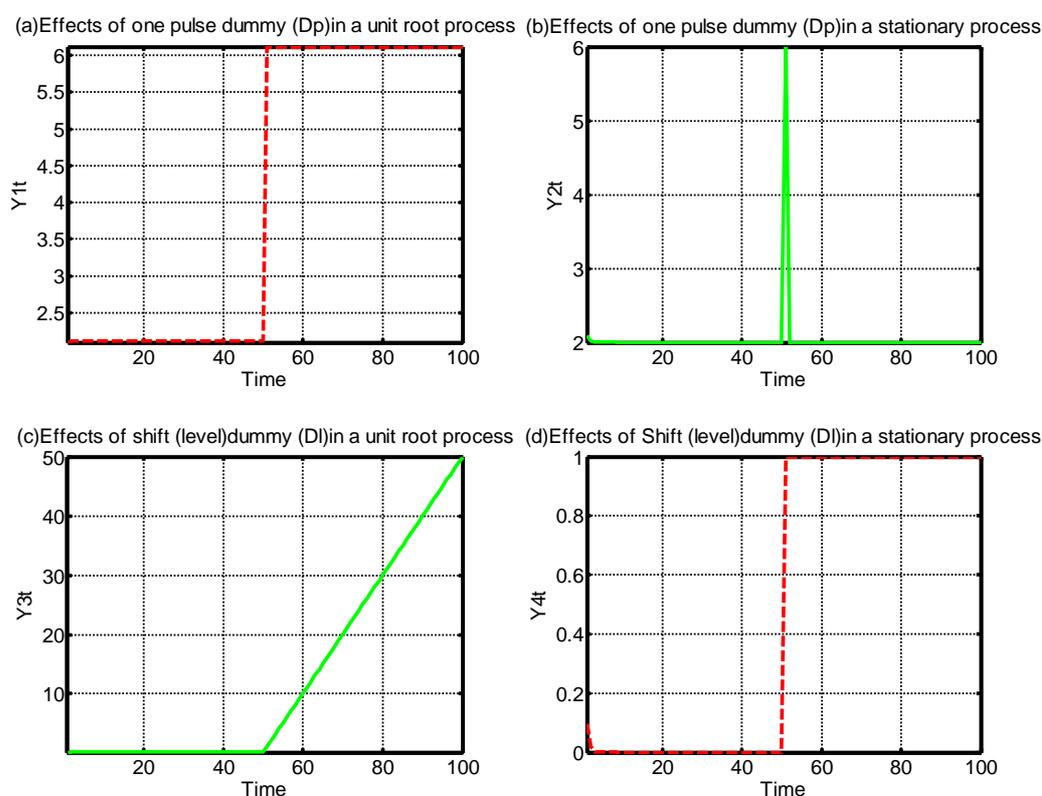
results from biased parameters. Specifically, the presence of structural breaks distorts the performance of pre-estimation tests such as AIC, BIC and ADF. For example, (Perron & Phillips, 1988) reveals that most macroeconomics time series suffer from structural breaks and this allows a unit root test to conclude that these variables have a unit root even when this is not the case.

Since the first generation test for a unit root process was used Dicky and Fuller (1979), many researchers have recognized the weaknesses of using an Augmented Dickey-Fuller test that does not account for structural breaks in the data generating process.<sup>137</sup> When a time series has one or a multiplicity of structural breaks the ADF test is biased and thus tends to accept that there is unit root process even when this is not the case. This means that the results from ADF imply that a time series variable is of integrated order one  $I(1)$  or higher while in actual fact the time series in question is a stationary process on two sub-samples around the structural break. It is therefore an important to use unit root test which allows structural breaks because it influences the first treatment of variables before regression and the choice of method for estimating the regression. The outcome of whether a particular variable possesses a unit root with structural break has a bearing on how such variable is estimated and analysed. Investigating structural breaks in a time series often takes several methods. For example, the following three modes of dummy variables are used to examine the form of structural changes exhibited by the time series under study.

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<sup>137</sup> (Baum, 2005, p. 54) revealed that the weakness of the Dickey-Fuller test for a unit root test with  $I(1)$  as a null hypothesis is its potential confusion of structural breaks in the time series as evidence of being non-stationary.

Figure 3.9 below illustrates the varying effects of structural breaks represented impulse and shift dummy variables in unit root process and in a stationary process.



First, in Figure 3.9 (a) and (b) we see the effects of a single pulse dummy variable in a unit root process and in a stationary process. The effects of single pulse dummy in a unit root process is that the mean jumps to a new value higher and never exhibits a tendency to return to the initial level before the break. The structural break as represented by the shift dummy will therefore have permanent effects on the level with a unit root process. However, if the structural break in a form of single pulse dummy occurs in a stationary process, this will generate a peak at the break date and thereafter converge on the level observed before the structural break. As shown in Figure 3.9 (b) this implies that the structural break (single pulse dummy) only has transitional effects on the data generating process.

The second form of the dummy variable analysed is that of the shift dummy (or level dummy) with the impact on the mean and slope of DGP. This is shown in Figure 3.9(c). The effects of the shift dummy on the data generating process with a unit root process is that it changes the slope from the break date without any tendency of this slope to return to a pre-break slope. This means that the structural break has permanent effects on

the slope of the unit root process. In chapter two we observed these patterns in some of the time series in Namibia in response to the 1998 East Asia financial crisis and the global financial crisis in 2008-2010. The former crises seemed to have a pulse or temporary effects on Namibia's economy while the later global crisis had persistent and long-term effects on Namibia. Hence, the 1998 financial crisis can possibly be captured by a pulse dummy while the global financial crisis can be captured by a shift dummy variable. The effects of a level shift dummy in a stationary process changes the level of the data generating process without changing the slopes; hence, it has a permanent shift without a change in the slope of the variable under study.

Finally, the third mode of structural breaks is captured by the trend dummy variable. This changes the slope of the deterministic trend line in both stationary and unit root data generating processes. Applying this to the group of variables in our study we observed that most of them do not show upward or downward trends. This was done with the exception to the retail spread, base spread and interest rate differentials. Hence, the unit root test with the endogenous structural breaks we estimated concentrated on the test concerning one change in the level (intercept), and on a change in the slope.

### ***3.3.2.1 Unit root test results allowing endogenous structural break***

This section presents the results of the unit root test with one endogenous structural break in the intercept. We used the procedure of Lanne, Saikkonen and Lutkepohl (2002) to determine the break dates instead imposing the break date ourselves. A unit root with an endogenous structural break is preferred to an exogenous break because it allows only those dates that are the most significant structural changes in the data generating process to be examined. Furthermore, an endogenous structural break is preferred because not all economic events produce significant structural breaks in a time series. For example Afandi (2005) observed that an economic shock that was deemed to have caused structural changes in many time series were found indeed to be statistically insignificant; therefore, imposing a structural break just because an event that occurred at that period might be statistically wrong. Thus, it is procedurally recommended to let the algorithm searches identify the most significant structural breaks and then test for a unit root process with these endogenous structural breaks included.

Lanne, Saikkonen and Lutkepohl (2002) suggest that a unit root test for processes with level or impulse shifts is designed to test a model given (in 3.14) below. Lanne, Saikkonen and Lutkepohl (2002) used a shift function  $f_t(\theta)' \gamma$ , which is added to the data generating process as follows:

$$y_t = \mu_0 + \mu_1 t + f_t(\theta)' \gamma + u_t \quad (3.14),$$

whereby  $\theta$  and  $\gamma$  are unknown parameters and the  $u_t$  is the errors generated by an AR(p) process. The shift function with date shift date  $T_b$  in DGP is defined as follows:

$$f_t^1 = d_{1t} = \begin{cases} 0, & t < T_b \\ 1, & t \geq T_b \end{cases} \quad (3.15)$$

The  $\gamma$  parameter in  $f_t(\theta)' \gamma$  is a scale parameter such that when we differenced the DGP this shift function will lead to an impulse dummy. One weakness with Lanne, Saikkonen and Lutkepohl's (2002) unit root test for structural changes is that it does not deal with a multicuity of breaks in the DGP. This problem of many structural breaks can be assessed with (Andrew & Zivot, 1992) test for unit root process with multiple structural breaks.

### *Results*

For the sake of space we only provide and discuss the t-statistics and graph results for the shift level dummy and the impulse dummy after differencing most variables used in this study. Tables 3-3 and 3-4 and figures 3-9 to 3-12 show the results of the unit root test with structural breaks. Firstly, the following variables of base spread, retail spread, risk premium, interest differential, repo rate, SA base spread, prime rate and M2/GDP fail to reject the null hypothesis of the unit root process with a structural break at a 5% significance level. Inflation, GDP growth rate and unconditional volatility measures all reject the unit process with a structural endogenous structural break. Specifically, all spreads exhibit the presence of unit roots even after accounting for structural breaks in the data generating process. In comparing the results with unit test without a structural break the results indicate a similar pattern with an exception for inflation, which suggests that the order of integration seems to depend on the presence of a structural break. An ADF test without a structural break shows that inflation has a unit root process while the later test rejects the unit root process in inflation. These results show that the degree of integration of spreads in Namibia is not affected by the presence of structural breaks within the time series. Next, we differenced the variables and test for the unit root process with a structural break represented by an impulse dummy.

Table 3-3 Unit root test allowing endogenous structural break (shift dummy)

Variable	t-statistic	Crit.-value 5%	Break date	Sample range
Base spread	-1.08	-3.03	1995 M05	232
Retail spread	-1.62	-2.88	2001 M06	232
Risk premium	-2.34	-2.88	1998 M06	232
Inflation	-4.04*	-2.88	1994 M04	232
Interest Diff.	-2.34	-3.03	1998 M06	232
ΔGDP	-7.66*	-2.88	2001 M01	232
Repo rate	-2.57	-3.03	1998 M07	232
SA spread	-2.30	-3.03	1998 M05	232
Vol. inflation	-5.31*	-2.88	1993 M03	232
Vol. interest rate	-3.50*	-2.88	1996 M06	232
Prime rate	-1.21	-2.88	1998 M07	232
M2/GDP	-2.78	-2.88	12009 M04	232

\*Critical values are for the Andrew & Zivot test with a 5% significance level. ADF test results without a structural break are given in Appendix C.2-2. In addition, the unit root test with a shift dummy and trend is given in Table C.3-5 in Appendix C.2-2.

Table 3-4 presents the unit root test with one structural break represented by an impulse dummy. When we difference the shift dummy this leads to an impulse dummy; thus, our results in Table 3-4 unit root with an endogenous break represented by an impulse dummy. Take note, we did not take first difference for the variables that were in Table 3-3, thus there is no difference results whether we use shift dummy or impulse dummy. As opposite to earlier results, the result of the unit root test with structural breaks for first difference variables indicates that all variables now reject the unit root process at first difference.

As shown in Table 3-3 and 3-4, and figures 3-9 to 3-12, the most significant structural breaks in spreads were observed at 1998M05, 1998M06 and 1998M07. In addition, the most significant structural changes occurred between 1997M04 and 1998M09. IMF staff (IMF, 1998) revealed that the effects of the East Asia financial crisis during this period was exacerbated by the resignation of Indonesia's prime minister and by a fall of the bilateral U.S. dollar exchange rates and equity prices by more than 40 percent of the index value.<sup>138</sup>

<sup>138</sup> See also Fischer (1998)

Table 3-4 Unit root test allowing endogenous structural break (impulse dummy variable)

Variable	t-statistic	Crit.-value 5%	Break date	Sample range
$\Delta$ Base spread				
$\Delta$ Retail spread	-7.35*	-2.88	2001 M01	232
$\Delta$ Risk premium	-6.72*	-2.88	1998 M06	232
Inflation	-4.04*	-3.03	1998 M04	232
$\Delta$ Interest Diff.	-4.14*	-2.88	1998 M06	232
$\Delta$ GDP	-7.66*	-2.88	2004 M01	232
$\Delta$ Repo rate	-6.18*	-2.88	1998 M09	232
$\Delta$ SA spread	-9.26*	-2.88	1998 M06	232
$\Delta$ Vol. inflation	-8.25*	-2.88	1993 M03	232
$\Delta$ Vol. interest rate	-7.06*	-2.88	1998 M08	232
$\Delta$ Prime rate	-5.10*	-2.88	1998 M08	232
$\Delta$ M2/GDP	-6.87*	-2.88	2009 M04	232

Furthermore, we find that the coefficient estimates of the shift function in equation (3.14) are statistically significant. In figures 3.10 and 3.11 the shift dummy is represented by a vertical line while in figures 3.12 and 3.13 the impulse dummy function is represented by a spike at the break dates.

Figure 3-10 Unit Root test with endogenous structural break: Base spread (Nabsprd) with shift dummy variable

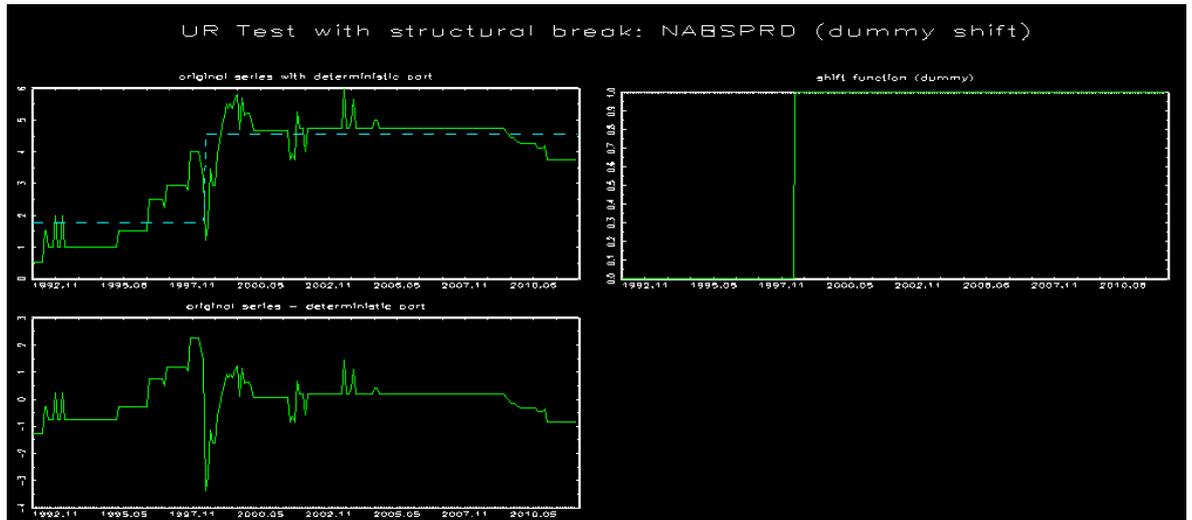


Figure 3-11 Unit Root test with endogenous structural break: Retail spread (Narsprd) with shift dummy variable

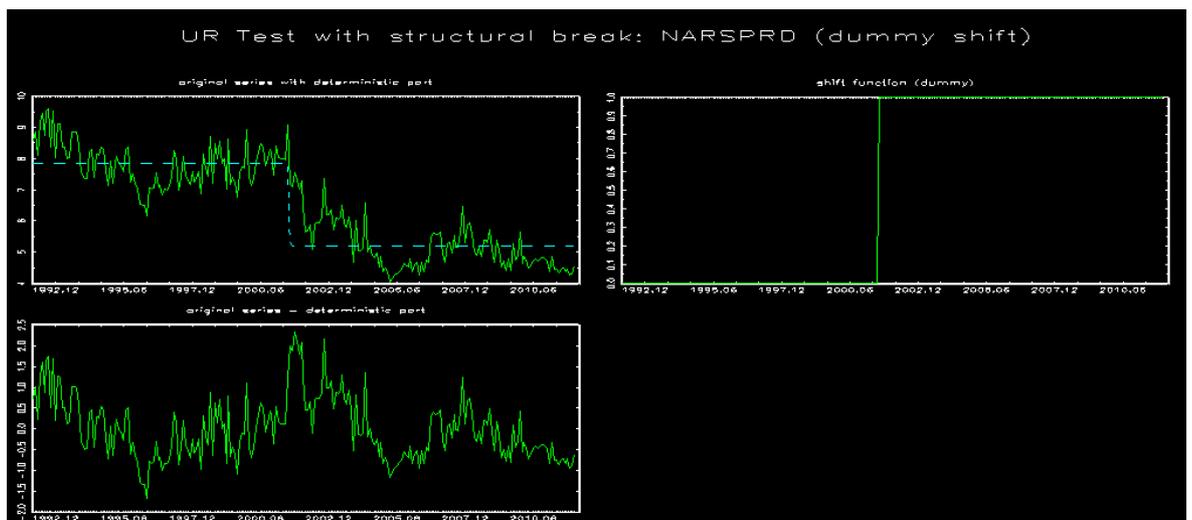


Figure 3-12 Unit Root test with endogenous structural break:  $\Delta$ base spread (Nabsprd\_d1) with impulse dummy variable

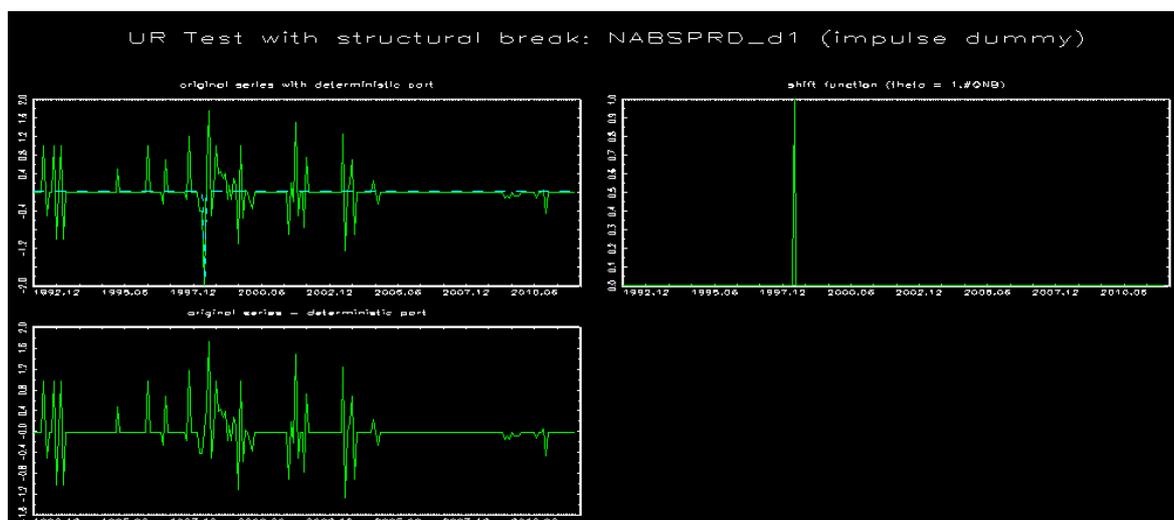
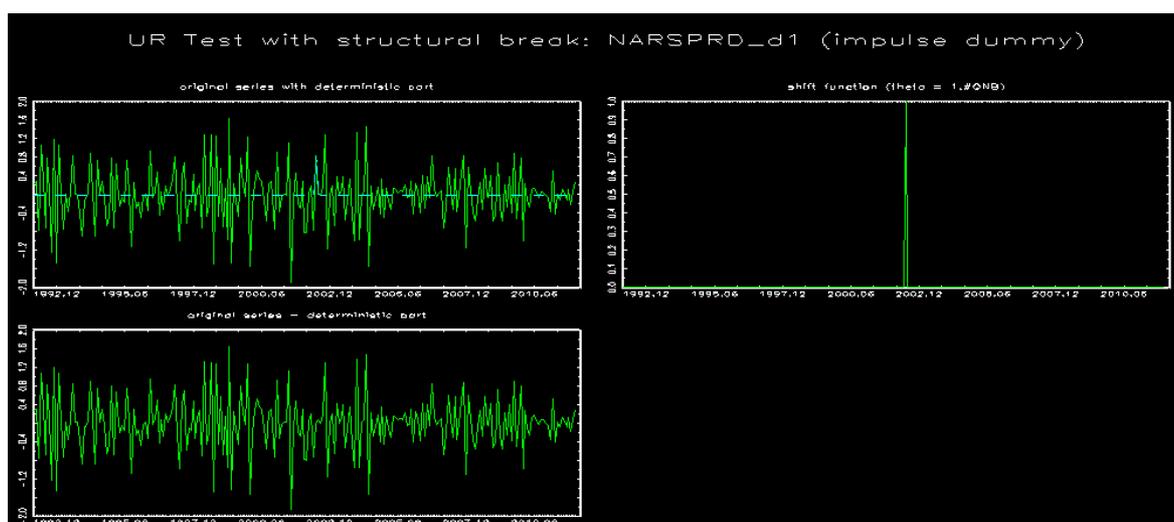


Figure 3-13 Unit Root test with endogenous structural break:  $\Delta$ retail spread (Narsprd\_d1) with impulse dummy variable



The results of the unit test with an endogenous structural break have the following implication on our model of determinants of spread in Namibia. Since our main variables of interest, which are the base and retail spreads, exhibit a unit root process even when we accounted for an endogenously determined structural break, this influenced our methodology of estimation in the following ways. First, this result implies that our single equation (3.8) will be estimated with all variables in the first difference and will include impulse dummies instead of a shift dummy to capture the effects of the endogenous structural break in the data. Inflation and other variables that are stationary with structural breaks will enter the regression model without differencing them. Secondly, these results imply that the smooth transition regressions are out of the question because the dependent

variables exhibit a unit root process in both sub-samples. Although STAR and LSTAR models are able to address the transition function in the time series and structural break issue, these models will also suffer from non-stationary problems.<sup>139</sup> In addition, the first differenced variables show weaker correlations among themselves, thus we opt for a GMM estimator, which is a less restrictive regime than other non-linear models. Therefore, we estimate the model with OLS, TSLS and GMM and account for endogenous structural breaks by using impulse pulse dummies, as identified by the unit root test in this section.

### 3.3.3 Methods of estimation

This sub-section presents the specification we used to estimate the determinants of interest spreads using macroeconomics and financial variables.<sup>140</sup> A macroeconomic view emphasises the role of macroeconomic stability and financial fundamentals in the determination of interest rate spreads. Our methods of analysis are motivated by the discussion about theoretical models in the literature review sub-section 3.2.2. Groth (2012) and Classens et al. (2006) suggest an implicit function which relates spreads to macroeconomic factors. In addition, Gertler, Hubbard and Kashyap (1991) and Birchwood Birchwood's (2004) empirical models serve as guides to our linear regression model and are used to estimate potential determinants of interest rate spread. To take into account the unit root and structural breaks observed in the last section we used the likelihood function given in equation (3.8) According to Woodford (2010), the total changes in spread in equilibrium are determined by changes in income, perceived risk and other fundamental factors.

In this empirical analysis we used two ex-ante definitions of changes in interest rate spreads: base spread and retail spread. Firstly, we explain the rationale for the macroeconomics view in regard to the determination of interest rate spreads. This is followed by a brief discussion about three methods of a moment's estimators: Ordinary Least Squares (OLS), Two Stage Least Square (TSLS) and Generalised Method of Moments (GMM). We chose these methods to estimate the two linear equations, as specified in (3.2). Advantages in using these linear estimators are that they can accommodate the contemporaneous interaction between the dependent and independent variables. In addition, results from these methods are easy to compare against each other.

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<sup>139</sup> Of course, STAR models might be appropriate to model a single equation model but this is possible when the dependent variable exhibits regime shifts and a stationary process over the sub-samples. However, we found that this was not the case with spreads.

<sup>140</sup> There is a significant sample size, with over 200 monthly observations available for some macroeconomic and financial variables. Data was collected from the Namibia Statistics Agency and The Bank of Namibia's databases and publications.

For example, we can check consistencies about the signs and size of the parameters across the three methods. Estimation techniques through OLS to GMM represent the approach from a restrictive regime to a more generalised method. Lastly, we discuss the results and the implications of the overall determinants of interest rate spreads in Namibia.

Do macroeconomic and financial variables play a role in the determination of the size of interest rate spread? Curdia and Woodford (2010), De Grauwe and Ji (2013) and the note by Groth (2012) illustrate that there are valid theoretical arguments that suggest that interest rate spread is a consequence of macroeconomic and financial conditions in the economy. Specifically Groth (2012) identified the implicit function which links interest spread to income, inflation expectation and interest rate level.

Another example is the empirical works by Beck and Hesse (2009), Classens et al. (2006) and Oreiro and de Paula (2010). These authors emphasise the importance of macroeconomic stability in determining interest rate spreads in the economy. For example, Beck and Hesse (2009) purport that interest rate spreads are influenced by economic cycles and macroeconomic policy such as monetary and exchange rate policy.<sup>141</sup> In the case of monetary policy, these include the level of nominal interest rate, the reserve requirement and the risk free rate (which can be regarded as the marginal cost of lending) as candidates that determine interest rate spread. These results concur with the latest IS-LM, which tries to link macroeconomic with financial intermediation, as exposed by Woodford (2010) and Groth (2012)

In our model specification we considered mostly macroeconomics and financial variables that are closely relevant as influences on interest rate spread, as suggested in the literature and the data in Namibia. As suggested in implicit function by Groth (2012), and the Classens et al. (2006) empirical model, we formulated two dynamic linear models that include both macroeconomic and financial variables. For example, we assume that changes in interest rate levels, interest rate volatility and inflation volatility are positively related to the size of the spread (see figure 3-4). As in Classens et al. (2006), the interest rate level represents the average cost of originating the loan, while higher volatility indicates the degree of uncertainty which increases the marginal cost of lending. Generally, the two volatility indicators capture and summarise the influence of macroeconomic and financial instability factors, including those factors that have been omitted. Additional important factors are the interest rate differential between Namibia and South Africa and the real

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<sup>141</sup> See also Gertler, Hubbard and Kashyap (1991).

effective exchange rate. Interest differential illustrates the link between Namibia and South Africa's financial sector. It therefore reflects the financial link between the two countries or foreign premium risk. In our model, this term will capture the 'catch-up effects' or correction between domestic spread and South Africa's interest rate spread. The two interest rates are linked through fixed exchange rate arrangements. For example, if domestic interest rate is lower in comparison to South Africa (or world interest rate) in the current period, then in the next period local banks will raise the interest rate to catch up with their foreign counterparts.

Furthermore, the retail spread model includes changes in the risk premium. This premium is defined as the difference between prime and short-term interest rates.<sup>142</sup> Theoretically, it is assumed that the higher the credit defaults, the more banks will charge higher premiums, which then translate into higher interest rate spreads.<sup>143</sup> Therefore, financial institutions will regularly change the premium to reflect the perceived risk of lending at the prevailing economic conditions. This variable therefore captures the changes in the perceived riskiness of lending. Finally, the two unconditional volatilities capture the direct impact of uncertainty from financial market change either in response to commodity or financial shocks. We define the measures of unconditional volatility using Evans' (1984) volatility measures. First, for unconditional interest rate and inflation volatility, we use three months of Treasury Bills and the monthly Namibia Consumer Price Index (NCPI). This is calculated as follows:

$$SRTB_t = \left[ \frac{1}{12} \sum_{i=1}^{12} (\Delta TB_{t-i} - \overline{\Delta TB}_t)^2 \right]^{1/2} \quad (3.16),$$

whereby  $\Delta TB_t$  changes in the short-term rate in month  $i$  of year  $t$ , and  $\overline{\Delta TB}_t$  is the average monthly change in year  $t$ . Similarly, unconditional inflation volatility is derived using the same volatility measure.<sup>144</sup> The greater the volatility in the inflation and interest rate is, the higher the spreads charged by financial intermediaries will be.

Next we take into account the long-term influences of economic activity and economic cycles that might not be captured directly by the two measures of volatilities. One of these factors is the rate of economic growth or changes in total income influences

<sup>142</sup> Others studies define risk premium as a difference between 10 year government bonds and AAA corporate bonds.

<sup>143</sup> Real effective exchange rate reflects the importance of current and capital and financial accounts, which therefore control for effects from the external sector on interest rate spread. However this was statistically insignificant.

<sup>144</sup> Evans' volatility measure can also be found in McMillin (1986) and Tatom (1985).

on interest rate dynamic behaviours. Firstly, we used the Denton method to transform the quarterly real GDP in to monthly observations. Quarterly GDP at high frequency was used as measure of economic activity in the absence of a Producer Price Index (PPI) in Namibia. Secondly, important factors are endogenous structural breaks identified with a unit root in the pre-estimation analysis. We take into account an endogenous break date of 1998M06 suggested by the unit root with a structural breaks test in section (3.3.2). These are now impulse dummies because of the first difference in the dependent variables. The dummies takes the value 1 for  $t_b = t$  and 0 elsewhere. Post-estimation dummies include shift dummies that aimed to address structural breaks in parameters after examining the residuals and the graph for individual parameters in the preferred regression. This is necessary especially when the impulse dummy is insignificant while there is evidence of structural breaks in the results. Finally, we considered the lags of dependent variables so as to capture the persistence as a result of the long memory observed in most time series variables. We believe that long memory in spreads is justified by the fact that central banks smooth the monetary policy rate while the policy reaction functions to facilitate and is moved from the current target to a desired target. Private credit/GDP ratio was excluded because private credit definitions changed a lot over the sampled period while the series for non-performing loans, reserve requirements and HHI form bank level were very short for these modelling exercises. Although it was possible to increase the frequency of QGDP to monthly frequency, we point out that this procedure was not applicable to non-performing loans, reserve requirements and HHI. This is because the annual sample of 2005 to 2010 does not completely overlap with the monthly observations sample, which starts from 1992M1 to 2013M12.

### 3.3.3.1 Empirical linear economic models

Birchwood (2004), Fuentes (2000), Brock and Franken (2002) and Classens et al. (2006) already revealed that there are significant disagreements on the appropriate method to model interest rate spreads. Therefore, with these challenges in mind, in this analysis we used the likelihood function in equation (3.8). This is based on implicit function suggested by Groth (2012), and the transformation of Classens et al.'s (2006) regression model. Groth's (2012) implicit function shows that in equilibrium changes an interest rate spread is a function of changes in income, liquidity, perceived riskiness of borrowers and other macroeconomic factors that influence the supply and demand of financial intermediary in the long-term. So, we specify that changes in interest spread in equilibrium are linear functions of changes in the benchmark interest rate (marginal cost), risk premium, volatilities, the adjustment term (catch-up-effect term) and other control variables that

affect the bank balance sheets over business cycles. In addition, we regressed these factors against two definitions of spreads to take into account the disagreements about the correct definition of interest rate spreads.<sup>145</sup> The two single equations are specified as follows:

$$\begin{aligned} \Delta Base Sprd_t = & \beta_0 + \beta_1 Inflation_t + \beta_2 \Delta Bank rate_t + \beta_3 \Delta Base sprd_{t-1} + \beta_4 Int. Diff_{t-1} + \\ & \alpha_5 gdp_{t-1} + \beta_6 \Delta M2/gdp_{t-1} + \beta_7 \Delta Risk pr_t + \beta_8 \Delta SA sprd_{t-1} + \\ & \beta_9 Un.Volatility_t + \beta_{10} D1998_t + u_t \end{aligned} \quad (3.17)$$

$$\begin{aligned} \Delta Retail Sprd_t = & \\ & \alpha_0 + \alpha_1 Inflation_t + \alpha_2 \Delta Bank rate_t + \alpha_3 \Delta Un.Volatility_{t-1} + \alpha_4 \Delta retail sprd_{t-1} + \\ & \alpha_5 gdp_{t-1} + \alpha_6 \Delta M2/GDP_{t-1} + \alpha_7 \Delta Risk_t + \alpha_8 D1998_t + \beta_9 Int. Diff_{t-1} + \alpha_{10} \Delta SA sprd_{t-1} + \\ & v_t \end{aligned} \quad (3.18)$$

Equation (3.17) shows the changes in the base spread as the dependent variable with inflation, changes in the bank rate, the lag of base spread, interest rate differential, QGDP growth rate, M2/GDP ratio, risk premium, the lag of South African base spread, unconditional inflation volatility and the structural break represented by an impulse dummy as an independent variable. Meanwhile equation (3.18) shows that the retail spread is the dependent variable with the inflation, bank rate, unconditional interest rate volatility, retail spread lag, QGDP growth rate, M2/GDP, risk premium, the lag of South African base spread, interest rate differential, and the structural break dummy as an independent variable. Inflation captures the effects of inflation risk on asset values as a financial intermediary and takes into account this factor in spread margins, while the bank rate captures the consequence of the monetary policy rate actions by adjusting the repo rate. Unconditional volatilities measures the effects of uncertainty and changes in the macro and financial fundamentals as argued by (De Grauwe & Ji, 2013) and (Beck & Hesse, 2009). The changes in the risk premium control the perceived riskiness of lending at the prevailing economic conditions with deteriorating government, household and business balance sheets. Interest rate differential is a correctional variable that keeps the spread level cointegrated while M2/GDP ratio captures the effects of financial depth. We make a distinction between the risk premium and interest differential as follows: a risk premium captures the marginal impact of the difference between risk free rate and prime rate charged by financial intermediaries on interest rate spread. This premium spread shows the private sector's level of confidence in the government's securities and its ability to fulfil

<sup>145</sup> A similar approach is applied in (Barajas, Salazar, & Stiener, 2000). Using changes rather than level of spreads as a dependent variable conveniently helps to eliminate the unit root and the shift dummies for different trends and therefore only applies the impulse dummy to control for the identified structural breaks in the dependent variables.

short and long-term contracts. Lower confidence induces private institutions to charge higher premiums on credit, which translates into a large retail spread.<sup>146</sup> Interest rate differential is the difference between Namibia and South Africa's interest rates. This difference forces interest rates between the two countries to co-integrate because of the fixed exchange rate arrangement. This term is lagged to indicate the speed of adjustment to catching up with the counterpart average spread in South Africa.<sup>147</sup> Interest differential is given by the  $[\text{Namibia repo rate}_{(t-1)} - \text{SA repo rate}_{(t-1)}]$ , which implies that if the difference in the last period was negative, in the current period the base spread will increase to catch up with the counterpart so that they will remain in equilibrium. It is also a forcing variable as it forces the interest spread to return to the equilibrium path with its counterpart when the Namibian base spread is hit by exogenous shock.

Further, M2/GDP ratio controls for any economic cycles in spreads. We assumed that this variable was associated with lower interest rate spreads; however, the sign on M2/GDP ratio and the quarterly growth rate may be uncertain because the cycles of M2 and GDP do not necessarily coincide. Curdia and Woodford (2010) and Groth (2012) showed that the effects of real GDP on spreads can be ambiguous. In other studies, such as Honohan's (2001), the current interest rate differential was used as indicator for political risk from the foreign investors' perspective.

Given that we have already discussed the relationship between macroeconomic variables and spreads above; in this section we give explanations for the priori expectation about the signs between the dependent and independent variables the two linear equations. Firstly, the constants  $\beta_0$  and  $\alpha_0$  give the conditional mean of changes spread, which should be close to zero in the complete perfect competitive market case.<sup>148</sup> For reasons already discussed, these coefficients of  $\beta_1, \beta_2, \beta_3, \beta_7, \beta_8$  and  $\beta_9$  are expected to be positive while  $\beta_4, \beta_5$  and  $\beta_6$  are priori expected to be negative. Similarly, the following coefficients of  $\alpha_1, \alpha_2, \alpha_3, \alpha_4, \alpha_7$  and  $\alpha_{10}$  are priori expected to be positive while  $\alpha_5, \alpha_6$ , and  $\alpha_9$  are expected to be negative. Interest rate differential coefficients capture the correcting effects in the model that keep the dynamic model integrated with South Africa's financial sector.

<sup>146</sup> We assumed that the prime rate takes into account risks such as default, taxation, liquidity, currency and political risk. Thus, in the event of declining confidence, private lenders anticipate that these risks will rise, therefore translating into higher prime rate, large risk premium and retail spread too.

<sup>147</sup> Honohan (2001, p. 79) in his model called this a 'catch-up effect'. We can also assume that it captures the perceived riskiness of investing in Namibia by foreign investors. Some researchers have used the difference between domestic and foreign interest rates as a measure for a country's risk profile.

<sup>148</sup> If banks have the same level of technology, the constant can also be considered as the average marginal cost of extending extra loans.

Some variables enter the models as lags to take into account the time effects on the spreads. For example, the current interest rate difference is only relevant to the next period spread while the lags of dependent variables in each equation are motivated by the fact that macroeconomic variables are sluggish in nature while others have a long memory. The validity of these assumptions will be examined through a Correlogram test for autocorrelation, partial autocorrelation and the redundant variable tests. In order to arrive at the preferred results, we use the strategy of moving from general to specific to arrive at the preferred results. This means that we started with an over-parameterised model and continued to drop off the insignificant variables to arrive at the representative results.

### 3.3.3.2 Empirical results

In this section we present the results of the two linear models in (3.17) and (3.18) as estimated with OLS, TSLS and GMM methods. The sample starts from 1992:01-2011:12, which makes 239 monthly observations. All results were estimated with robust standard errors through a HAC-Newey-West covariance weighting matrix – this is a heteroscedasticity and autocorrelation consistent estimator. Our procedure starts by estimating the linear models as given by the two equations. We then evaluate the quality of results from these specifications through different dimensions: functional form, dynamic structure (lags), the stability of coefficients in each linear model and finally arrive at the results reported in tables 3-2 and 3-3. Specifically, we evaluate the regression results with a redundant test to determine individually and jointly whether insignificant variables in the regression are redundant. This is followed by the omitted variable test, which evaluates individually and jointly whether some of the variables removed through the redundant test or those that we deemed to be part of the regression model are omitted from the final results. At the end we provided the summary discussion of the coefficient, residuals and stability diagnostic tests for the final results.

First, Table 3-2 presents OLS, TSLS and GMM results using the changes in the base spread as the dependent variable of equation (3.11). Table 3-3 shows OLS, 2SLS and GMM results using the changes in the retail spread as the dependent variables in equation (3.12). Each column shows coefficient estimates from three methods: OLS, TSLS and GMM. Meanwhile, the results of some of the specifications and diagnostic tests and the list of instruments are listed in the rows below.<sup>149</sup>

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<sup>149</sup> Other regression results that contain other determinants such as unconditional interest volatility and others variables listed in the linear models specification are not reported here.

**Table 3-2** OLS, 2SLS and GMM Coefficient Estimates of Macroeconomic Determinants of the Base Spread (dependent variable  $-\Delta$ base spread)

Independent variables	OLS	2SLS	GMM
Constant	0.04 (1.43)	0.03 (0.53)	0.05 (0.47)
Inflation <sub>t</sub>	<b>-0.03</b> <b>(-1.67)*</b>	<b>-0.08</b> <b>(-2.00)</b>	<b>-0.07</b> <b>(-2.38)</b>
$\Delta$ Bank Rate <sub>t</sub>	<b>8.01</b> <b>(5.63)</b>	<b>7.16</b> <b>(3.86)</b>	<b>6.52</b> <b>(4.73)</b>
$\Delta$ Base Spread <sub>t-1</sub>	<b>-0.22</b> <b>(-2.19)</b>	<b>-0.21</b> <b>(-2.78)</b>	<b>-0.19</b> <b>(-3.31)</b>
Interest Differential <sub>t-1</sub>	-0.08 (-1.19)	-0.10 (-1.34)	-0.04 (-0.69)
$\Delta$ South African Interest Spread <sub>t-1</sub>	-0.01 (-0.08)	-0.00 (-0.01)	-0.02 (-0.40)
$\Delta$ M2/GDP <sub>t-1</sub>	<b>-0.38</b> <b>(-3.76)</b>	<b>-0.44</b> <b>(-3.84)</b>	<b>-0.47</b> <b>(-4.52)</b>
$\Delta$ Risk premium	<b>0.40</b> <b>(6.32)</b>	<b>0.38</b> <b>(4.93)</b>	<b>-0.58</b> <b>(-3.08)</b>
Impulse Dummy(1998M06)	<b>-0.06</b> <b>(-1.77)*</b>	-0.13 (-0.80)	0.17 (1.01)
2007-08-09 Fin. Crisis Dummy	<b>0.34</b> <b>(2.52)</b>	-0.16 (-0.34)	
Adjusted R-Square	0.32	...	...
S.E. of Regression	0.29	0.31	0.32
Prob.(F-statistic)	0.00	0.00	0.00
Instrument Rank		14	15
J-Statistics		2.81	2.75
Prob.(J-statistic)		0.72	0.83
D-Watson statistic	2.0	1.91	1.87
Normality J-Bera (P-value)	0.00	0.00	...
HAC Standard Errors (Newey-West)	Yes	Yes	Yes
Included observations: (After Adjustments)	238	237	237
Instruments: $\Delta$ Base spread (-2), Inflation (-1), $\Delta$ Bank rate (-1), Bank rate (-2), Interest differential (-1),			

Interest differential (-2), Interest Volatility (-2), GDP (-1),  $\Delta$ SA Spread (-1),  $\Delta$ SA Spread (-2), M2/GDP (-1), Dummy 1998,  $\Delta$ risk premium (-1) and Constant.

Notes: The (\*) indicate significance at 10.0 percent significance level, while the remainder bold case estimates are statistically significant at the standard 5.0 percent significance level. T-statistics are given in (). (...) indicates that the variable is excluded through redundant variable test when it is not significant and its removal does not change the result much. We tested the residuals from OLS with the Augmented Dickey-Fuller. ADF rejects the null hypothesis  $H_0$ : unit roots in the residuals. In order to preserve parameters stability some of the insignificant dummy variables in OLS equation were not deleted. Results on parameter stability test are given in Fig.C.3-1 and 3-3 on the Appendix C. Diagnostic tests the null hypotheses are F-test: explanatory variables equal to zero; J-Bera test: normality - the residual are normally distributed; and J-test: instruments are valid. The p-values for J-statistic show that we do not reject the null hypothesis that our instruments are valid, thus we conclude that our regressions are correctly specified.

### OLS results

Column (2) in Table 3-2 presents OLS results with independent variables: inflation rate,  $\Delta$ bank rate,  $\Delta$ base spread<sub>t-1</sub>,  $\Delta$ SA spread, interest differential,  $\Delta$ M2/GDP<sub>t-1</sub>, and two dummy variables that capture the structural break 2006M09<sup>150</sup> and the 2007-08-9 financial crisis. The dummy variables were introduced to take into account significant structural breaks in the results from the stability test.<sup>151</sup> First, the OLS regression results show that the inflation,  $\Delta$ bank rate,  $\Delta$ M2/GDP,  $\Delta$ risk premium and structural breaks dummies are statistically significant. The SA base spread and interest differential are statistically insignificant. M2/GDP, which represents financial depth, inflation and  $\Delta$ bank rate results, were estimated with signs as priori expected in the literature. The  $\Delta$ base spread has a negative relationship with  $\Delta$ M2/GDP and a positive relationship with inflation. In unreported results, the GDP growth rate and unconditional volatility were individually and jointly statistically insignificant; as such, these were dropped out of the regression without significantly influencing the results from the OLS equation.

The sign on the  $\Delta$ bank rate show that there is a positive relationship between policy rate and  $\Delta$ base spread. The positive sign indicates the initial partial effect of the  $\Delta$ bank rate on the base spread before the prime rate adjusts to reflect the increase in the base rate. Honohan (2001) and Classens et al. (2006) find that there is a positive long-term relationship between intermediation spreads and policy rate. We observe that changes in the repo rate are followed by changes in the base spread that balance the demand and supply of financial intermediation services in the financial sector. However, taking into account the non-normality of this result it seems that this coefficient might have overestimated the role of changes in the policy rate in the size of the base spread. Further, we examined the Variance Inflation Factor (VIF) for this coefficient in order to check the

<sup>150</sup> This is the impulse dummy identified with the unit root test with a structural break. However, due to the persistence of structural instability in some of the parameters we changed this dummy to shift dummy with a permanent effect on the trend of base spread.

<sup>151</sup> In the post-estimation analysis we used Wald and CUSUM tests to identify any significant structural breaks and parameter instability in both the residuals and the individual parameters.

severity of collinearity with other explanatory variables in the regression. We observed that this coefficient has a VIF= 1.78 far less than 5.0 or 10 values, which are regarded as the cut for the tolerance level of multicollinearity to exist in the regression.<sup>152</sup> Inflation is statistically significant and negative; this result is contrary to Crowley (2007), who discovered that high inflation is associated with higher interest rate spreads in English-speaking countries of Africa. Similarly, SA spread is statistically insignificant and estimated with a negative sign. An interest rate differential coefficient captures the correcting effects in the model that keeps the spread integrated with South Africa's financial sector. Others assume that the interest rate differential reflects the perceived riskiness of investing in Namibia by foreign investors. However, in this study we interpret the effects from this variable as having a correctional effect towards long run equilibrium. It helps to implement the two countries' spreads trend together in the long-term. Interest differential is statistically insignificant and shows -0.08 percent of 'catch-up effects' or correction effects from the past period to the current base spread. We argue that the negative sign for this coefficient indicates that the Namibia's repo rate has been below SA's repo rate over the sample period. The lag of the base spread is statistically significant and shows a negative sign. It is widely recognised that central banks smoothen interest rates; therefore, we append the regression to include the lags in order to capture any memory of changes in the base spread.

After examining the ACF and PAC results it shows that the  $\Delta$ base spread have shorter memories that are statistically significant to the current base spread. Empirically, this term improves the model fit by reducing the presence of serial correlation in the residuals.  $\Delta$ M2/GDP ratio is statistically significant and the negative sign indicates that financial depth is inversely related to spread as priori expected. The coefficient for the dummy for the structural break at 1998M06 identified by the structural break test in section 3.3.2 is statistically significant. Another financial crisis dummy was created after examining the stability of individual coefficients. The 2007-08-09 financial crisis dummy is statistically significant, and these results show that the last financial crisis had a major positive impact on the spreads in Namibia. Although the redundant test shows that the insignificant variable contribution is less significant we decided to leave insignificant level dummies in the model in order to preserve parameter stability. After taking into account the structural breaks in parameters with the specified dummy the outcome effects are observed in the results of recursive residual in Figures C.3-1 to C.3-7 in Appendix C.

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<sup>152</sup> VIF statistics quantify the severity of multicollinearity in OLS regression analysis. Often the rule of thumb is that the VIF should not exceed 5 or 10. See Table C.3-8 for full result for VIF.

Firstly, this post-estimation of results shows that the obtained residuals are within the 95% confidence intervals of the cumulative sums of the squares test. Secondly, changes in spread have a shorter memory with  $Q^*$  statistics showing that there is a correlation after the second lag. This indicates that in equilibrium the significant variables have a strong relationship with the  $\Delta$ base spread.

### TSLS results

The estimation above was repeated with a TSLS estimator to overcome the problem of endogeneity between the covariates and the error term. Results from TSLS are presented in Column (3). As can be seen, the results from TSLS show that the variables of inflation,  $\Delta$ bank rate,  $\Delta$ risk premium, lag term for base spread,  $\Delta$ M2/GDP and the endogenous structural break dummy are statistically significant. The M2/GDP as a financial depth indicator has the correct sign and it is statistically significant. Although  $\Delta$ SA spread and interest rate differential remains statistically insignificant in the TSLS results we decided to leave these variables in the model on the basis that, when we dropped them, they considerably changed the size of other parameters in the regression. As expected, we note that there are small marginal differences between the results obtained through OLS and TSLS methods. The size of some parameter drops has become statistically insignificant because of large standard errors from the TSLS estimator. For example, although the structural break dummies have improved the stability of coefficients in TSLS results these are not statistically significant in the overall results. The p-value for the J-statistic shows that we do not reject the null hypothesis that these instruments are valid for the TSLS regression. Since we are not sure whether the functional form between the spread and macroeconomic factors are realised in the countries we further estimate this relationship with GMM. This estimator takes into account the fact that the single equation we used was a partial specified model.

### GMM results

In order to present a balanced view of the relevance of these factors to the base spread, we used a GMM method, which fits in well because the linear models in (3.17) and (3.18) are partially specified. There is no guarantee that the relationship between spreads and macroeconomic fundamentals is linear. Holly and Turner (2012, p. 21) pointed out that ‘the main advantage of a GMM estimator is that we don’t have to write down a conventional regression relationship. Instead we can specify an implicit relationship

between variables.’ For example, the p-values for the J-Bera test statistic show that the residuals from OLS and TSLS are not normally distributed. Thus, to overcome this strict criterion we applied the GMM estimator, which only requires generalised moment conditions and independently distributed errors. As can be seen in column (4), the GMM results show that inflation,  $\Delta$ bank rate,  $\Delta$ M2/GDP ratio,  $\Delta$ risk premium, lag of  $\Delta$ base spread and one structural break dummy are statistically significant. Inflation rate is statistically significant although it bears the negative sign, which is contrary to what priori expected in the theory. This inverse relationship may be due to the lack of a clear alternative variable to control for economic cycles given that the economic growth rate variable was rejected by both omitted and redundant variable tests. Interest differential and SA base remain statistically insignificant. The financial depth indicator seems to indicate that shallow and lower finance in relation to demand will increase the cost of credit such as base spread.

#### *Specification and diagnostic results*

Finally, we evaluated the results from OLS, TSLS and GMM with specification and diagnostic tests. We start with coefficients diagnostic tests which are mostly applicable to the OLS and TSLS regressions. Firstly, we used omitted and redundant variable tests to evaluate whether unconditional inflation and interest rate volatilities are omitted or redundant variables in the OLS and TSLS regressions. The omitted variable test result is given by F-statistic (df. 2, 227) = 0.52 and p-value = 0.36. The F-statistic indicates that we do not reject the null hypothesis that unconditional inflation and interest rate volatility are jointly insignificant, which means that their contribution to the variation the dependent variable is negligible or zero. However, the redundant variable test rejects the null hypothesis that  $\Delta$ SA spread is a redundant variable in the base spread equation; therefore these regressors remained in the based spread equation. Results from these tests were consistent both in the TSLS and GMM equations.<sup>153</sup> Second, we examined the severity of multicollinearity among regressors using the VIF statistics. Table C.3-8 show that none of the VIFs both centred and uncentred display a value higher than 5, which is a conservative cut of the level. Third, we evaluate the residuals using the following residual diagnostic tests: Q\*-stat correlogram test for serial correlation; Jaque-Bera test for normality; and the White test for heteroscedascity. Table C.3-5 on the Appendix C shows the Q\*-stat correlogram with PAC and AC statistics and their associated probabilities at 13<sup>th</sup> lag. The

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<sup>153</sup> GMM alternative for redundant test is the J-statistic and its associated p-value for the difference that comes from comparing the likelihoods from restricted and unrestricted regressions.

Q\* correlogram and LM-test [F-stat. (2, 227) =0.49] show that there is no serial correlations in the residuals for the base spread equation. However, the J-Bera with p-value= 0.00 shows that we reject the null hypothesis in relation to how these residuals from OLS are normally distributed. For the stability diagnostic tests, we present the result in figures C.3-1, C.3-2 and C.3-3 in the Appendix. The results show a Recursive Least Squares Test, Cumulative Sum of squares (CUSUM) and the Recursive Least Square Test for individual coefficients in the  $\Delta$ base spread equation. The first two figures show that the residuals lie within 5% confidence intervals. These indicate stable residuals while in the last figure, C.3-3, we see that inflation coefficient and interest rate differential coefficients are showing signs of shift in the year 2003. We made efforts to use an impulse dummy at this point, which was statistically insignificant and thus rejected by the regression. Finally, the J-statistics for both TSLS and GMM regressions show that we do not reject the null hypothesis that these instrument variables used are valid for these regressions. Generally, a large J-statistic with a significant p-value of less than 5% casts doubts on the validity of the list of instruments used in the estimation.

In all the results, using the  $\Delta$ base spread as the ex-ante definition of interest rate spread, we found empirical evidence which supports the view that changes in some macroeconomic and financial variables explain interest spreads. In Namibia, some of these fundamentals are the  $\Delta$ bank rate, inflation,  $\Delta$ SA spread,  $\Delta$ M2/GDP ratio, risk premium and interest rate differential rate. In the following section we use retail spread as an alternative definition for interest rate spread.

Table 3-3 on the following page presents the results from OLS, TSLS and GMM estimation using equation (3.18) with  $\Delta$ retail spread as the dependent variable. Using equation (3.18) we examine the following macroeconomic and financial variables such as bank rate, unconditional inflation volatility, SA spread,  $\Delta$ M2/GDP ratio, risk premium, retail spread (-1), the East Asia financial crisis and the 2007-08-09 financial crisis dummies, which produce a significant stable economic relationship with retail spread. As usual, each column in Table 3-3 presents the coefficient estimates of a different regression with the same independent variables.

Table 3-3 OLS, TSLS and GMM Coefficient Estimates of Macroeconomic Determinants of Retail Spread (dependent variable  $-\Delta$ retail spread)

	OLS	TSLS	GMM
Constant	-0.02 (-0.82)	-0.02 (-0.74)	-0.02 (-1.22)
Inflation Rate <sub>t</sub>	<b>0.10</b> (1.98)	<b>0.10</b> (1.98)	<b>0.07</b> (1.99)
$\Delta$ Unconditional Infl. Volatility <sub>t</sub>	<b>0.21</b> (1.67)*	0.21 (1.58)	0.19 (1.56)
$\Delta$ SA Base Spread <sub>t-1</sub>	<b>-0.11</b> (-1.64)*	<b>-0.11</b> (-1.61)*	<b>-0.12</b> (-1.60)*
$\Delta$ M2/GDP <sub>t</sub>	<b>0.47</b> (3.24)	<b>0.46</b> (3.30)	<b>0.47</b> (3.51)
$\Delta$ Retail Spread <sub>t-1</sub>	<b>-0.57</b> (-7.20)	<b>-0.57</b> (-7.38)	<b>-0.49</b> (-6.82)
$\Delta$ Retail Spread <sub>t-2</sub>	<b>-0.24</b> (-4.53)	<b>-0.24</b> (-4.54)	<b>-0.22</b> (-4.23)
$\Delta$ GDP <sub>t-1</sub>	<b>-3.99</b> (-2.03)	<b>-4.05</b> (-2.06)	<b>-3.32</b> (1.85)*
2007-08-09 Fin. Crisis Dummy	0.11 (1.09)	0.11 (1.09)	0.11 (1.27)
Adjusted R-Square	0.32	30	...
S.E. of regression	0.30	0.46	0.48
Instrument Rank		12	14
J-Statistics		9.82	8.84
P-value (J-statistic)		0.14	0.11
Prob(F-statistic)	0.00	0.00	...
D-Watson Statistics	2.02	2.02	2.19
Normality J-Bera (P-value)	0.28	0.31	...
HAC standard Errors (Newey-West)	Yes	Yes	Yes
Included observations (After Adjustments)	237	237	237
Instruments: $\Delta$ Retail spread (-1), $\Delta$ Retail Spread (-2), Inflation (-1), $\Delta$ M2/GDP (-1) $\Delta$ Bank rate (-2), $\Delta$ Risk premium (-1), $\Delta$ GDP (-1), $\Delta$ GDP (-2) Inflation Vol. (-1), Inflation Vol. (-2), $\Delta$ SA Spread (-1), Dummy08-09 and constant.			

Notes: The (\*) indicate significance at 10.0 percent significance level, while the remainder bold case estimates are statistically significant at the standard 5.0 percent significance level. The t-statistics are given in (). While the (...) indicates that the variable is excluded when it is not significant and its removal does not change the result much. Residuals from all three estimations are stationary. In order to preserve parameters stability, the insignificant dummy variables in OLS equation were not deleted. Stability diagnostic tests are given in Fig. C.3-5 and Fig.C.3-7 in the Appendix C. Diagnostic tests the null hypotheses are F-test: explanatory variables equal to zero; J-Bera test: normality - the residual are normally distributed; and J-test: instruments are valid. The p-values for J-statistic show that we do not reject the null hypothesis that our instruments are valid, thus we conclude that our regressions are correctly specified.

### OLS results

Firstly, column (2) presents the OLS regression results which indicate that inflation,  $\Delta SA$  base spread, unconditional inflation volatility,  $\Delta M2/GDP$  ratio, retail spread lags and the GDP growth rate are statistically significant while the endogenous structural break dummy is statistically insignificant. Inflation rate is estimated with a positive sign therefore indicates a positive relation with retail spread. It suggests that financial institutions take into account the rate of inflation so as to maintain asset value in the long-term. Thus, inflation and unconditional volatility form part of the fundamentals that influence retail spread. Further, we find that financial depth indicator  $\Delta M2/GDP$  is estimated with a positive sign in the retail spread equation. The positive sign might be attributed to the fact that the economic cycles of M2 and GDP do not coincide over the sample. However, economic growth suggests that higher growth is associated with lower changes in the retail spreads. The structural break dummy for the 2008-09 financial crisis remained in the equation in order to induce stability in the parameters. The lag terms for the dependent variable indicate the persistent effects of retail spread, which show that changes in the retail spread have longer memory. The results from retail spread equation passed most criteria form OLS, as shown by the diagnostic tests. For example, the J-Bera test statistic shows that the residuals from this regression are normally distributed and have no serial autocorrelation up to the 2<sup>nd</sup> lag.

### TSLS and GMM Results

The GMM results are similar to the TSLS results; the only difference is that the measure for macroeconomic instability is now statistically insignificant. However, positive relationship inflation, unconditional inflation volatility and  $\Delta$ retail spread is consistent with the argument that uncertainties, fear in the financial market, and the prospect of financial instability perpetuate the rise of spreads in the economy.<sup>154</sup> In addition, as Groth (2012) illustrated, the lack of economic growth might lead to high margins on the supply of financial intermediary services. Other candidate variables such as unconditional interest

<sup>154</sup> See (De Grauwe & Ji, 2013) for two divergent views about the determinants of spreads.

rate volatility, changes in the policy rate, risk premium and the structural break earlier identified in the dependent variables remained insignificant; therefore, these were left out of the retail spread equation. Although the result from OLS passed strong criteria for least square we emphasise the GMM results. This is because of the possibility of endogeneity between some of the covariates and the error term as suggested by VIFs in Table C.3-12. Other variables such as SA spread and the crisis dummies indicate some degrees of consistency with the overall result. GMM result shows that inflation rate, unconditional inflation volatilities, SA spread and the 2008-09 financial crises are some of the significant factors that explain  $\Delta$ retail spread.

Lastly, we evaluate the results from OLS, TSLS and GMM with the *specification* and *diagnostic tests*. Firstly, we report the omitted and redundant variables tests concerning changes in the nominal bank rate and interest rate volatility. The omitted variable indicates that bank rate can be omitted from the retail spread equation when tested alone; however, the null hypothesis is rejected when this variable is jointly tested with unconditional interest rate volatility. The omitted variable test result is given by F-statistic (df. 2, 225) = 0.09 and p-value = 0.36. This indicates that we reject the null hypothesis whereby bank rate and unconditional interest rate volatility are jointly statistically insignificant. Hence, we conclude that this variable's contribution to the variation in the dependent variable is not negligible. Similarly, the VIF statistics in Table C.3-12 show that the collinearity among regressors in the retail spread equation is less than 5%, which means it is less severe. Next, the redundant variables test shows that interest rate differential is a redundant variable in the retail spread equation; therefore, this covariate was dropped completely from the based spread equation. Results from omitted variables and redundant tests were consistent both in the TSLS and GMM equations. Third, we evaluated the residuals with the following diagnostic tests: the Q\*-stat correlogram test for serial correlation, the J-Bera test for normality and the White test for the presence of heteroscedascity. Table C.3-9 in Appendix C shows the Q\*-statistic correlogram with PAC and AC statistics and their associated probabilities at 13<sup>th</sup> lag. The Q\* correlogram and LM-test [F-stat. (2, 226) = 0.59] show that there is no serial correlations in the residual for the  $\Delta$ retail spread equation. The heteroscedascity test (i.e. White test: F-stat. df. [41, 195] = 0.65) shows that we reject the null hypothesis of heteroscedascity and find that the residuals from the retail spread equation for OLS are homoscedascitic. Similarly, the J-Bera with p-value = 0.28 and 0.31 show that we do not reject the null hypothesis that these residuals from OLS and TSLS equations are normally distributed. For the stability parameters, Figures C.3-5, C.3-6

and C.3-7 show the results from the Recursive Test, the Cumulative Sum of Squares (CUSUM) and the Recursive Least Square Test for individual coefficients in the retail spread equation. Figures C.3-5 and C.3-6 show that the residuals lie within a 5% confidence interval. This, therefore, indicates stable residuals while the last Figure (C.3-7) shows that SA spread and retail spread (-2) coefficients were showing signs of structural shifts in the year 2005. Finally, the J-statistics of in both TSLS and GMM show that we do not reject the null hypothesis, as these instrument variables are valid in these regressions.

In all, the regression results in Tables 3-2 and 3-3 establish the importance of macroeconomic and financial variables in the determination of interest rate spreads. Although we emphasised that the factors might be different from country to country, it seems that inflation, the policy rate, financial depth, economic growth and changes in the risk are some of the fundamental determinants of spreads in Namibia. Using both definitions of ex ante interest rate spreads – that is,  $\Delta$ base spread and  $\Delta$ retail spread – these empirical results show that there is a statistically significant economic relationship between macroeconomic and financial fundamentals and intermediation spreads. This analysis concurs with Mujeri and Yunus (2009), Chirwa and Mlachila (2004) and Saunder and Schumacker (2000), who found that interest rate spreads are significantly influenced by macroeconomic factors such as inflation, high policy rates and other operating costs in the financial sector.

### **3.4 Conclusion and Policy Implications**

In this chapter, we investigated the macroeconomic fundamentals that explain spreads by using two distinct definitions of interest rate spreads: the ‘ex ante’ *base and retail spreads*. Starting with an extensive literature review, we recognise the following essential views about interest rate spreads. Firstly, although there is considerable coverage about the topic, particularly at the micro-level, we observe that many authors on this topic lament that there is no agreed framework on how to model interest rate spreads. This problem has made it difficult to compare empirical results about what factors determine interest rate spreads. However, we view that there is a consensus among economists that interest rate spreads are a major cause of concern in many economies. As Blinder (2013) indicates, spreads make borrowing prohibitively expensive and destabilise the economy as whole. As a result, several government packages in the recent financial crisis have aimed to reduce excessive changes in spreads in order to restore confidence and pre-crisis volume lending. In addition, we find in the literature that the persistent problem of huge spreads is

significantly observed in Latin America, Caribbean and Pacific, Sub-Saharan Africa and East Asian economies.

Secondly, researchers such as Beck and Hesse (2009) have grouped determinants of interest rate spreads under four broad classes: market structure view, risk view, macroeconomic view and small financial system view. This means that, in equilibrium, spreads can be analysed as an outcome of market structure in place, changes in perceived risk or risk perceptions, and macroeconomic fundamentals realised in the country. In the case of Namibia, we identified that there is lack of empirical evidence about what explains large interest rate spreads, the dynamic interaction among spreads and the impact of interest rate spreads on sectors such as households and businesses. In order to fill this gap, we used the available data to examine the unit root with structural breaks, cause and dynamics of spreads in Namibia. These efforts contribute to empirical knowledge on the topic and therefore can help to develop possible policy proposals about how to address spread in the long run. In this study we encountered problems concerning interest rate spreads as defined by base and retail spread. Some of the problems with spreads are regime shifts from structural breaks as identified with the unit root test with structural breaks. Although different regime shifts could be addressed with methods such as smooth transition autoregressive and logistic smooth transition models, these alone could not help in the presence of unit root and endogenous structural breaks. When a unit root is present even after accounting for endogenous structural breaks in the time series it is recommended to use first difference and then an impulse dummy to cater for an endogenous break in the data. In our preliminary results we find that base spread can be modelled with a smooth transition method; however, the base rejects the non-linear part of the STAR model. This means that both linear and non-linear regimes in the time series have a unit root. As an alternative to this method we applied the GMM with first difference variables and a dummy to take care of the unit root and the apparent structural breaks. The spread equation in the first differences is consistent with the static implicit function suggested by Groth (2012). This implicit function shows that, in equilibrium, total changes in the spreads are determined by changes in perceived risk, changes in income and other fundamentals realised in the country.

Firstly, the descriptive statistics show that the unconditional mean base and retail spreads are significantly different from zero over the sample period. Average intermediation spreads trend above the mean zero and the null hypothesis so that the unconditional mean of spread over this sample period is statistically equal to zero is

rejected. We find that on average most spreads are significant and always there; however, it is true that their movements are significantly amplified during crisis periods, which is reflected by different mean shifts and structural breaks over the sample period. Second, the unit root test results showed that spreads in Namibia have a unit root with endogenous structural breaks. We find that most significant endogenous structural breaks were identified between 1997M1 -1998M8 periods. This period coincided with the East Asia financial crisis. The presence of unit root process in spreads is contrary to the view that theoretically there is nothing that can make us expect a unit root process in the interest spreads. Thus, it generally expected that spreads are of integrated order of less than one and are cointegrated. Third, our regression results from OLS and GMM show that fundamental factors such as inflation, inflation volatility, bank rate, financial depth, risk premium and economic growth are some of the statistically significant factors that explain large changes in interest rate spreads in Namibia. We find that  $\Delta M2/GDP$  is inversely related to  $\Delta$ base spread while interest rate volatility and inflation volatility are positively related to retail spread.

Nominal policy rate also significantly influences the  $\Delta$ base spread. In all, whether we defined interest spread as the  *$\Delta$ retail spread*, the difference between average lending rate and average deposit rate or the  *$\Delta$ base spread*, or the difference between prime lending rate and the bank rate, our empirical results indicate that there is a statistically significant role of macroeconomics and financial variables in the determination of interest rate spreads. This is shown by the consistence between the results from descriptive statistics and the regression results from OLS, TSLS and GMM. Finally, the endogenous structural break dummies identified by the unit test with structural breaks were not all statistically significant; however, if we replace these with the shift dummies then we have significant coefficients and improvement in the stability of parameters in OLS and TSLS regression.

### 3.4.1 Policy implications

In terms of policy proposals we suggest that policymakers should take into account the presence of endogenous structural breaks in the spreads when devising policy proposals to address large spreads in Namibia. This is because significant structural breaks affect the size of parameters and the forecasts based on these parameters. Further, we suggest that policymakers should enact policies that target the reduction of volatility, risk perceptions and uncertainty. At the macro level, fiscal authority and the central bank should use both monetary and fiscal policy to smoothen the credit supply to the economy. This strategy will improve macroeconomic and financial stability as the risk premium decreases. In

addition, low inflation volatility and hence less uncertainty will translate into smaller changes in average spread in the long run. Our result suggests that maintaining small interest differentials will help to reduce the average size of interest rate spreads. Finally, our empirical evidence agrees with evidence from Crowley (2007) and Beck and Hesse (2009). These authors find that nominal interest rate, inflation and risk premium,  $\Delta M2/GDP$  and economic growth are some of the determinants that influence the size of spread in Namibia. This implies that changes in volatility, risk perception, economic growth and financial depth determine the changes of spreads, which bring the demand and supply of financial intermediation into equilibrium. Additionally, Hossain (2012) Barajas, Salazar and Stienen (2000), Beck and Hesse (2009) and Mujeri and Yunus (2009) have established that a higher interest rate spread in developing countries is mainly caused by high operating costs and macroeconomic instability.

## Appendix C

### Appendix C.3.1 Namibia Financial system: A brief overview

Namibia's banking sector currently consists of eight banks of which five are retail banks and two, specialized banks which are majorly owned by the government. Overall above on the hierarchy is the Bank of Namibia which is the central bank and government banker. Its main aims are to 'support economic growth and development, act as fiscal advisor and banker to government, promote price stability, manage reserves and currency, and ensure sound financial system and conduct economic research' (Bank of Namibia, 2010). As indicated in the last essay that Namibia maintains a currency peg one-to-one of the Namibian dollars to the South Africa Rand. Although this arrangement exists, Allen, Otchere, & Senbet (2011) point out that Bank of Namibia has major influence on monetary policy to some degree to pursue interest rate level different from South Africa.

Commercial banks dominate the financial sector as main lenders to various economic agents in the economy. Although banks participate in the Namibia Stock Exchange, the stock market is largely dominated by industrial metals, food and drugs, retailers and mining companies. As a result, commercial banks are major financiers of economic activity in agriculture, construction, manufacturing and the services sectors. The bond market is dominated by government as the main issuer and attracts mostly commercial banks, investment trusts, insurance company, and stock brokers as participants. For example, Vollan (2000) reveals that most allotments at primary issue are made to commercial banks which also makes many banks depend on government treasury bills.

#### *List of Banks in Namibia* (December 2013)

1. First National Bank of Namibia (Ltd.)
2. Standard Bank of Namibia (Ltd.)
3. Bank Windhoek (Ltd.)
4. Nedbank Namibia (Ltd.)
5. FIDES Bank (Ltd.)<sup>155</sup>

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<sup>155</sup> FIDES Bank (Ltd.) and SME Bank (Ltd) are new established in 2010 and 2012. These banks mainly lend to SMEs and target enterprises in the economy. As for this analysis they are excluded in the sample due to the fact their operations are yet small to make a significant impacts on the spread. There is also NAMPOST

Other banks (specialized banks)

6. Agricultural Bank of Namibia Ltd

7. Development Bank of Namibia Ltd.

8. SME Bank Ltd.

The stock market in Namibia is managed by the Namibia Stock Exchange (NSX) which was established in 1992. The Table 3.1 below shows the market capitalization of the Namibia Stock Exchange (NSX) which illustrate a low level of liquidity. As the case with stock exchanges in Southern Africa, many companies listed on NSX are dual listed to trade on Johannesburg Stock Exchange (JSE) in Johannesburg, SA.

Table C.3-1 Namibia Stock Exchange (NSX) Market Capitalization

Year	2002	2003	2004	2005	2006	2007	2008	2009	2010
Local market (N\$ million)									
Market capitalisation	1 728	2 054	2 492	2 630	3 820	4 781	5 720	7 126	7 782
Listed securities	12	11	9	9	9	7	7	7	7
Liquidity (%)	1.96	1.86	10.6	2.62	7.00	6.20	5.15	2.58	1.72
Overall market (N\$ million)									
Market capitalisation	386 617	460 315	573 878	769 585	1 112 542	1 186 365	736 456	1 047 527	1 178 257
Listed securities	35	35	32	28	28	27	29	33	33
Liquidity (%)	0.45	0.47	7.16	6.75	8.76	11.24	12.72	0.83	0.64

Source: NSX

While, on average, the Namibian's banking sector can be describe as an oligopoly market, it is also much linked to South Africa's financial sector. Fitchat and Ikhide (2002) reveal that competition seems to be lacking among banks in Namibia. If it exists, it is rather through advertisement and less through prices and charges. Three out of the major eight retail banks in Namibia are subsidiaries from South Africa while two are state-owned banks which only lend to specific sectors such as agriculture and the development industry which target SMEs, franchise and other upcoming entrepreneurs. Namibia's strong link to South Africa has many economics and financial benefits albeit with some costs too. For

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SAVING Bank which is part of Namibia Post and Telecom Holdings, however, this is also very small and its major customers are pensioners and people with disabilities.

example, free capital movements between the two countries do less to encourage innovation and development of the locals' financial markets.<sup>156</sup> As for the last decade, Namibia has become a net export of capital to South Africa because their market is relatively developed than local counterpart.

There are also well established non-financial institutions such as pension institution funds, insurance, and microfinance institutions that serve as alternative sources for liquidity to banks. According to the current review in the NFSS (2011), there are about 167 active registered pension funds, 18 long term insurance companies and 186 microfinance institutions registered in Namibia. Among the pension fund institutions, the Government Institution Pension Fund (GIPF) is the main player and accounts for about 70 percent of assets of pension funds in the country. In money markets the most instruments are call deposits, interbank loans and deposits, bank acceptances, negotiable certificates of deposits, and treasury bills.

In comparison to many countries, Namibia is sparsely populated, only surpassed by Mongolia. It is argued that due to the large scattered population of Namibia, the costs of running a banking business in Namibia are very high.<sup>157</sup> These facts in some quarter are used to justify why interest rate spreads are so high, because banks need to take into account the transportation and security costs in their spreads. In addition, although there are about seven banks in the economy, the real market power concentrates on the top three largest banks – First National Bank of Namibia Limited, Standard Bank of Namibia Limited and Bank Windhoek Limited. As shown in Table 2 these three banks dominate the banking sector as their total assets account for more than half of all assets in the banking sector. The data in Table 2 shows that there is a high concentration of assets in the three major banks. These three banks hold more than 80 percent of total assets with almost equal shares of the loan market.

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<sup>156</sup> One the reasons that prevent innovation are the lack of willingness from foreign institutions to spend on local training of human resources and money market development. Although these measures are applied with the aim to keep costs very low they have also disadvantage financial development in Namibia.

<sup>157</sup> World Bank Quick Facts shows that Namibia has: surface area about 824.3 (thousands sq. km); population 2.32 million; GDP Per Capita 6,600 (current US\$); Category: Middle Income country. For world ranking on least densely populated countries see: <http://www.aneki.com/sparsely.html>

**Table C.3-2.** Banking Industry Structure Year (2010)

Rank	Bank Name	Value USD	Cumulative values	%	Cumulative %
	<b>Total Assets - Last available year</b>	<b>8,255,103</b>	<b>37,911,159</b>	<b>100</b>	
1	First National Bank of Namibia Limited	2,334,546	2,334,546	28.28	28.28
2	Bank Windhoek Limited	2,298,838	4,633,384	27.85	56.13
3	Standard Bank Namibia Limited	2,155,498	6,788,882	26.11	82.24
4	Nedbank Namibia Ltd	1,052,069	7,840,951	12.74	94.98
5	Agricultural Bank of Namibia - Agribank	217,343	8,058,293	2.63	97.62
6	Development Bank of Namibia	196,809	8,255,103	2.38	100.00

Data Source: Bank Scope. Table author's own construction.

In order to gauge the amount of competition in the banking sector, we calculated the Herfindahl-Hirschman Index (HHI) based on the sum of squared loan market shares. Herfindahl-Hirschman Index measures the size of firms in relation to the banking industry and the level of competition among banks. The conventional interpretations of HHI are as follow: the index below 1000 indicates a highly competitive industry, between 1000 and 1,500 indicates un-concentrated markets; 1,500 and 2,500 indicates moderates concentration; and 2,500 or above indicate high concentration. The HHI = 2,930 which is above 2,500 index value, indicates there is a high market concentration in the banking sector in Namibia. The evidence, therefore, supports the argument that there is lack of competition which increases inefficiency which as a result manifests in the form of high interest spreads. This index is used to test whether competition significantly affects interest rate spread in the econometric model.

**Table C.3-3.** Herfindahl-Hirschman Index (HHI)

	2010	2009	2008	2007	2006	2005
<b>HHI</b>	2442.2	2431.7	2456.5	2431.2	2461.3	2409.6
<b>HHI*</b>	2930.4	2917.8	2947.6	2917.3	2953.4	2891.4

\* Source: Author's own construction.

## Appendix C.2

### Bank of Namibia media release 22 July 2010



REF: 9/6/2  
**22 July 2010**  
 Attention: The News Editor

FOR IMMEDIATE RELEASE

## MEDIA RELEASE

### **BANK OF NAMIBIA ENCOURAGES COMMERCIAL BANKS TO NARROW INTEREST RATE SPREAD BY OCTOBER 2010**

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The Bank of Namibia has been inundated by media and public enquiries over the reduction of the spread between the repo and prime rate, following recent media reports and public statements surrounding this matter.

The Bank of Namibia has made it a requirement for all the commercial banks to reduce the spread between repo and prime rate to 375 basis points before the end of October 2010. The Bank of Namibia does not prescribe how and when this is achieved, as long as the final deadline is met. In this regard, the Bank of Namibia took note and commends Bank Windhoek for taking the lead to become the first commercial bank to comply with the Bank of Namibia's call to narrow the spread between the repo rate and prime lending rate to 375 basis points (from 11.25% per annum to 10.75% per annum) effectively on the 8<sup>th</sup> of July 2010, well before the set deadline.

All other commercial banks are further reminded that it remains a requirement to continue striving towards narrowing the spread between the prime and the repo rate.

**Ndangi Katoma**  
**HEAD: CORPORATE COMMUNICATIONS**



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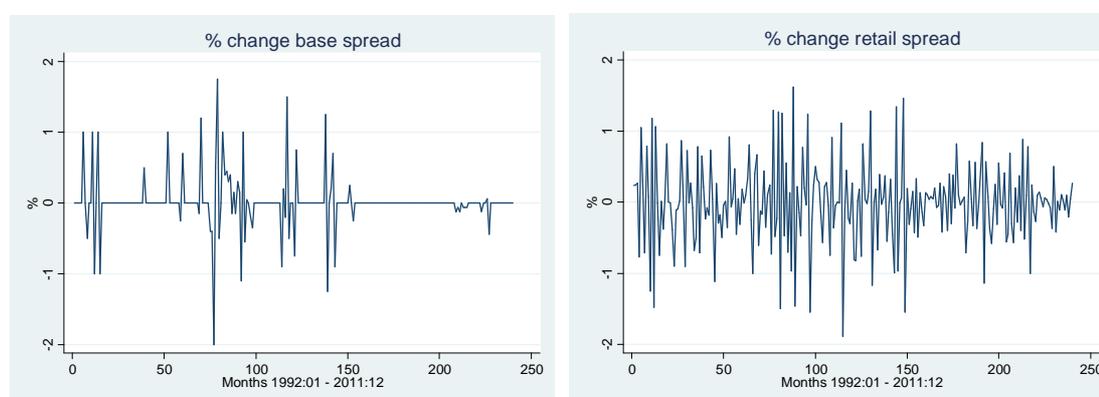
## Appendix C.2-2 Descriptive statistics and Unit Root test results

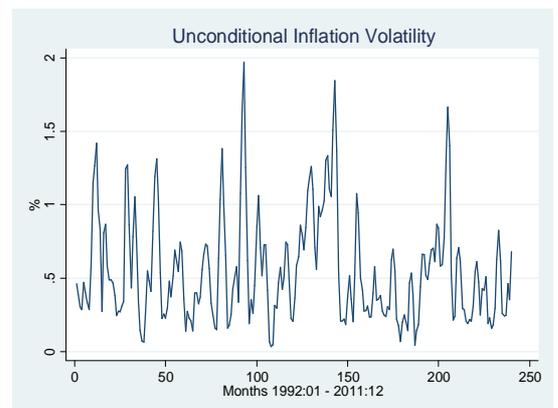
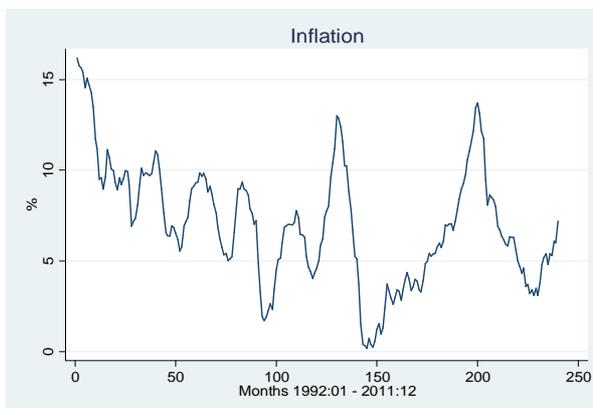
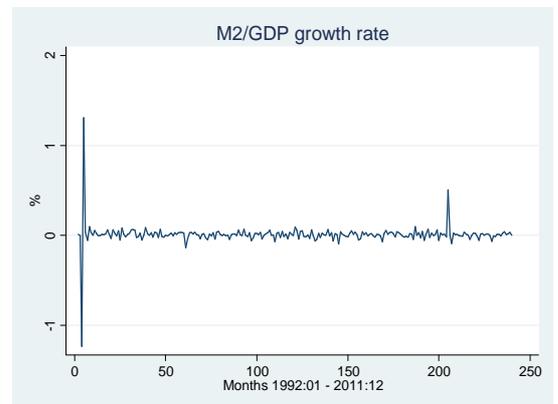
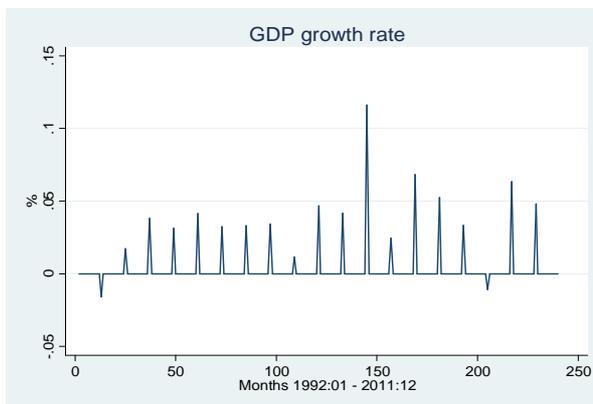
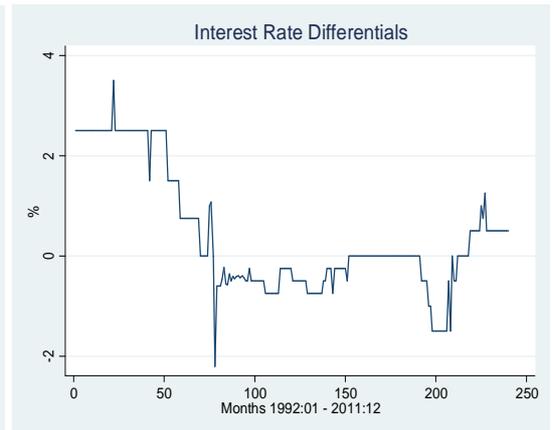
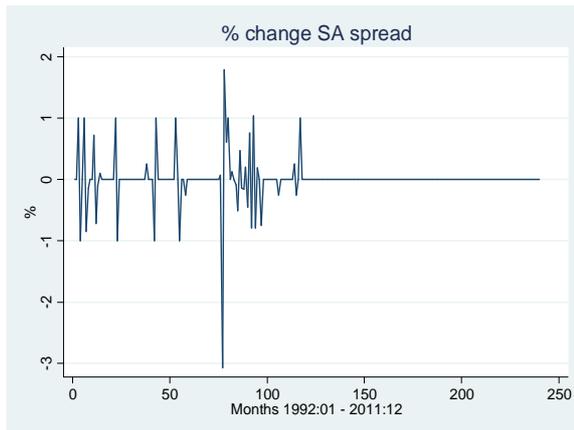
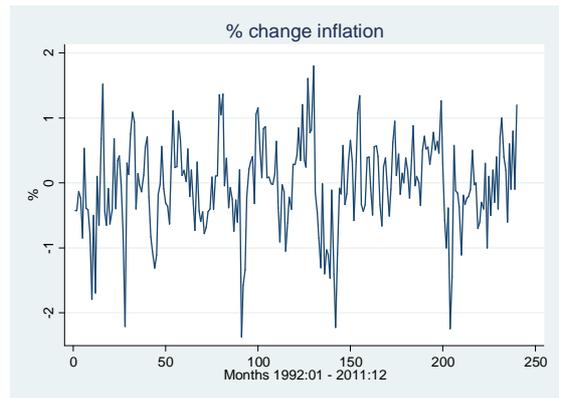
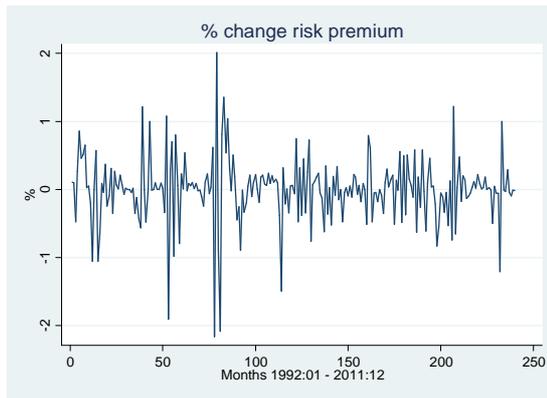
**Table C.3-4** Pair-wise correlation statistics for the first difference variables, sample 1992:01 – 2011:12

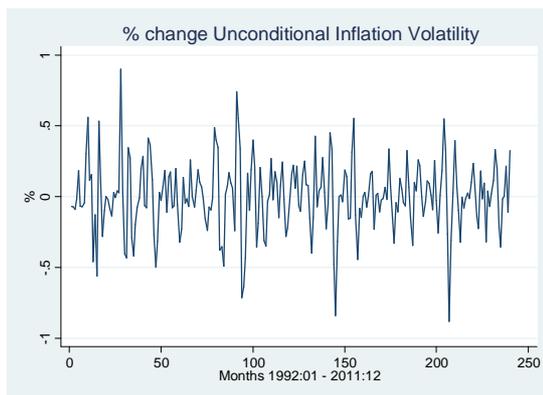
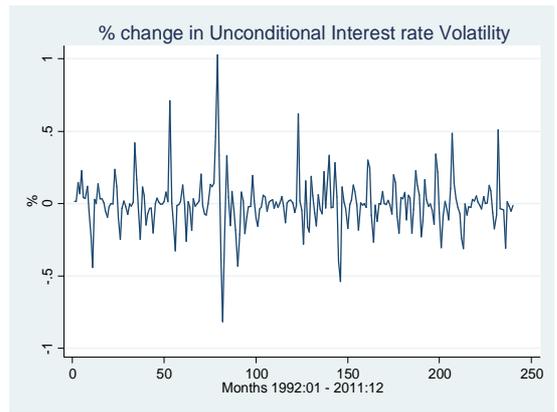
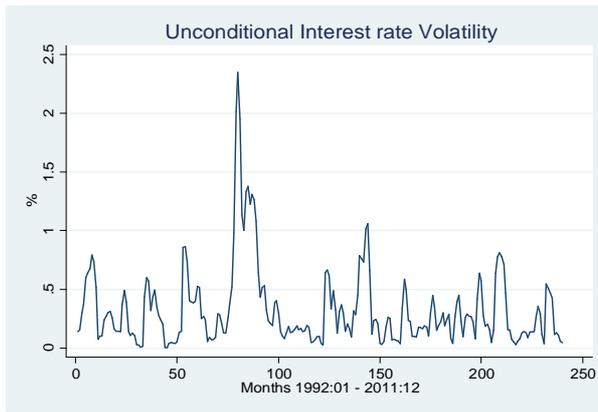
	$\Delta$ Base sprd	$\Delta$ Retail sprd	$\Delta$ Risk pr.	$\Delta$ M2/ GDP	$\Delta$ Infla	$\Delta$ Int. Diff.	$\Delta$ GDP	$\Delta$ Vol. Inf.	$\Delta$ Vol. Int.	$\Delta$ SA spread
$\Delta$ Base spr	1									
$\Delta$ Retail spr	0.20* (0.09)	1								
$\Delta$ Risk spr	0.30* (0.00)	0.04 (0.53)	1							
$\Delta$ M2/GDP	0.03 (0.40)	0.19* (0.00)	0.03 (0.54)	1						
$\Delta$ Inf	0.03 (0.61)	0.13* (0.03)	-0.01 (0.86)	-0.05 (0.38)	1					
$\Delta$ Int. Diff.	-0.06 (0.91)	0.01 (0.89)	-0.08 (0.19)	-0.01 (0.91)	0.06 (0.34)	1				
$\Delta$ GDP	-0.03 (0.55)	-0.20* (0.00)	-0.01 (0.83)	-0.12* (0.05)	-0.02 (0.68)	-0.04 (0.45)	1			
$\Delta$ Vol. Inf.	0.07* (0.09)	-0.12* (0.06)	0.12* (0.08)	-0.10* (0.08)	-0.10* (0.08)	-0.02 (0.72)	-0.15* (0.00)	1		
$\Delta$ Vol. Int.	-0.02 (0.96)	-0.02 (0.63)	-0.10* (0.06)	0.03 (0.58)	0.07 (0.28)	-0.01 (0.79)	-0.11* (0.08)	0.04 (0.52)	1	
$\Delta$ SA sprd	0.46* (0.00)	-0.15* (0.09)	0.16* (0.01)	0.15* (0.02)	-0.03 (0.59)	-0.02 (0.72)	-0.03 (0.55)	0.10* (0.07)	0.11* (0.09)	1

\*indicates the 10% significance level.

**Figure C.3-0** Interest rate spreads, macroeconomic and financial variables in first difference







### Appendix C.3-4 Residual and Stability Diagnostic Tests

Table C.3-5 Base spread Q\* statistic with probabilities adjusted for one dynamic regressors

	AC	PAC	Q-Stat	Prob*
1	-0.036	-0.036	0.3204	0.571
2	-0.027	-0.028	0.4971	0.780
3	0.030	0.028	0.7219	0.868
4	-0.019	-0.018	0.8122	0.937
5	-0.054	-0.054	1.5238	0.910
6	-0.136	-0.142	6.0539	0.417
7	-0.159	-0.176	12.281	0.092
8	0.061	0.039	13.210	0.105
9	-0.029	-0.029	13.414	0.145
10	-0.001	0.000	13.414	0.201
11	0.019	-0.010	13.503	0.262
12	0.048	0.012	14.073	0.296
13	-0.023	-0.065	14.204	0.360

Table C.3-6 Breusch-Godfrey Serial Correlation LM Test:

F-statistic	0.707426	Prob. F(2,227)	0.4940
Obs*R-squared	1.474224	Prob. Chi-Square(2)	0.4785

Table C.3-7 Heteroskedasticity Test: White

F-statistic	0.740237	Prob. F(43,194)	0.8785
Obs*R-squared	33.54550	Prob. Chi-Square(43)	0.8490
Scaled explained SS	294.4562	Prob. Chi-Square(43)	0.0000

Table C.3-8 Variance Inflation Factors (VIF)

Sample: 1992M01 2011M12, included observations:  
238

Variable	Coefficient Variance	Un-centred VIF	Centred VIF
C	0.000818	4.866403	NA
INF	0.000905	2.178071	1.810222
ΔBank rate	1.936935	1.783333	1.782303
ΔSA sprd(-1)	0.004378	1.667112	1.561798
Int. Diff.(-1)	0.005175	1.474540	1.439261
ΔM2/GDP(-1)	0.009024	1.248832	1.227664
ΔBase sprd(-1)	0.004324	1.648056	1.601241
ΔRISK	0.003648	2.692820	2.485641
D9908	0.001258	5.474075	1.529361

Fig.C.3-1 Recursive Least squares test for parameters stability in the base spread eq.

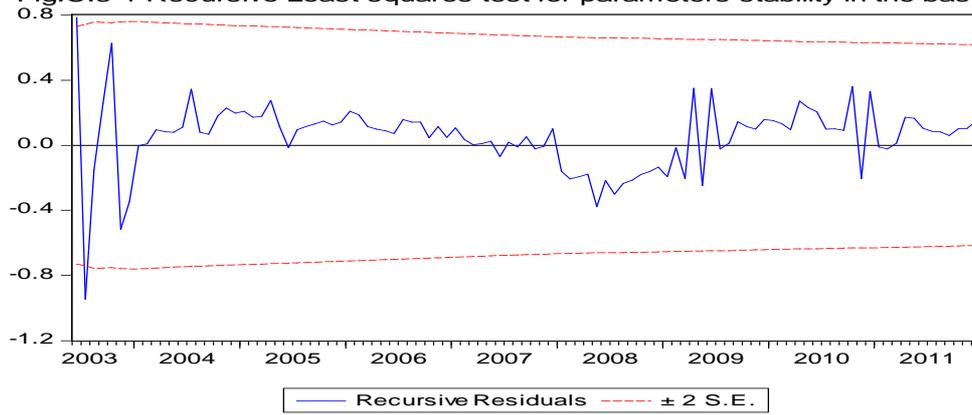


Fig.C.3-2 CUSUM test for parameters stability (base spread eq.)

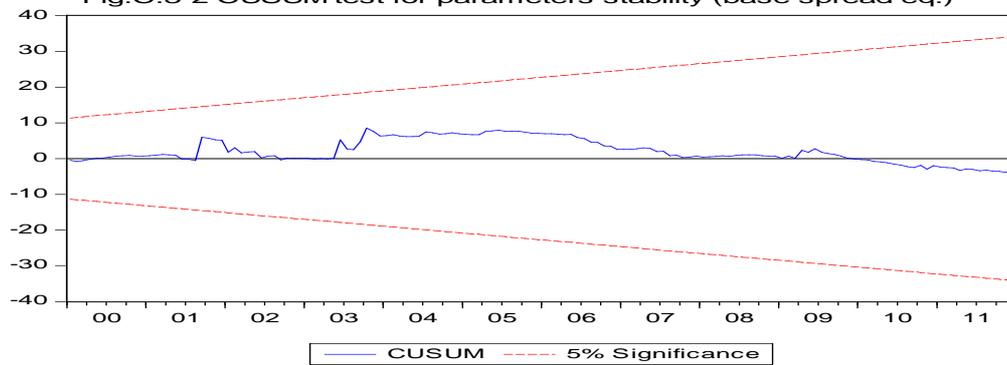


Fig.C.3-3 Recursive parameter stability test for individual parameters in the base spread eq.

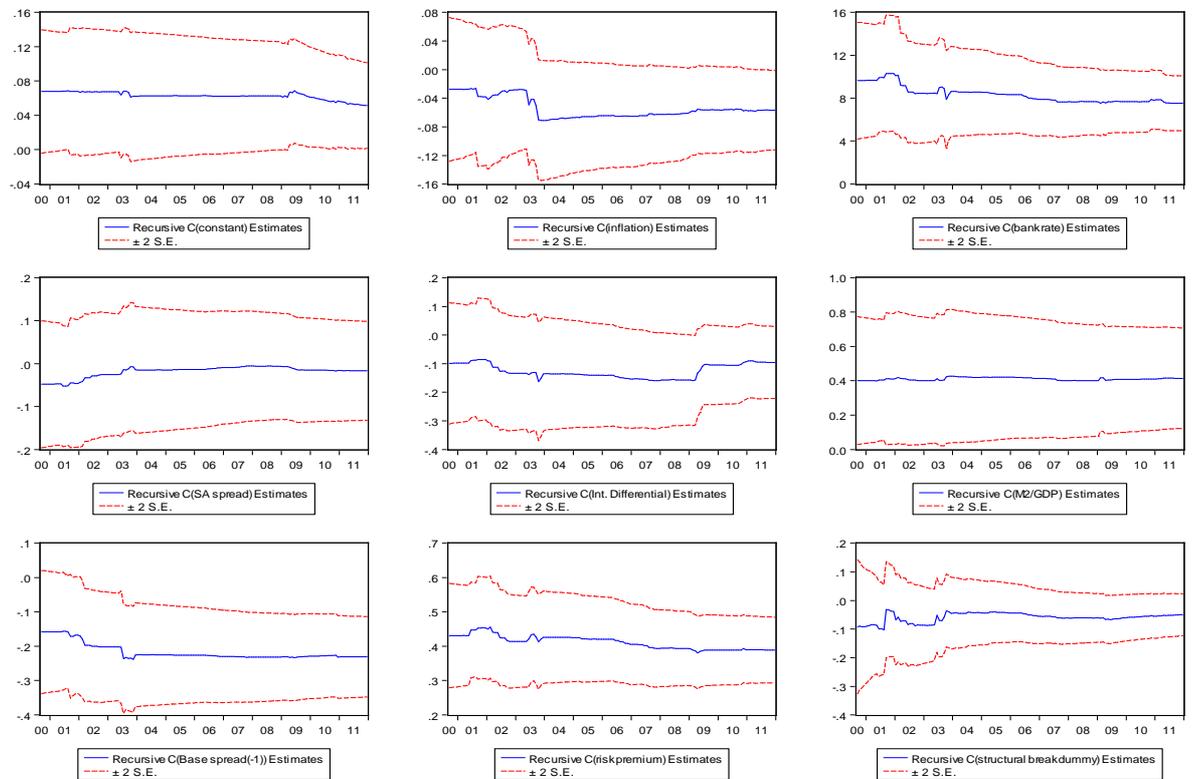
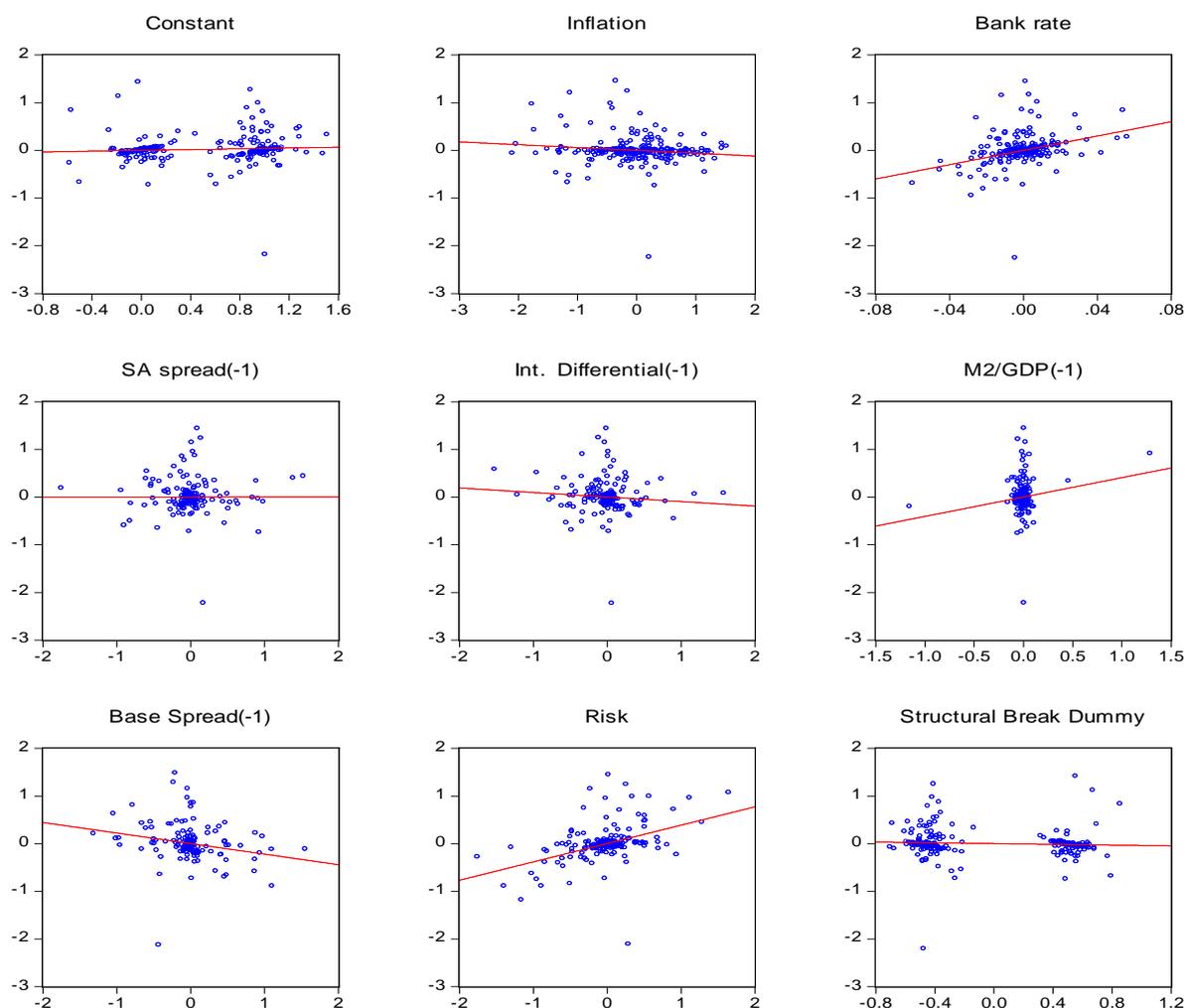


Fig. C.3-4 Leverage plot Base Sprd vs Variables (Partialled on Regressors)



(1) Recursive Residuals test shows plots of recursive residuals about the zero mean within two confidence bands of  $\pm 2$  standard errors. The recursive residuals outside the area indicate parameter instability. (2) CUSUM test indicates parameters instabilities when the cumulative sum of recursive residuals goes out the confidence bands  $\pm 2$  s.e. The CUSUM that fall exactly on the zero indicate perfect parameter stability. The CUSUM test results shows that with the inclusion of dummy variables in both equations the parameters have become statistically stable.

### Residual and stability Diagnostic Tests Retail spread Equation

**Table C.3-9** Retail spread  $Q^*$  statistic with probabilities adjusted for one dynamic regressor.

	AC	PAC	Q-Stat	Prob*
1	-0.012	-0.012	0.0336	0.855
2	0.017	0.017	0.1009	0.951
3	-0.086	-0.086	1.9090	0.592
4	-0.117	-0.120	5.2187	0.266
5	-0.114	-0.117	8.3915	0.136
6	-0.017	-0.028	8.4634	0.206
7	-0.024	-0.045	8.6037	0.282
8	0.011	-0.027	8.6330	0.374
9	-0.035	-0.069	8.9296	0.444
10	0.045	0.016	9.4338	0.491
11	0.060	0.050	10.347	0.499
12	0.097	0.085	12.710	0.390

13 0.028 0.027 12.904 0.455

Table C.3-10 Breusch-Godfrey Serial Correlation LM Test:

F-statistic	0.516682	Prob. F(2,226)	0.5972
Obs*R-squared	1.078728	Prob. Chi-Square(2)	0.5831

Table C.3-11 Heteroskedasticity Test: White

F-statistic	0.892835	Prob. F(41,195)	0.6578
Obs*R-squared	37.45873	Prob. Chi-Square(41)	0.6288
Scaled explained SS	38.08430	Prob. Chi-Square(41)	0.6009

Table C.3-12 Variance Inflation Factors (VIF) retail spread Eq.

Sample: 1992M01 2011M12, included observations:  
237

Variable	Coefficient Variance	Un-centred VIF	Centred VIF
Constant	0.000889	1.154140	NA
Inflation	0.002957	1.889105	1.817837
$\Delta$ SA sprd(-1)	0.005105	1.433719	1.428555
$\Delta$ M2/GDP	0.020016	1.489899	1.481368
$\Delta$ Retail Sprd(-1)	0.006121	1.538727	1.522749
$\Delta$ Retail Sprd(-2)	0.002947	1.756569	1.756404
$\Delta$ GDP(-1)	3.852947	1.256278	1.219135
VOL. Inflation	0.018151	1.145555	1.139618
D0708	0.011880	1.648231	1.522867

## Stability Diagnostic tests

Fig.C.3-5 Recursive Least Squares test for parameters stability (retail spread equ.)

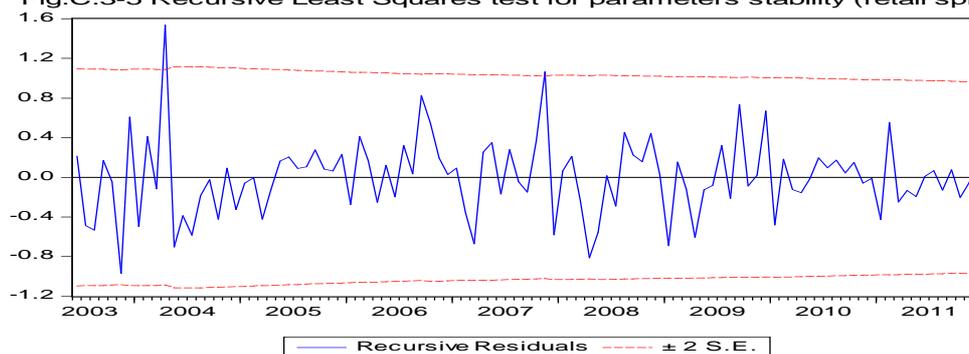


Fig.C.3-6 CUSUM test for parameters stability in retail spread eq.

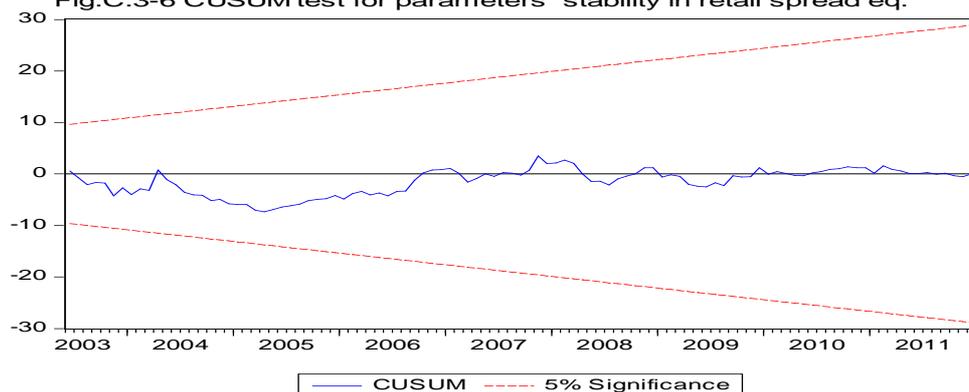


Fig.C.3-7 Recursive Least Squares individual parameters stability test retail spread eq.

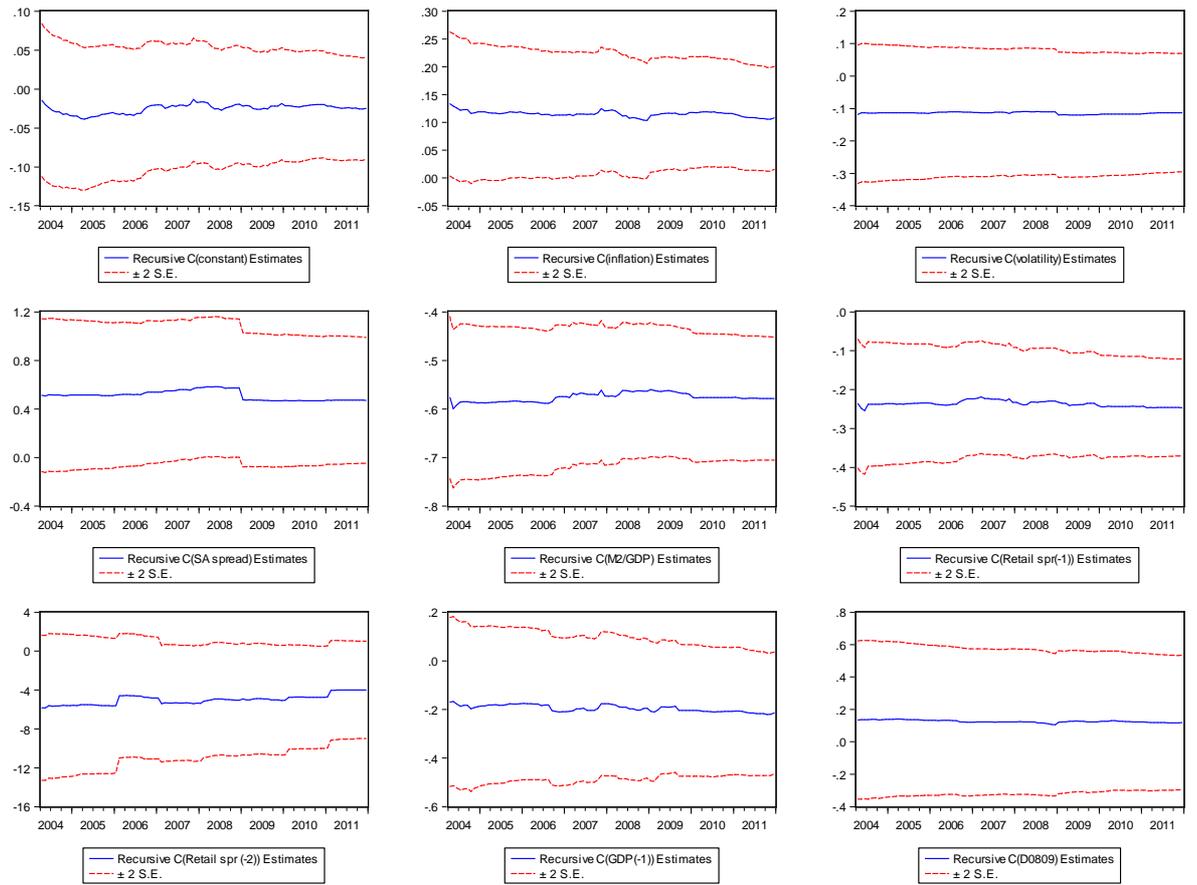


Fig.C.3-8 Leverage plot Retail spread vs Variables (Partialled on Regressors)

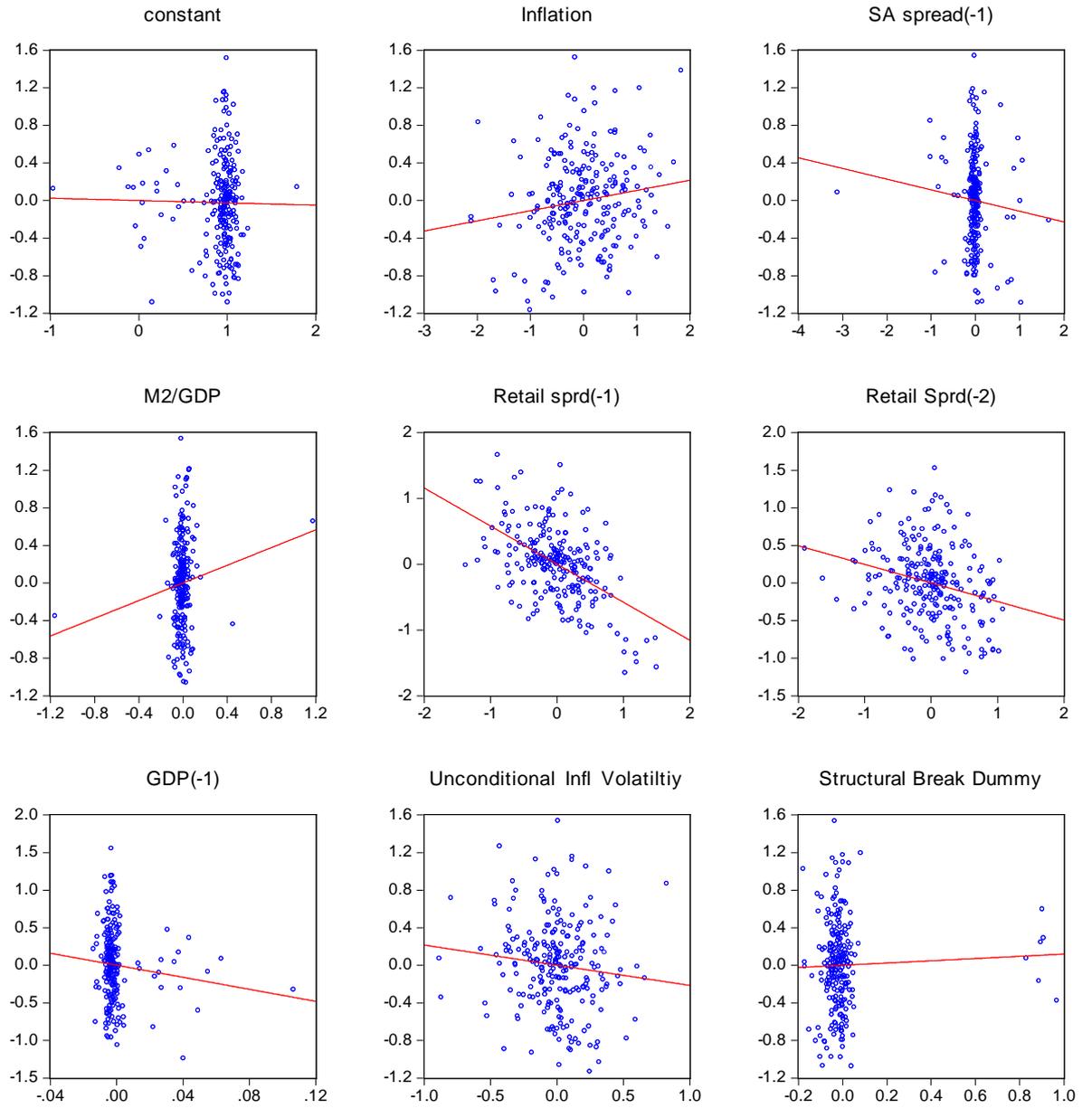


Table C.3-13 Augmented Dickey-Fuller Unit Root Test

Variable	t-statistic (Level)	Crit.-value 5%	Observations
Base spread	-2.25	2.87	238
Retail spread	-1.45	2.87	238
Risk premium	-3.00*	2.87	238
Inflation	-2.26	2.87	238
Interest Diff.	-1.97	2.87	238
GDP	-3.55*	2.87	238
Repo rate	-1.42	2.87	238
SA spread	-5.93*	2.87	238
Vol. inflation	-4.83*	2.87	238
Vol. interest rate	-4.50*	2.87	238
Prime rate	-1.08	2.87	238
M2/GDP	-1.60	2.87	238

Note: MacKinnon (1996) critical values, Minimum lag=2, Maximum lag =14.

## CHAPTER FOUR

### Simple Spread-adjusted Taylor Rule (STR): Empirical evidence

‘Financial stability is part of the ‘genetic code’ of central banks and the uncertainty of the last five years has proved that it has consequences for different departments and functions, in particular monetary policy. The line between monetary policy and financial stability has blurred as central banks have been forced to intervene to maintain stability and confidence in markets.’ ....Goodhart C. (2013).

‘An important question is whether and by how much monetary policy should adjust to financial market disturbances to prevent spill over to the rest of the economy. [...] one possible approach to adjusting the systemic component of monetary policy would be to subtract a smoothed version of this spread from the interest rate target [...]Such an adjustment has the advantage of being more transparent and predictable than an arbitrary or purely discretionary adjustment.’ (Taylor, 2008, p. 3).

#### 4.1 Introduction

Financial instability resulting from the recent 2008-2009 financial crisis has once again revived the debate about the implementation of monetary policy such as the standard Taylor rule. As part of this debate, Curdia and Woodford (2009), McCulley and Toloui (2008), and Taylor (2008), proposed a simple STR that seems to adequately respond to economic and financial disturbances. This innovation was deemed necessary so that monetary policy rule can perform its main task which is to guide the implementation of monetary policy strategy in normal and abnormal times. It is widely acknowledged in the last decade that the ‘Taylor rule’ by John B. Taylor (1993) has made the subject of feedback rules very popular among academic economists and central bankers. Taylor rule has influenced monetary policy framework and the communication of monetary policy to the public. Underlying advantages are that monetary policy rules convey greater information which has increased transparency, cemented the public interests in the implementation of monetary policy, and simplified the process of economic stabilization.<sup>158</sup>

Historically, monetary policy rules evolved from fixed-exchange rate targeting, nominal income targeting, money growth targeting to interest rate targeting regime. Accordingly, this effort to revise current monetary policy rule is a continuation of

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<sup>158</sup> Monetary policy rules show with simplicity how central banks go about to stabilize the economy in the short term. Taylor & Williams (2011) reveals that for the past 25 years the general public have become more familiar with the systematic behaviors of central bank as result.

monetary policy evolution so that it can adequately responds to macroeconomic shocks on multiple fronts. There are challenges that face modern monetary policy and these include: how to stimulate economic growth when nominal policy target is near zero level; how to respond to rising financial instability in an environment of low stable inflation; and how to fight inflation in the face of tight credit conditions in the financial sector. For example, monetary policy in a low stable inflation environment induces growth of asset price bubbles which if it continues unencumbered, it will generate financial instability and destabilises the economy as a whole.<sup>159</sup>

STR is proposed to address the inadequacy of standard Taylor rule – a near strategy loosely followed by many central banks to set the interest rate target. In this study we empirically estimate and examine the posterior means and the posterior densities of this rule. Spread-Adjusted Taylor is proposed by Taylor (2008) and McCulley & Toloui (2008) and theoretically calibrated by Curdia & Woodford (2009), Hirakata, Sudo, & Ueda (2011), Teranishi (2011) and Sudo & Teranishi (2008). STR adjusts downward the nominal policy target in response to tight credit conditions as a result of rising spread. For example, STR may be useful in response to an economic shock which increases external finance premium and eventually slows down economic activity. Proponents of STR argue that it can mitigate the effects of economic shock by adjusting the nominal policy rate downward by less than one percent or equal to one percent change in the credit spread.

Many researchers ponder at the question about what information is missing or neglected by the standard Taylor rule. Taylor rule is well known to emphasise the price stability as an overriding goal for monetary policy stabilization. However, it has been exposed that the price stability is not a sufficient condition for financial stability. Thus, Curdia & Woodford (2009), Taylor (2008) and Teranishi (2011) suggest that the standard Taylor rule should be adjusted so that it includes a financial indicator such as spread (credit spread) as an explicit target variable to which monetary policy responds in a systematic manner. According to their works, there are economic disturbances although not posing inflationary danger, they however increase equilibrium spread which contract the supply of credit. Aside from the debate about monetary policy rules versus discretion policy in the literature, many economists that advocate for the rule-based monetary policies such as the standard Taylor rule concedes that current monetary policy rule that weight inflation and

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<sup>159</sup> See also Bayoumi et al. (2014, p. 4).

output seems not to work effectively in the face of financial instability.<sup>160</sup> The problem is now recognized that it goes beyond the insufficient in the feedback rules. As Blinder (2013, p. 238) indicates, ‘it is all about the spreads’. Blinder argues that spreads are very important because they ‘provide an objective, numerical market-base measure of financial market distress.’

#### 4.1.2 Main Objective

Curdia and Woodford (2009) and Teranishi (2011), proposed a monetary policy rule that responds to equilibrium spread with parameter value  $\theta_\omega \in [-1,0)$ .<sup>161</sup> Our objective is to estimate the posterior parameter values of the simple STR using the Bayesian linear regression method.<sup>162</sup> We used Bayesian method so that we can make use of available information about STR model. It is well known that classical maximum likelihood method (frequentists) ignores any prior knowledge about the model that is being measured. The advantage of using Bayesian analysis is that: it combines prior information we have about the model with the sample data in the likelihood function to estimate posterior means for the parameters in the model under study. We used data from South Africa (SA) with the sample period that starts from January 1991 to December 2011. This sample covers both pre- and inflation-target regime period in SA. We combined the prior information about standard Taylor rule and Spread-adjusted Taylor Rule with data to estimate what these parameters would have been suppose the central bank in South Africa responds systematically to equilibrium spread.

The chapter proceeds as follows: section 4.1 starts with the introduction; section 4.2 reviews the literature which discusses with monetary stability vis-à-vis financial stability

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<sup>160</sup> The demand for rich financial model(s) that includes financial friction gave the impetus of spread adjusted and credit policy rules which cater for much of the information that should be incorporated in the monetary policy decisions. Of course, we acknowledge that this is not the first time call to adjust the Taylor rule. There were other calls like the call to include asset price, or exchange rate in the policy rule as we pointed out in our main conclusion of chapter one of this thesis. Some feedback rules were rejected e.g Taylor rule with exchange rate; Taylor & Williams (2011, p. 834) indicate that feedback rule with exchange rate will be ‘too herky-jerky’, this negatively feed into the economy. Another important policy proposal is the Credit policy feedback rule. This is an independent rule different from Taylor rule and it is aimed at stabilizing financial sector in the same way that Taylor rule stabilizes output and prices. It emerged in recognition of the importance of financial frictions in determining economic activity.

<sup>161</sup> Nominal interest rate target should be lowered when credit spread increase by one unit or less than a unit change in equilibrium interest rate spread to prevent further credit supply contractions from the rising equilibrium interest rate spread.

<sup>162</sup> As in the present case, these parameters are obtained through calibrations of dynamic stochastic general equilibrium (DSGE) model; however, in this study we estimate this parameter of spread adjusted Taylor rule and observe how close they are to the values proposed in the theoretical models. In addition, our goals hear is estimation of parameters values and models comparison between STR and standard Taylor rule.

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goals. We discussed optimal monetary rules from households' inter-temporal optimizations and advantages of using simple monetary policy rules. Section 4.3 -4.5 present the results from the simple STRs and finally concluded with what we have learned from this exploratory analysis. As with Ball (1999) we point out that our analysis emphasises empirical evaluation based on data rather than optimal rules from agents based inter-temporal optimization models.

## 4.2. Literature Review on Monetary Policy in the face of Financial Instability

One of many important lessons learned from the global financial crisis of 2007-2008 is that price stability does not guarantee financial stability. Hence, it is possible to experience excessive financial instability in an environment characterised by stable prices (i.e. stable inflation). Goodhart (2013, p. 1) argues that after the recent financial crisis, central banks have taken the goal of financial stability seriously, and therefore there is a need to rethink the construction of the monetary policy strategy in place. He asserts that: ‘the line between monetary policy and financial stability has blurred as central banks have been forced to intervene to maintain stability and confidence in markets.’<sup>163</sup> The idea that price stability should remain a primary and overriding goal for monetary policy is undermined by the insufficiency of standard monetary policy framework which was unable to address financial instability in the financial system. This deficiency resulted in a clarion call by many researchers to amend the standard monetary policy framework that elevates price stability above financial stability. For example, Villa & Yang (2011) proposes independent credit policy that should be used to strengthen the response of inflation targeting monetary policy in the face of financial instability. Currently, there is proliferation of monetary policy rules aimed at taking into account financial conditions such as financial imbalance indicators, financial stress and interest rate spreads to address financial instability within monetary policy framework.

Schwarz (1998) and many others argue that price stability is the pre-requisite or sufficient condition for financial stability. It is pursued as the main long run goal for monetary authority to determine the level of inflation which is compatible with efficient utilization of economic resources. Furthermore, it is assumed that central banks essentially maintain price level stability in order to ensure financial stability which promotes sound banking through proper valuation of assets. For example, Issing (2003) argues that stable prices with properly focused monetary policy will ensure stable financial markets. Issing’s argument demonstrates why many central banks elevated the goal of price stabilization above other goals of stabilization. Price stability goal was and is still pursued with vigour based on the understanding that when achieved, it will guarantee the financial stability in the financial sector. Additionally, price stability prevents consequential outcomes of high and volatile inflation or deflation. Issing (2003) and others well noted in the literature that high and volatile inflation presents an environment for fraud, corruption and mismanagement of financial resources. However, the contrary is less emphasised.

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<sup>163</sup> See also (Reichlin, 2013).

Experience now shows that price stability<sup>164</sup> also bleeds excessive leverage and assets overvaluation which eventually threatens financial system through financial instability. For example, the period of great moderation (i.e. 2000-2006) gave birth to overconfidence and over leveraging of the financial sector in advanced and emerging economies. The unwelcome events that followed the financial crisis of 2007-2008 showed that we need a robust monetary policy rule. We believe that such rule must systematically and explicitly take into account financial instability indicators such as spreads and financial imbalance in monetary policy reaction function. In addition, the financial crisis showed that financial system can also be undermined or compromised by economics disturbances originating independently from inflation or deflation e.g. government debts.<sup>165</sup> Although pre-crisis literature such as Issing (2003) show that financial stability and monetary stability reinforce each other, there was lethargy from central banks to explicitly integrate financial indicators into monetary policy rules. Thus, the main aim of the STR is to adjust standard Taylor rule such that it takes into account explicitly important financial indicators in the financial sector.

Issing (2003) and Palley (2003) revealed early efforts to integrate financial stability in monetary policy reaction function. These authors illustrated in their work how central banks tried to improve monetary policy framework and how to remedy the weaknesses of inflation targeting strategy. For example, Issing (2003) argued that we need to understand that there might be some trade-off between price stability and financial stability objectives as introducing financial variable in monetary policy will produce conflicts between inflation targeting and financial stability goals. Although there might be conflicts in targeting price and financial stability concurrently, recent events have shown that the two objects need to be co-ordinated in the monetary policy strategy without waiting for one goal to be achieved before the other goal is attained. Curdia and Woodford (2009) and Teranishi (2011) revived the subject of monetary policy in the face of financial instability with the proposal to add smoothed deviations of equilibrium spread to the standard Taylor rule. STR is just one among many proposals of feedback rules designed to address economic and financial shocks that create financial instability either in low inflation environment or in an environment where credit condition are tight and inflation creeps around in the corner. Similar proposal includes a credit policy that is independent from

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<sup>164</sup> Borio & Lowe (2002) claim that success can breed overconfidence and banish doubt, sowing the seed of its own destruction.

<sup>165</sup> See (Nolan & Thoenissen, 2009) for the discussion about financial structure shocks as an independent source of volatility in quantitative models.

standard Taylor rule but complementary in the mission to stabilize prices, output and financial sector.

Bauducco, Bulir and Cihak (2011) argued that monetary policy that responds to credit conditions instantly will trade-off more variability in output and inflation as compared to the standard Taylor which only responds to inflation deviation from the target and output gap. Bauducco, Bulir, and Cihak (2011) defined financial condition indicator as the rising of default rate; and in this paper they altered monetary policy so that it can responds simultaneously to price and financial stability. Using a new-Keynesian model in DSGE their result suggests that monetary policy rule amended to respond to financial shock can militate against the effects of financial instability. However, Bauducco, Bulir and Cihak (2011) did not explicitly indicate how central bank will go about to forecast the default rate that will prevail in the future periods as to calculate the forecast errors that should be included in the policy reaction function. Furthermore, they have not provided a motivation or justification why the default rate possesses a random component which plays significant role in determining the success of this policy innovation. Thus, it is a challenge to use this default indicator in the credit policy so that it can provide real guidance on monetary policy in a practical environment.

Curdia and Woodford (2009) and Teranishi (2011) examined the success or welfare gains from STR. In these papers, the authors examined how STR improves household welfare as compared to the standard Taylor rule without credit spread. Teranish (2011) theoretically analysed optimal monetary policy adjusted with credit spread in the dynamic stochastic general equilibrium (DSGE) with heterogonous loan contracts. He finds that STR is optimal in the new-Keynesian model with heterogonous loan contracts. STR produces welfare with minimum loss as compared to Taylor rule that does not take into account spread. However, he revealed that the sign for spread's coefficient in the optimal monetary responses is ambiguous. Teranish (2011) concludes that the sign of spread in optimal monetary policy response is determined by financial structure that is, the cost channel and transaction cost in which the disturbance occurred.

Taylor (2008), McCulley & Toloui (2008), and Curdia and Woodford (2009) explored the ways of modifying monetary policy so that it can sufficiently respond to inflation and output in the face of financial instability. Curdia and Woodford (2009) gave a detail analysis on how monetary policy with spread would respond to various economic disturbances. In this analysis, they examined one proposal: the spread in the Taylor rule. Firstly, they examined the impact of adjusting the standard Taylor rule with changes in

level of credit spread. Secondly, the effects of using spread deviations from the trend as an additional variable in the monetary policy rule. The algebraic presentation of the spread adjusted rule is as follows:<sup>166</sup>

$$R_t = \pi^* + r^n + \theta_\pi(\pi_t - \pi^*) + \theta_y(y_t - y^*) - \theta_\omega\omega_t \quad (5.1)$$

Spread-adjusted Taylor rule (STR) is fundamentally similar to standard Taylor rule with one difference in the last term. The policy instrument is the usual short-term nominal interest rate which represents a target set by central banks. As in the standard Taylor rule, central bank raises nominal rate when inflation is above the target and output above the potential trend. In addition, central bank explicitly lowers the intercept in the Taylor rule by changing the interest rate spread to prevent tight credit condition from rising equilibrium credit spread which increases financial instability. Curdia and Woodford (2009) show that STR helps to maximize average welfare in the DSGE model. Other things being equal, a positive increase in interest rate spread will suggest that central bank will adjust downward nominal target by less than one percent change of the spread.<sup>167</sup> Interest spread is important because it is at the heart of monetary transmission mechanism as it was shown by wide spread effect in the credit crunch and the subsequent sovereign debts crisis. As shown by Bauducco, Bulir and Cihak (2011) that in the presence of deteriorate conditions in the financial system, central banks will adjust the rule by changes in the spread. This intervention will produce different outcomes as compared to the standard Taylor rule without spread. Financial stability is therefore recognised by many as equally important goal that should be explicitly included in the monetary policy rule. This can be done by choosing a target that recognises influence of variation of credit spread or the variation of private sector credit. Monetary policy strategies that incorporate financial information should clearly define the variables that should form parts of the reaction function. In addition, central bank should determine whether the financial targets should be defined in deviation or levels.

Curdia and Woodford (2009) analysis used the credit spread defined as the difference between deposit rate (which is assumed to be equal to policy rate) and the prime lending rate. Credit spread enters the monetary policy rule either as level or deviation from

<sup>166</sup> We discussed the model in detail explaining the parameter and variables in the methodology. The variables can be interchanged from level of spread or deviation of the spread from the time trend.

<sup>167</sup> We agree that Tinbergen Arguments against the standard Taylor rule are still applicable to STR. Issing (2003): (i) one instrument -one goal, Tinbergen spirit-one instrument should be assigned for one objective, (ii) division of labor who is to do the job central bank or another independent institutions (iii) Conflicts arises when trying to achieve both objectives at the same time hence central bank should indicate the degree of preferences, (iv) the chance of calling for more inflation which seems to be the unpopular thing to do.

the trend. Curdia and Woodford (2009) theoretical analysis shows that credit spread deviations produces better results than using the level of credit spread. This result is similar to Teranish (2011). However, it does not depend on the financial structure of the financial system.

Hirakata, Sudo and Ueda (2011) examined the subject of spread adjusted Taylor rule in Japan. In this paper Hirakata, Sudo and Ueda (2011) showed that the performance of STR largely depends on how shocks such as financial and total productivity shocks influence credit spread. Thus, in the event whereby financial shock increases the external finance premium the STR will minimize (dampen) effects on household welfare, but this depends on the weight attached to credit spread by households. The work of Teranish (2011) suffers from two caveats. Firstly, credit spread deviation or smoothed spread are non-observable variables; secondly, the elasticity of household responses to spread is not constant but rather depends on the level of debts household owned. In addition, other factors such as the recognition and implementation lags; and low inflation may prevent the successes and impact of the STR. For example, when there are no immediate threats to the goal of price stability central banks may not act fast enough to prevent credit contraction by equilibrium spread in the economy if price stability remains a perceived guarantor for financial stability.

Borio (2004) and Borio & Lowe (2002) argued for monetary policy to incorporate aggregate credit in order to address the weakness of current monetary policy in the presence of financial instability. They argued that simple standard Taylor rules that set nominal policy rate target so that inflation rate will be close to its target are less optimal on many occasions. Hence, central bank should incorporate more financial information such as financial imbalance indicator in the simple standard Taylor rule. Additional financial indicator is needed to capture important information which may not be represented by inflation and output gap indicators. Borio & Lowe (2002) suggest the financial imbalance indicator as alternative because it contains useful information about future developments in the financial system.

#### **4.2.1 Optimal rules versus Simple policy rules**

Estimating monetary policy rule usually raises the question of how optimal is such rule in comparison with other existing rules. There are vast numbers of studies that compare simple monetary policy rules with optimal rules derived from inter-temporal optimization models. From the central bank perspective, optimal rules are justified on the ground that the monetary rule chosen and applied should yield optimal results i.e. minimal

welfare losses and induce small variation on future output as well as consumption. However, most monetary rules used in practice are simple policy rules that capture observed behaviours of central banks. Simple monetary rules are robust and perform statistically well in contrast to optimal rules. Keatings & Smith (2012) assert that simple policy rules fits data and provide clear information on the success of the simple monetary rule than the complex rules from welfare optimization. Simple monetary policy rule are easy to implement and communicate to the general public. However, successes of simple monetary rules are subject to data revisions and measurement errors.<sup>168</sup> It is argued by many researchers that they are too simplistic and sometimes less realistic.

Optimal monetary rules which take into account the full theoretical structure of the general equilibrium are complex in nature. One main advantage is that optimal rules can help to build a tractable monetary policy framework and are also useful to perform counterfactual analyses. However, Taylor & Williams (2011) claim that the benefit or information advantages from large optimal rules are very small as compared to simple monetary policy rules. Ball (1999) examined the efficient rules which minimize inflation and output variances. He finds that efficient rules do a better job on the variances of inflation and output as compared to nominal GDP targeting. However, he found that in a backward looking model, Taylor rule as specified with weight of 1.5 on inflation and output are inefficient as compared to Taylor rule with more weight on output.

#### **4.2.2 Augmenting monetary policy rules with Assets prices and exchange rate**

As we indicated in the introduction of this chapter, there are other important factors that have been considered for inclusion in the monetary policy rule i.e. whether systematic reactions should be called for in order to achieve price and financial stability. Of course, most of these alternatives are aimed at improving price stability rather the financial stability which is our main point of discussion. In this section, we briefly discussed two alternatives of augmented Taylor rules: one with asset prices (i.e real estate, stock prices), and second with the exchange rates. We point out the important roles of asset prices, and the weakness of adjusting the Taylor rule with the asset price and exchange rates.

Firstly, augmenting Taylor rule with changes in asset prices is one of the alternatives overwhelm discussed in the literatures -see Lansing (2008), (Mishkin, F. S.,

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<sup>168</sup> See Stuart (1996) and Taylor & Williams (2011) for example, CPI, RPI and GDP deflator are all measures of inflation; however, some measures include components that are distorting the true movement of the inflation indicator. Secondly, the simple monetary rules use expected future inflation: but there is no agreement on how much in the future should be included in the simple monetary policy rule.

2007b), Malkiel (2010), and (Borio, 2004).<sup>169</sup> One clear example of asset price implication to financial instability was manifested by the catastrophic consequences of asset price crashes in the last global financial crisis. Asset prices had an incredible role in the 2008-2009 global financial crises by weakening balance sheets of financial institutions and households through deteriorating net worth and financial distresses. Empirical evidence showed that asset prices lead to increases in wealth while the reverse of asset prices level results in sharp declines in economic activity worldwide.<sup>170</sup> Given the important role asset price channel, many economists argue that central banks should react systematically to asset prices in addition to inflation and output gap. For example, Mishkin (2007b, p. 15) indicated that many economists suggest that 'monetary policy should react to asset prices changes when changes in the prices provide useful information about the future development inflation and future path of the economy'. Proponent argues that when monetary policy take into account the asset price bubbles this prevent the spillover effects when the asset prices bubble bust.

However, there are serious weaknesses associated with adjusting or augmenting Taylor rule with asset prices such as real estate and stock prices. Malkiel (2010), Goldstein and Weatherstone (2010) argued that asset price misalignments are difficult to recognize in advance. Practically, it is rarely that central bankers, financial regulators and governments know that asset price bubbles exist or developing in the financial market. Even those that claim to know in advance they rarely present convincing evidences rather than speculations. Furthermore, there is no reliable methodology how to tackle bubbles and associated misalignments effectively as interest rate rule may be a blunt tool to do the job. Therefore, this uncertainty about when asset prices are misaligned and time lag from recognition to reaction to the anomalies in asset prices may prevent monetary policy to take into accounts the changes in the assets prices. It is therefore unclear when monetary policy should respond and which assets should be considered for this role in the Taylor rule. Some empirical works such (Keatings & Smith, 2012) suggest augmenting Taylor rule with asset prices will leads worse outcome than a monetary strategy that systematically react to inflation and output. Hence, the monetary policy that aimed to target asset prices in order to prick the bubble might even cause more damage by accelerating the down fall and financial instability than the bubble itself. Although asset

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<sup>169</sup> Lansing (2008) specifically suggest Taylor rule with assets although be it address the price stability.

<sup>170</sup> Mishkin (2007b) pointed out that most serious economic down turns in the global economy are associated with financial instability.

price have clear implication to financial instability through leverage of both consumers and financial institutions this is not clearly the case with exchange rates.

Bouyami, Laxton, Kumhof and Naknoi (2004) emphasized the benefits of exchange rate in monetary policy formulation, because of its ability to change relative prices of goods in the presence of price rigidities. Exchange rates are shock absorbers of the effects from the rest of the world to the domestic economy. Therefore, their inclusion in monetary policy rule is very important as it may help achieve the goal of price stability. It is argued that the advantage using exchange rate as an addition target to augment monetary policy rule. However, exchange rates naturally fluctuates and explosive volatile to form a stable indicator for monetary policy decisions. Mishkin (2007b) indicated that exchange rates are important prices as the depreciation can cause massive financial instability triggered by ensuing financial crisis. He also argued that exchange rates excessively fluctuate compared to others indicators such as interest rate spreads. Hence, this incorporation of exchange rate will make monetary policy less transparent and obscure to the general public which it want to serve in the first place. Others such as Taylor and Williams (2011) argue that responding systematically to exchange rates will make monetary policy too 'herky-jerky' and this may create instability in its own merit to the economy.

In all, while it is true that central bank and government care about the role of exchange rate and asset prices this is primarily for the goal of price stability. Hence, there are significant weaknesses on implementing these alternatives in order to achieve the goals of price stability and financial stability. Some of these indicators do not fit directly the characteristics desired for an indicator that should form part of systematic monetary policy rule. For example, exchange rate prices are not directly concerned with financial instability but rather they affect the real sector thereby impacting price stability. Monetary policy with asset price or exchange rate are not as transparent as the spread adjusted Taylor rule.<sup>171</sup> Empirically, these innovations to augment monetary policy might be easy to estimate with classical regression methods. However, they might be too difficult to estimate using Bayesian method because they lack precise information on what should be the prior means and variances in the likelihood function. Therefore, these indicators are not easy to follow by the general public therefore they cannot serve as communicating devices in sending the message as to what central intending to do.

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<sup>171</sup> This means that while it may be easy to estimate and come up with the policy parameters for asset prices and exchange rates it may not as transparent communicating to the general public as the case with the spread. For spread, it clear that central bank will systematically adjusts the target when spread by less than one percent when spread increase by one percent above the target.

### 4.3. Methodology: Bayesian Structures, STR Model and Result Presentation

Our method of estimation and analysis in this chapter is the Bayesian linear regression method. The aim is to derive Bayesian parameters by combining the sample data and prior information about the STR model specified by Curdia and Woodford (2009).<sup>172</sup> Taylor (2008), McCulley & Toloui (2008) considered the desirability to incorporate equilibrium interest rate spread in the standard Taylor rule model. The spread augmented Taylor rule forms the economic model which represents the likelihood function that will be used in the Bayesian estimation. The economic meaning and relevance of standard Taylor rule is discussed in the last section. Hence, this section starts with brief descriptions of the structures for Bayesian analysis, and these are: prior distribution, likelihood function, and the posterior distribution. We discussed the Bayesian estimators used to obtain posterior means, priors selection and roles of prior information in the posterior parameters. Finally we present the posterior results and inferences of the posterior distributions.

#### 4.3.1 Bayesian Linear Regression structures

According to Bolstad (2007) Bayesian inference procedures depart from classical regression methods by utilizing what is called the prior beliefs or initial information about the process being measured to obtain posterior model probabilities for inferences. Meanwhile classical regression methods such as MLE/LS emphasize the sample data while neglecting prior information available or already known by the researcher. Bolstad (2007) asserts that ‘throwing or ignoring this prior information away is wasteful of useful of information.’ Essentially, prior information are important in empirical analyses because they represent the researcher’s past experiences, existing theories or empirical evidence form past literature. For example, theoretical literature suggests that monetary policy reacts negatively to interest rate spread and the response parameter falls in the range or class interval of [0,1] in absolute terms.<sup>173</sup> In addition, Taylor rule principle suggests that interest rate should rise by more than one and half percent to keep monetary policy effective when inflation increase by one percent. This information can be used as prior beliefs for scale parameter and prior density when estimating the STR. Bayesian method

<sup>172</sup> See Curdia & Woodford (2009) for detail derivation from inter-temporal utility maximization and welfare analysis. In their paper the spread-adjust Taylor rule is stated in current term ( $n=0$ ). We argue that whether we use one lag or current term, this does not change the fact that output and inflation are generally available with the lag. Hence, STR in their paper is backward-looking model.

<sup>173</sup> A value of zero means spread not part of the rule while one implies that one percent increase in the spread results in a cut of the same amount to target.

combines prior information using a single tool called Bayes theorem to generate the posterior distribution of parameter values in the model.

Empirical researchers that used Bayesian methods emphasize the advantages of Bayesian over classical regression methods. According to Bolstad (2007, p. xxi) the main advantage of Bayesian method is that it relies on a single tool the Bayes theorem which is used in all situations. This is unlike classical methods which are clustered with so many formulas to obtained fixed parameters. Other advantages are that, Bayesian method can be applied in the face of small sample size. Bayesian is convenient when the specified model has many parameters to estimate –e.g. VAR system, or when the parameters of the model are not constant over sample period. Another advantage is the fact that the Bayesian method use prior information about the process being measured rather than solely depend on sample data information to calculate the posterior parameter values of the model understudy. In all, Bayesian posterior probabilities help to account for parameters uncertainty and risk which are expressed as probability distributions rather than fixed points parameters as the case in the classical regression analysis.

Bayesian method has two main components combined to produce results called posterior distributions. These are:

$$(i) \quad \text{Data Likelihood function } f(y|\beta), \quad (4.2)$$

$$(ii) \quad \text{Prior Distribution } p(\beta), \quad (4.3).$$

The prior and likelihood are combined based on the Bayes Theorem to form a joint posterior distribution  $p(y, \beta)$ . The joint distribution of data and parameter is described as

$$p(y, \beta) \propto f(y|\beta)p(\beta), \quad (4.4)$$

and the marginal distribution of the data

$$p(y) = \int f(y|\beta)p(\beta)d\beta \quad (4.5).$$

Finally, using Bayes rule we can form a posterior distribution of parameters given the data as follows:<sup>174</sup>

$$p(\beta|y) = \frac{f(y|\beta)p(\beta)}{p(y)}. \quad (4.6)$$

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<sup>174</sup> Bayes Rule:  $p(A, B) = p(A|B)P(B) = p(B|A)p(A)$ , implying  $p(A|B)p(B) = p(B|A)p(A)$  or  $p(A|B) = \frac{p(B|A)p(A)}{p(B)}$ .

In simple terms, the probability density  $p(\beta|y)$  describes what we know about  $\beta$ , given the sample data. For us to estimate this probability density by applying the Bayes theorem we need to formulate prior beliefs about  $p(\beta)$  and specify the parametric model  $f(y|\beta)$ .

As is the case in the classical maximum likelihood methods, the Bayesian approach uses the likelihood function which represents the empirical or theoretical model that describes the distribution of data for the given parameters or reflects the economic theory. We write the likelihood function in the matrix forms as follows:

$$y = \mathbf{X}\beta + \epsilon \quad (4.7),$$

$y$  is a vector of  $n \times 1$ ;  $\beta$  is vector of  $k \times 1$ ,  $\mathbf{X}$  is  $n \times k$  matrix with column 1 consist of ones, and other elements of  $\mathbf{X}$  are fixed variables independent from  $\epsilon$ . Further,  $\epsilon$  is an  $n \times 1$  vector of errors  $\epsilon \sim N(0_n, I_n \sigma^2)$ . Koop (2003) defined the variance  $var(y|\mathbf{X})$  as follows  $h = \sigma^{-2}$  for convenience purpose. He argues that it is convenient to work with error precision than the variance itself. So, the error term is rewritten as  $\epsilon \sim N(0_n, h^{-1}I_n)$  with  $I_{n \times n}$  as the identity matrix. From the multivariate normal density, the likelihood function can be written as:

$$L(y|\beta, \sigma, \mathbf{X}) = (2\pi\sigma^2)^{-\frac{n}{2}} \left\{ -\frac{1}{2\sigma^2} (y - \mathbf{X}\beta)' (y - \mathbf{X}\beta) \right\}. \quad (4.8)$$

After rearrangement of terms in the brackets the likelihood function is expressed as follows:

$$L(y|\beta, h) = 2\pi^{-\frac{N}{2}} \left( h^{\frac{1}{2}} \exp \left[ -\frac{h}{2} (\beta - \hat{\beta})' \mathbf{X}' \mathbf{X} (\beta - \hat{\beta}) \right] \right) (h^{\frac{v}{2}} \exp \left[ -\frac{hv}{2s^2} \right]) \quad (4.9)$$

Well known estimators for OLS such as, OLS estimator for  $\hat{\beta}$ , population variance  $\sigma^2$  or sample variance  $s^2$ , and  $v$  -the degrees of freedom are given here as follows:<sup>175</sup>

$$\text{OLS estimator for } \hat{\beta} = (\mathbf{X}'\mathbf{X})^{-1} \mathbf{X}'y \quad (4.10)$$

$$\text{Variance } \sigma^2 = \frac{1}{n-k} (y - \mathbf{X}\hat{\beta})' (y - \mathbf{X}\hat{\beta}) \text{ or } s^2 = \frac{1}{v} (y - \mathbf{X}\hat{\beta})' (y - \mathbf{X}\hat{\beta}) \quad (4.11),$$

$$\text{and the degrees of freedom } v = N - k \quad (4.12).$$

#### 4.3.1.1 Priors

Aside from specifying the likelihood function, Bayesian inference procedures progress in the following logical steps to posterior densities of the linear regression model.

<sup>175</sup> See Hayashi (2000) Green (2003) matrix definitions of OLS estimators. Koop (2003) shows the algebraic procedure how to obtain the likelihood from (4.8) to (4.12). In as convection, the  $\mathbf{X}$  is usually dropped from the conditional probability function.

We start with prior information about the parameters of the model summarized in the prior distribution. Choosing priors implies that we decide on what we believe are the mean values of the coefficients in the model. There are many different forms of prior distributions; however, some priors make the computation of posteriors very complex and cumbersome. We avoid these by choosing *normal* or *flat* conjugate priors that are straightforward to interpret and take the form that make computational of posteriors easier. It is also worthy to say that it is important that the researcher should be able to come up with the likelihood function otherwise it is not possible to proceed further; while for the priors, it is possible to use flat priors to feign ignorance about the mean and variance about parameters in the model. Prior distributions indicate researchers' beliefs and information held about unknown parameters before looking to the data. These beliefs are updated as new information becomes available after looking to the sample data. In this Bayesian estimation we used three kinds of priors: non-informative priors and informative priors (this also known as flat priors and normal priors); and empirical Bayesian priors derived from pre-sample OLS estimation. Bagasheva, Fabozzi, Hsu, & Rachev (2008) show that prior distributions account for uncertainty and risk around the parameters; and thus, they incorporate information necessary to estimate parameters. Generally, it is convenient to work with priors that come from same class of distributions as the posteriors. These priors are called Natural Conjugate priors. Natural Conjugate priors when combined with the likelihood function yield a posteriors distribution that have similar characteristics as the priors. The joint prior distribution for  $\beta$  and  $h^{-1}$  is given as follow:<sup>176</sup>

$$p(\beta, h) = p(\beta|h)p(h) \quad (4.13)$$

$$\beta|h \sim N(\underline{\beta}, h^{-1}\underline{V}) \quad (4.14)$$

$$h \sim G(s^{-1}, \underline{v}) \quad (4.15).$$

Equation (4.14) is normally distributed with the mean  $\underline{\beta}$  and variance  $h^{-1}\underline{V}$ , and equation (4.15) is the Gamma distribution with the mean  $s^{-1}$  and *variance*  $\underline{v}$ . Hence, the joint prior distribution for (4.14) and (4.15) forms the Normal-Gamma prior distribution which is a natural conjugate prior for the parameters  $\beta$  and  $h$ . Take note: the underscore notation is used to distinguish hyper-parameters (i.e. the parameters before see the data) from posteriors parameters (i.e. parameters after updating our prior beliefs sample data). The natural conjugate prior is noted as follows:

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<sup>176</sup> The mathematical proofs of the these formulae are given in Koop (2003) and Greenberg (2013). See also Bolstad (2007) for further analytical solutions.

$$\beta, h \sim NG(\underline{\beta}, \underline{V}, \underline{s}^{-2}, \underline{v}) \quad (4.16).$$

The hyper-parameter  $\underline{\beta}$  is a  $k \times 1$  vector of coefficients, and  $\underline{V}$  is  $k \times k$  priors variance-covariance matrix. The parameter  $\underline{v}$  represents the fictitious sample that is assumed to generate the hyperparameters set by the researcher before looking to the data. The researcher chooses the priors  $\underline{\beta}$ ,  $\underline{V}$ ,  $\underline{s}^{-2}$  and  $\underline{v}$  as priors information which are combined with the likelihood function in order to form the posterior distributions.

#### 4.3.1.2 Posterior

The posterior is the ‘result’ which is the main object of interest in Bayesian estimation. This is obtained as proportional product of the likelihood function and joint prior’s distribution. Posterior density summarizes the information contained in the priors and sample data about the unknown parameters  $\beta$  and  $h$ . Individual posteriors are obtained from the marginal posterior distribution of  $\beta, h$  conditional on data which is given as follows:

$$\beta, h|y \sim NG(\bar{\beta}, \bar{V}, \bar{s}^{-2}, \bar{v}) \quad (4.17),$$

Whereby

$$\bar{V} = (\underline{V}^{-1} + \mathbf{X}'\mathbf{X})^{-1} \quad (4.18),$$

$$\bar{\beta} = \bar{V}(\underline{V}^{-1} \underline{\beta} + \mathbf{X}'\mathbf{X}\hat{\beta}) \quad (4.19),$$

$$\bar{v} = \underline{v} + N \quad (4.20),$$

$$\bar{s}^{-2} \text{ is implicitly defined as } \bar{v}\bar{s}^2 = \underline{v}\underline{s}^2 + \underline{v}s^2 + \frac{(\hat{\beta} - \underline{\beta})^2}{\underline{V} + (\mathbf{X}'\mathbf{X})^{-1}} \quad (5.21).$$

As can be seen, the posterior distribution in equation (4.17) is similar to the prior distribution in equation (4.16) with both distributions drawn from a Normal–Gamma distribution. However, the parameters in the posteriors are noted with a-bar on top to distinguish them from hyper-parameters. This differentiation is necessary to indicate that the posterior parameters represent updated parameters that reflect information from the sample data and prior beliefs. Equation (4.19) show that the posterior mean of  $\bar{\beta}$  is a matrix weighted average of information in the error precision of the prior variance ( $\underline{V}^{-1}$ ) and the sample data  $\mathbf{X}'\mathbf{X}^{-1}$ . These two components play a significant role in determining the value the posterior mean  $\bar{\beta}$ . The weights are the proportions of the error precisions to the

posteriors precision. Lastly, we gave the posterior distribution of  $h$  conditional on the sample data. This is given as follows:

$$h|y \sim G(\overline{s^{-2}}, \overline{v}) \quad (4.22).$$

The mean and variance of  $h$  given by:

$$E(h|y) = \overline{s^{-2}}, \text{ and}$$

$$var(h|y) = \frac{\overline{2s^{-2}}}{\overline{v}}. \quad (4.23)$$

At this juncture, we briefly explain the roles and implications of different priors in the posterior distribution. We start with roles of *non-informative priors* in the posterior distributions. Non-informative priors are obtained by setting a larger variance  $\underline{V}$  which means that  $\underline{V} \rightarrow \infty$  ( i.e. more uncertainty about the posterior mean); and by setting the pre-sample of the prior  $\underline{v} = 0$ . The former implies that when that  $\underline{V} \rightarrow \infty$ , then  $\underline{V}^{-1} \approx 0$  in equation (4.18). Meanwhile the  $\underline{v} = 0$  shows that posterior sample is equal to the data sample in (4.20). Thus, in the case of non-informative priors,  $\overline{V}$  is completely driven by information from the data sample. Similarly when  $\underline{V}$  is very large (i.e.  $\underline{V}^{-1} \approx 0$ ) the equation (4.19) will also imply that the posterior mean  $\overline{\beta}$  will equal to  $\hat{\beta}$  from the data. In summary, when we use non-informative priors the posterior parameters contain information from the likelihood function only (i.e. the information from the sample data). Therefore, arguably the results estimated under non-informative prior's assumption should be as close to the results from OLS regression. This is because the Bayesian estimator for  $\overline{\beta}$  under non-informative priors is the same as the estimator for  $\hat{\beta}$  under the OLS. The Bayesian estimators given in equations (4.17) to (4.21) illustrate the quantities involved under informative prior's assumption. These normal conjugate prior distributions allows us to combine it with likelihood function formulated under normal conditions to analytically calculate the posterior distribution which will also be a normal conjugate posterior distribution as given in (4.14) and (4.15). For convenience in the estimation, there are common procedures that Bayesian econometricians follow to obtain priors for hyper-parameters in (4.17). For example, a Bayesian econometrician can start with non-informative priors; theory informative prior; or use OLS estimates for  $\hat{\beta}$  from a regression run on pre-sample data. The advantage of non-informative is that the researcher demonstrates that he is unsure of the exact parameters the model should take. In the case of theory based informed prior, we can use the parameter values and variance which are

already suggested in the theory and therefore gauge the impact such priors on posterior values.

#### 4.3.1.3 Bayesian Models' Comparison

The last Bayesian result for statistical inferences we would like to discuss is called the posterior odd ratio. The posterior odd ratio is derived from the Bayes theorem, and it shows which among many models analyzed by the researcher are supported by the prior beliefs and sample data. The ratio allows the researcher to make comparisons between two or more models conditional on the sample data. In this study, we calculated the posterior odd ratio so that we can compare between the Taylor Rule models as to which model is supported by the prior beliefs and sample data. We start with the standard Taylor Rule without spread as model one ( $M_1$ ) nested into the simple Spread-adjusted Taylor Rule as model two ( $M_2$ ). The standard Taylor Rule is nested into Spread-adjusted Taylor Rule because the two models only differ by the last term  $\omega_t$  in (5.1) which captures the interest rate spread, while the rest of the terms in the models are the same. Simply the standard Taylor rule can be regarded as the restricted model with the coefficient on the spread set equal to zero while STR is the unrestricted model. The posterior odd ratio is given by:

$$PO_{12} = \frac{p(M_1|y)}{p(M_2|y)} \quad (4.24)$$

$$PO_{12} = \left(\frac{p_1}{p_2}\right) \left(\frac{\int f_1(y|\theta_1, M_1)\pi(\theta|M_1)d\theta_1}{\int f_2(y|\theta_2, M_2)\pi(\theta|M_2)d\theta_2}\right) \quad (4.25)$$

The first term in equation (4.25) represents the odd ratio whereby the  $p_1$  and  $p_2$  are prior probabilities attached to model one and model two. The second term is the ratio of the marginal likelihoods from  $M_1$  and  $M_2$ . The posterior odd ratio ( $PO_{12}$ ) is given by the product of the prior's odd ratio multiplied and the marginal likelihood ratio.<sup>177</sup> In the case whereby the researcher attaches equal weights (i.e. equal probabilities  $p_1$  and  $p_2$ ) on each model the posterior odd ratio equals the ratio of marginal likelihoods. The odd ratio is interpreted as follows: a large value of  $PO_{12}$  points to empirical evidence in favour of  $M_1$  that is  $M_1$  is better supported by the prior information and the sample data; a small value of  $PO_{12}$  less than one indicates that  $M_2$  is better supported by sample data and the prior information than  $M_1$ . Meanwhile,  $PO_{12}$  around 1 indicates that both models are all equally supported by sample data and the prior information.

Having defined the Bayesian estimators involved in the Bayesian linear regression, we are now ready to set values for the priors and provide the motivations for our prior

<sup>177</sup> The subscripts 12 in ( $P_{12}$ ) refers to model 1 compared to mode 2.

means and variances in the parametric model. Our empirical model is the Spread-adjusted Taylor rule suggested by Taylor (2008) and McCulley & Toloui (2008) and discussed in the theory of Curdia & Woodford, 2009 (2009). In this study we restrict our Bayesian analysis to three forms of priors: non-informative priors, theory based informative priors and empirical Bayesian priors derived from OLS results.

#### 4.3.2 Simple Spread-Adjusted Taylor Rule

STR is described as the standard Taylor rule augmented with another term ‘credit spread’ (or simple spread) which adjusts nominal policy rate downwards by a fraction of changes in the current credit spread. As given in equation (4.26):  $R_t^*$  represents the target-rate (repo rate) which responds to inflation rate, output gap and changes in the level of spread. Thus, depending on the framework pursued by individual central banks, we assumed that nominal target rate is set in response to past inflation, output gap and current spread level; or in the case of forward-looking the nominal target rate set in anticipation of that expected inflation will increase above the inflation target, output gap forecast and current changes in the spread. Teranishi (2011) and Taylor (2008) show that the Central Bank reacts negatively to spread in the money market to improve economic conditions for growth. Simple STR includes the spread as a financial indicator which explicitly captures financial information to achieve the goal of financial stability. Simple STR target and the backward-looking STR are specified as follows:

$$R_t^* = \theta_0 + \theta_\pi(\pi_t - \pi^*) - \theta_x(x_t) - \theta_\omega\omega_t \quad \text{STR (target) (4.26)}$$

$$R_t = \theta_0 + \theta_\pi(\pi_{t-n} - \pi^*) - \theta_x(x_{t-n}) - \theta_\omega\omega_t + u_t \quad \text{STR (4.27)}$$

We explain the variables in the rule as follows:

$R_t^*$  represents the target repo rate<sup>178</sup> (expressed as a monthly or quarterly percentage), which is the nominal overnight repo rate for bank reserves. Repo rate is the price at which banks charge each other for overnight loans.  $\pi_t$  = inflation rate – this is a four quarterly average consumer price inflation in percentage term.  $\pi^*$  = inflation target set by the monetary policy committee in quarterly percentage term.  $(\pi_{t-n} - \pi^*)$ , this is the deviation of inflation from its target. We assumed that SA has a fixed-inflation target, although practically, SA has the inflation target range of 3-6%. So our assumption implicitly means a fixed annual inflation target of approximately 4.5%.  $x_{t-n} = (y_t - y_t^*)$  is the output gap or deviation of GDP from its trend expressed in quarterly percentage term.  $y_t$  = real GDP

<sup>178</sup> This is central bank’s monetary policy rate referred to as repurchase rate (repo rate) in the South Africa.

(400xlog) and  $y_t^*$  = real potential GDP (400xlog). For simplicity, we assumed that  $y_t^*$  is the long run aggregate output which matches full-employment and the natural rate of employment.

Spread is our main variable of focus in the Taylor rule.  $\Delta\omega$  represents the changes in the level of spread while  $\tilde{\omega} = (\omega_t - \omega_t^*)$  is the deviation of spread from the trend obtained from HP-filter.  $\omega_t$  is the cyclical component of the spread and  $\omega_t^*$  is the trend component of the spread. We use three different spread indicators credit spread, base spread and risk premium. Credit spread is difference between 10 year government bond and 1 year government bond in SA. Base spread is defined as the difference between the prime lending rate and the repo rate. Risk premium is the difference between the prime lending rates and short term risk-free rates. When we use deviation of the spread we are assuming that there is a specific natural equilibrium spread or target spread that stabilises the financial sector interest rate spreads. Thus, the deviation from this target or natural path makes monetary authority to adjust the intercept by  $\theta_\omega$  weight. Taylor (2008) suggested a value approximately  $\approx 0.5$  of percentage point of the smoothed spread. The parameter  $\theta_\omega$  is a prior expected to be negative and has the absolute magnitude  $\theta_\omega \in (0,1]$ . If  $\theta_\omega = 0$  we have the standard Taylor rule, while  $\theta_\omega < 0$  suggests that the Central Bank reacts negatively to spread by adjusting the intercept downwards by the value of  $\theta_\omega$  when spread increases above the trend by one percent. The backward-looking model in (4.27) gives the likelihood function of STR.

$$f(y|\theta, \mathbf{X}) = \theta_0 + \theta_\pi(\pi_t - \pi^*) + \theta_x(x_t) - \theta_\omega\omega_t + u_t. \quad (4.28)$$

This likelihood function has three independent variables and intercept. In the following section we set the prior values for informative priors and variances on these coefficients ( $\theta_0$   $\theta_\pi$   $\theta_x$   $\theta_\omega$ ) and the error term  $u_t$ . In our first estimation, we applied theory informed prior and non-informative priors, followed empirical Bayesian priors to estimate the posterior means.

#### 4.4. Data and Prior Setting

To estimate the STR model through Bayesian linear regression method, we used monthly data from South Africa with the sample that starts from January 1991 to September 2013. We used the first 38 observations - from January 1991 to December 1993- to derive pre-sample empirical Bayesian priors from OLS. The overall sample period covers both pre-inflation target regime from 1991 to 2000 and inflation targeting regime which started from January 2000 until now. Spread-adjusted Taylor rule is expressed as a linear relationship with the repo rate as policy variable, inflation rate and quarterly real GDP or (monthly) Producers Price Index (PPI) represent demand and supply economic factors while the spread indicator captures the effects of financial conditions.<sup>179</sup>

Next, we used three measures of spread interchangeably. Alternative measures of spread are motivated by the fact that literature about the Spread-adjusted Taylor rule does not clearly specify the type of spread that should be augmented into the rule. This lack of specificity in the rule shows one limitation about the application of Spread-adjusted Taylor rule. While this might be a setback, we wish to point out that in the last chapter we established that on average, most spreads are co-integrated in the long run; thus, it means that statistically all three measures of spread contain information about the true representative spread (equilibrium spread) in the economy. Although, it is possible that in the short run these spreads do not show perfect correlations among each other, however in the long run, they follow the equilibrium spread.

Globally, and as well as in SA the trends for repo rate, money market interest rates and inflation have been falling in the last two decades. These patterns are observed in Figure 5-1 showing trends for repo rate, inflation, growth rate for producer price index, credit spread and risk premium. SA repo rate varies between 5 – 18 percent while inflation varies between 0.5 percent and 14 percent. Although volatile, industrial production remained in the range of -1 to 2 percent while quarterly real GDP varied between -0.4 and 6 percent inflation varied between 0.2 and 15 percent while spreads gravitate around the mean between 0 and 5.0 percent over the sample period. Next, we used this information and our general knowledge about the SA's economy to set prior means for parameter values in the STR model.

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<sup>179</sup> We used the PPI as an indicator for economic activity in the place of real GDP. Quarterly real GDP figures were used in the estimation for robust analysis to check whether this will improve the statistics on output in the STR.

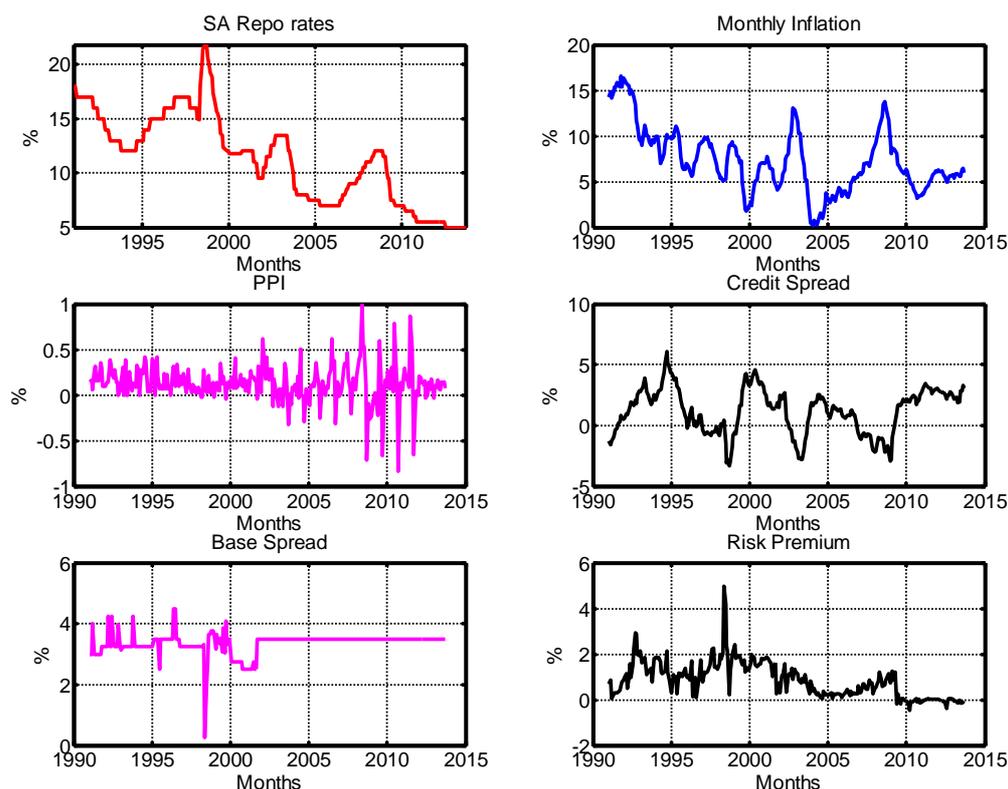


Figure 4-1 Repo, Inflation, PPI, Credit spread, Base Spread and Risk premium trends.

#### 4.4.1 Priors -setting

Firstly, it is well known that the South Africa Reserve Bank (SARB) monetary policy is based on an inflation targeting framework with the annual target range fixed between 3.0 – 6.0 percent. We assume that on average the nominal repo rate posits the average nominal target of 4.5 percent plus 2.0<sup>180</sup> percent average nominal interest rate observed in advanced economies. Thus, in equation (4.28) we set the prior mean for  $\theta_0 = 6.5$  percent in the STR model. The posterior mean for  $\theta_0$  represents the average expected mean for the policy rate-target set by the monetary policy committee given that inflation rate, output and spread remained constant. For the rest of the parameters, we used prior means from the literature. Inflation prior mean is set as  $\theta_\pi = 1.5$  percent. This prior mean value is derived from the Taylor rule principle which suggests that monetary policy target should move in the same direction as inflation by an amount greater than the increase observed in inflation. When inflation rate increases by one percent above the target, the Central Bank needs to raise interest rates by more than one and half percent.<sup>181</sup> Next, the prior mean for output is set as  $\theta_x = 0.5$  percent. The prior mean for output is set at a value

<sup>180</sup> A 2.0 percent nominal policy rate corresponds to the average nominal rate in major economies Canada, US and UK.

<sup>181</sup> See Woodford (2001)

less than the weight on inflation to indicate central banks' preferences for more weight on inflation than output. Simply, price stability guarantees financial and economic stability in the long run. In addition, prior mean 0.5 percent is observed on output in the studies such as Taylor (1993).<sup>182</sup> Lastly, spread is suggested to take a prior mean between 0 and 1 in absolute terms. Hence, we set prior mean for  $\theta_{\omega} = -0.5$  percent. This hyper-parameter is set midway of the interval suggested by Taylor (2008, p. 2), Curdia & Woodford (2009) and McCulley & Toloui (2008). Altogether the column vector for the prior means is given as follows:

$$\underline{\theta} = (6.5, 1.5, 0.5, -0.5)' .$$

The above informative priors are derived from standard literature concerning Spread-adjusted Taylor rule and also based on our knowledge about the SA's monetary policy. However, the difficult exercise lies in how to choose the variances that we should attach to individual priors in the model. Variance represents the degree of confidence we have in these prior densities. Thus it captures the precision errors which specifically help us to determine the lower and upper bounds of an increase in inflation, output and spread for a one unit change.<sup>183</sup> Generally, population variance statistics are rarely known or given, thus we based these estimates on our prior knowledge about the variation of monetary policy target in SA. For example, monetary policy targets are commonly adjusted by 25 basis points with exceptions to crisis periods. This practice makes policy targets to move in a lock steps pattern as can be seen in Figure 4-1. Many central banks employ this strategy to ensure a gradual process from a current target level to a desired target level which stabilises inflation and output. This is done to avoid policy surprises or sudden stops in the economy due to large changes in the policy target. Therefore with this prior information in mind, we assumed that a conservative monetary policy committee adjusts the target for the next three quarters by a percentage within the range of 0.25 - 3.0 percent. This means the committee is ready to make an error less than 3.0 percent overall until the next revision. Since we assume Gaussian errors, this means the 3.0 percent off-target translates into a standard deviation ( $s$ ) of approximately 1.5 percent errors either way. Alternatively, a non-conservative monetary policy committee may be satisfied with 6.5 percentages overall which translate into  $s = 3.25$  percentage errors either above or below the target. Using this strategy helps to ensure that 95% of errors of non-conservative

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<sup>182</sup> Koop (2003) indicated that usually choices of prior means are based on economic theory, or common sense knowledge from earlier studies that used different data sets.

<sup>183</sup> Prior variance represents the degree of confidence a researcher has in the informative priors – with large variances reflecting uncertainty while small variances reflect high confidence about each prior.

monetary policy committee will be less than 6.375 percent while the former will yield 95% errors less than 2.94 percent (i.e. 2.94 % of target). Adopting the choice for non-conservative monetary policy implies that the sample variance is  $s^2 = 40.64$  and the standard deviation  $s = 6.5$  percent. This means that we set the value of the error precision in equation (5.14) as  $h = \frac{1}{40.46}$ . This implies that sample variance equals  $s^{-2} = 2.46 \times 10^{-2}$ . We set prior variance for  $\theta_0$  the intercept equals  $s^2 = 8.45^2$  percent and the prior variance for inflation at  $s^2 = 8.45^2$  percent. This implies the effects of inflation (i.e. the posterior density of  $\theta_0$  and  $\theta_\pi$ ) will fall within  $(1.96s - 6.5; 6.5 + 1.96s)$  95% intervals. For output, we set the variance of  $s^2 = 6.25^2$  percent while the prior variance for spread is set at 3.705 percent which means the standard deviation  $s = 1.925$  percent. As can be seen above, these priors' elicitation are rough and readily based on our knowledge. Thus, we set pre-sample  $\nu = 3$  when assuming informative priors and  $\nu = 0$  for the non-informative priors.<sup>184</sup> A pre-sample of  $\nu = 3$  implies that we attached less than 1 percent of the sample to the prior variances above. Bolstad (2007) suggests another strategy that seems transparent in choosing the priors for  $\theta$  and  $\sigma$ . First, we decide on what we think is the mean for each parameter. Second, we decide on what we think are the points below and above that should be lower and upper bounds of the dependent variable. Finally, divide the difference by 6; this will give you the prior standard deviation.

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<sup>184</sup> This implies that these variances are derived from a fictitious sample of three observations. This is about 1% of the total sample (276 observations) used in the study (Koop, 2003, pp. for more details see 48-54).

## 4.5 Results

### 4.5.1 Posterior Distributions: Results based on Informative priors

Table 4-1 presents the summary of posterior distributions for the regression coefficients in the Spread-adjusted Taylor Rule with credit spread. Meanwhile, the results from STR model with two alternative measures of spread: base spread and risk premium spreads are presented in Table 4.2 and Table 4.3. The results in each table are given in the following order: the prior means (see column three), posterior means, standard deviations, credibility intervals with lower and upper bounds<sup>185</sup>, probability posteriors and posterior odd ratios. The Informative priors in column (2) are the theory-informed priors derived from literature on Spread-adjusted Taylor rule while results based on empirical Bayesian priors are given in Tables 4-4 to 4-6.

For easy interpretation, the coefficients in the vector  $\theta_{k \times 1}$  represent the marginal effects on expected values for the dependent variable (repo rate) given a small change in the value of the independent variables (i.e. inflation, output, and spread). The standard deviations and 95% credible interval estimates provide measures of uncertainty around the posterior mean. Using the credibility intervals in conjunction with the posterior probability we assessed whether the posterior means are individually different from zero. Specifically, we are interested to know whether our belief of  $\theta_{\omega} = 0$  is credible given the data. In addition, these criteria and posterior odd ratios are used to evaluate the following hypotheses  $p(\theta_0, \theta_{\pi}, \theta_x, \theta_{\omega} > 0 | y, X)$  and make model comparisons about which model is better supported by the prior beliefs and the sample data. For the sake of space, in column (8) we provide the posterior odd ratio for the spread, the remainder variables we already know form part of the standard Taylor rule. Thus, we only need the posterior odd ratio for the spread in standard Taylor rule. A posterior odd ratio greater than one suggests that Taylor rule without spread is better supported by the priors and sample data while the posterior odd ratio less than one shows the results are in favour of the Spread-adjusted Taylor rule. If the posterior odd ratio is equal to one or close to one then there are no significant differences between the two models.

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<sup>185</sup> Note: The (-) under non-informative prior imply a zero mean. Credibility interval (CDI) indicates the degree of confidence that a parameter lies within the confidence bounds. This means that every point inside the credible intervals has higher believability than any point outside the CDI. The Bayesian credible interval for  $\theta$  is the posterior mean  $\pm$  the critical value  $\times$  the posterior standard deviation i.e.  $(\theta - 1.96 \times s; \theta + 1.96 \times s)$ .

Table 4-1 Summary of Posterior Distribution for the coefficients ( $\theta_0$   $\theta_\pi$   $\theta_x$   $\theta_\omega$ ): STR model with Credit Spread

Part A	Coeff.	Informative Priors	Posterior mean	Std. Deviation	CDI-Lower	CDI-Upper	Prob. Posterior	Post. ODD Ratio
	$\theta_0$	6.5	7.5346	0.6503	6.2590	8.8102	1	-
	$\theta_\pi$	1.5	0.5880	0.0856	0.4200	0.7559	1	-
	$\theta_x$	0.5	0.6729	1.0460	-1.3791	2.7249	0.74	-
	$\theta_\omega$	-0.5	-0.5502	0.1264	-0.7979	-0.3025	0.00	0.0096

Part B	Coeff.	Priors Non-Informative	Posterior mean	Std. Deviation	CDI-Lower	CDI-Upper	Prob. Posterior	Post. ODD Ratio
	$\theta_0$	-	7.5790	0.6681	6.2683	8.8896	1	na
	$\theta_\pi$	-	0.5827	0.0877	0.4107	0.7546	1	na
	$\theta_x$	-	0.6725	1.0590	-1.4051	2.7500	0.73	na
	$\theta_\omega$	-	-0.5549	0.1279	-0.8057	-0.3040	0.00	na

**Notes:** Part A contains posterior results under informative priors, while Part B contains results based on non-informative priors. CDI- refers 95% credibility intervals. Probpos –probability posterior. Na- posterior odd ratio is not available from models with non-informative priors.

We start with the results in Table 4-1 Parts A and B, with Part A showing the results obtained under informative priors and Part B under non-informative priors' assumptions. In Part A, the posterior means are approximately equal to the results obtained under non-informative priors which reflect OLS estimates.<sup>186</sup> Although there are small indications of posterior means shrunk towards the priors; these results suggest that the posterior means are largely influenced by the sample data information rather than the prior information used in the model. In addition, the posterior means obtained under informative prior falls between the priors and the posterior means under non-informative priors which indicate more weight attached to the sample data than priors.

We interpret these posterior values as follows. Under informative priors, the intercept is estimated with the posterior mean equal to 7.5346 percent. This posterior mean represents the average expected mean for the target set by monetary policy committee conditional on the sample data and that no changes have occurred in other economic factors that enters the STR model. On average and after observing data, it is certain that the expected mean of the target is positive and it takes probability values within the (6.2590; 8.8102) 95% credibility interval. In the case of inflation, the posterior mean is estimated at 0.5880 percent (58 basis points). This posterior mean represents the marginal effects for a one percent increase in inflation above the inflation-target. Other things being equal,

<sup>186</sup> Koop (2003) shows that the Bayesian estimators for a linear regression model under non-informative priors are similar to OLS estimators. This is because Bayesian estimators under non-informative priors are closely equal to OLS estimators.

monetary policy committee in SA will raise the policy target by more than 0.5880 percent to counter the increase in inflation by one percent above the target. The posterior mean for inflation is somewhat smaller compared to the prior mean theoretically suggested by the Taylor rule principle. According to Walsh (2010), the Taylor rule principle implies a coefficient between 1 and 1.5 percent as a weight attached on inflation. Our posterior mean for inflation is much lower than 1.5 percent in the Taylor rule principle. The posterior mean for output gap is estimated at 0.67 percent. This value represents the marginal effects in response to one percent increase in output. This posterior mean shows that ‘other things being equal’ the South Africa Reserve Bank will raise the repo rate target by 0.6729 percent in response to one percent increase above the potential output. However, the picture is not clear-cut about the significance of the posterior mean for output under informative and non-informative results. Evaluating this posterior mean using credibility intervals shows that  $\theta_x$  could be zero; however, the probability posterior shows that there is a 74% chance that  $\theta_x$  is positive hence the Null Hypothesis:  $p(\theta_x > 0|y)$  is not rejected. Credibility intervals under informative priors show that the 95% symmetric Bayesian intervals for  $\theta_x$  is (-1.3791, 2.7249), while under non-informative prior the interval is (-1.4051, 2.7500). These credibility intervals include zero which suggests that we cannot rule out the possibility that this variable has zero influence in the determination of monetary policy target using the STR model. Using the credibility interval at 95% we find that there is evidence to suggest that the posterior means  $\theta_0, \theta_\pi > 0|y$ , and the  $\theta_\omega < 0|y$ . However, the posterior mean for output gap is probably equal to zero whether we use informative or non-informative priors. This uncertainty around  $\theta_x$  is clear from the fact that its associated credibility intervals are not entirely negative or entirely positive. Therefore, we cannot exclude the possibility that the posterior mean of  $\theta_x$  is equal to zero.

Our main goal is to examine whether there is empirical evidence to suggest that the Central Bank systematically reacts negatively to spread in the Spread-adjusted Taylor rule. Empirically from this Bayesian estimation this means based on the credibility interval and posterior probability criteria, we would like to reject the following null hypothesis:  $p(\theta_\omega > 0|y, X)$ . The results for posterior parameter value on credit spread show that whether we use theory-based informative prior or non-informative prior we find that the posterior mean  $\theta_\omega = -0.5502$  percent. The posterior mean for the spread in the STR model given the data is less than zero and these results are consistent with the 95% credible interval with the (-0.7979; -0.3025) lower and upper bounds. Thus, using the probability posterior in conjunction with the 95% credible interval we reject the null hypothesis that  $\theta_\omega > 0|y$ . In all,

we find that on average a higher credit spread is associated with probability that the policy target will be adjusted downward by 55 basis points in response to a marginal increase of one percent in credit spread. The posterior mean is likely to vary between -79 and -30 basis points with 95 % credible intervals. In addition, we find that an increased inflation rate above the target by one percent is associated with probability that the repo rate target will be raised by an amount within the range of 42 -75 basis points, while little can be said about central banks' reaction to a marginal increase in output .

Table 4-2 Summary of Posterior Distribution for the coefficients ( $\theta_0$   $\theta_\pi$   $\theta_x$   $\theta_\omega$ ): STR model with Base Spread

Part A	Coeff.	Informative Priors	Posterior mean	Std. Deviation	CDI-Lower	CDI-Upper	Prob. Posterior	Post. ODD Ratio
	$\theta_0$	6.5	12.1433	1.7800	8.6514	15.6351	1	-
	$\theta_\pi$	1.5	0.7603	0.0791	0.6052	0.9155	1	-
	$\theta_x$	0.5	-0.1354	1.0413	-2.1781	1.9073	0.44	-
	$\theta_\omega$	-0.5	-1.8600	0.5132	-2.8667	-0.8533	0.00	0.0381

Part B	Coeff.	Priors Non-Informative	Posterior mean	Std. Deviation	CDI-Lower	CDI-Upper	Prob. Posterior	Post. ODD Ratio
	$\theta_0$	-	14.5896	2.1251	10.4208	18.7584	1	na
	$\theta_\pi$	-	0.7373	0.0797	0.5811	0.8936	1	na
	$\theta_x$	-	-0.2141	1.0451	-2.2643	1.8360	0.41	na
	$\theta_\omega$	-	-2.5302	0.6037	-4.0912	-1.3460	0.00	na

Notes: Part A contains posterior results under informative priors, while Part B contains results based on non-informative priors. CDI- refers 95% credibility intervals. Probpos –probability posterior.

We repeated the same exercise however, with different measures of spread and the results are presented in Table 4-2 and Table 4-3. The use of alternative measures of spread is motivated by the fact that there is no agreement as to which spread should be used in the estimation of Spread-adjusted Taylor rule. Apart from the spread, other variables in the model remain the same and so their priors do too. Table 4-2 parts A and B summarises the posterior distributions of STR with the base spread. Base spread represents the margins over the repo rate (i.e. policy rate) set by financial institutions after borrowing from the Central Bank. Empirical results of STR with the base spread show some minor differences such as large posterior mean for the intercept and inflation much higher than earlier observed while output and spread have much lower posterior means than results in Table 4-1. Credibility interval and probability posteriors associated with the intercept and inflation confirms that these parameters are significantly positive. Similarly, we cannot make a clear conclusion about the posterior density for output. The probability posterior shows that the null hypothesis is not rejected while the associated credibility interval contains zero. The posterior mean for base spread is negative and it falls within the

negative credible interval. However, the magnitude of the posterior mean seems overstated as one percent increase in the spread suggests that monetary policy committee will aggressively lower the policy target by more than -1.86 percent. Although such aggressive reactions are a possibility, we argue that such drastic monetary policy actions are limited to crisis periods.

Table 4-3 Summary of Posterior Distribution for the coefficients ( $\theta_0$   $\theta_\pi$   $\theta_x$   $\theta_\omega$ ): STR model with Risk premium

Part A	Coeff.	Informative Priors	Posterior mean	Std. Deviation	CDI-Lower	CDI-Upper	Prob. Posterior	Post.ODD Ratio
	$\theta_0$	6.5	5.0744	0.3806	4.3278	5.8209	1	-
	$\theta_\pi$	1.5	0.4442	0.0562	0.3339	0.5545	1	-
	$\theta_x$	0.5	-0.2474	0.7070	-1.6343	1.1396	0.36	-
	$\theta_\omega$	-0.5	3.5675	0.2037	3.1679	3.9670	1	$2.85 \times 10^{-42}$

Part B	Coeff.	Priors Non-Informative	Posterior mean	Std. Deviation	CDI-Lower	CDI-Upper	Prob. Posterior	Post ODD Ratio
	$\theta_0$	-	5.0307	0.3883	4.2690	5.7924	1	na
	$\theta_\pi$	-	0.4492	0.0570	0.3373	0.5611	1	na
	$\theta_x$	-	-0.2436	0.7150	-1.6463	1.1590	0.36	na
	$\theta_\omega$	-	3.5732	0.2048	3.1715	3.9750	1	na

Notes: Part A contains posterior results under informative priors, while Part B contains results based on non-informative priors. CDI- refers 95% credibility intervals. Probpos –probability posterior. Na- posterior odd ratio is not available from models with non-informative priors.

In Table 4.3 we present the results from STR model augmented with risk premium. Risk premium is the difference between the prime lending rates and short term risk-free rates. This premium represents the private sector's assessment of the risks of investing in short term bonds. We observed that the posterior mean for  $\theta_\omega$  is significantly different from earlier results for spread. When we use risk premium as measure of spread the magnitude of  $\theta_\omega$  is over-stated and it is positive. This is contrary to the theoretical proposition that central banks react negatively to spread with a magnitude between 0 and 1 percent in absolute terms. Lastly, Table 4-1 to 4-3 show the posterior odd ratios of 0.009, 0.038, and  $2.85 \times 10^{-12}$  which are close to zero. These posterior odd ratios are in favour of the Spread-adjusted Taylor rule than the standard Taylor rule without spread. Next, we discuss the posterior results obtained under pre-sample data priors.

We find that credit spread produces consistent results closely to what is predicted by Akinci (2013) and Taylor (2008). STR model with credit spread shows that whether we use theory motivated priors, or non-informative priors, the posterior means obtained are negative and have magnitudes between 0 and 1 in absolute term. In addition, the estimated

posterior means for the intercept, inflation, and spread fall within credible intervals. This Bayesian estimation could not find conclusive evidence about the marginal effects of output in the STR model. Credibility intervals and probability posterior criteria both give conflicting results. The results for the posterior odd ratio show that the STR is better supported by the prior beliefs and the sample data.

#### 4.4.2 Posterior Distributions: Results based on empirical Bayesian priors

Table 4-4 Summary of Posterior Distribution for the coefficients ( $\theta_0$   $\theta_\pi$   $\theta_x$   $\theta_\omega$ ): STR model with Credit Spread

Coeff.	Emp. Bayesian Priors	Posterior mean	Std. Deviation	CDI-Lower	CDI-Upper	Prob. Posterior	Post. ODD Ratio
$\theta_0$	7.39	7.4539	0.3905	6.6877	8.8200	1	-
$\theta_\pi$	0.63	0.5977	0.0587	0.4825	0.7128	1	-
$\theta_x$	0.54	0.6725	1.0349	-1.3576	2.7027	0.73	-
$\theta_\omega$	-0.51	-0.5410	0.1125	-0.7618	-0.3203	0.00	1.156x10 <sup>-4</sup>

Notes: Posterior results under empirical Bayesian priors; CDI- refers 95% credibility intervals, and Probpos – probability posterior.

Tables 4-4 to Table 4-6 present the results based on empirical Bayesian priors. We did not present non-informative results here because they are the same as those given in part B in Tables 4-1 to 4-3. Empirical Bayesian priors in column (2) are obtained from OLS regression results based on the pre-sample January 1991 to December 1994. The prior vector of  $\underline{\theta}$  is given as follows:  $(\theta_0, \theta_\pi, \theta_x, \theta_\omega) = (7.39, 0.63, 0.53, -0.51)$ . Firstly, based on these empirical Bayesian priors, the average expected posterior mean is estimated at 7.4539 percent. This parameter value is close to 7.5346 percent and 7.5790 percent obtained under theory-based informed priors and non-informative priors' assumptions in Table 4-1. These results show that the posterior means in  $\theta$  are pulled toward non-informative results. Although, our prior means 6.5 and 7.39 percent average target fall within the credibility intervals it seem we have underestimated the intercept of the repo rate when compared with the posterior mean of 7.4539 percent above. The posterior mean for inflation is estimated at 0.5977 percent which is 97 basis points higher than the result obtained under theory of informed priors. Results obtained show that regardless of whether we use theory informed priors, empirical Bayesian priors or non-informative priors, the probability posterior that  $\theta_\pi > 0$  is certain; and this result is consistent irrespective of the measures of spread included in the STR. Therefore, the probability weights 1.0 – 1.5 percents implied that the standard Taylor rule seems to overstate the reaction of monetary policy committee to inflation above the inflation target in SA. Our results again show that

the marginal effects of output in the STR remain inconclusive under empirical Bayesian priors. The posterior parameter on the credit spread is estimated at -0.5410 percent.

Table 4-5 Summary of Posterior Distribution for the coefficients ( $\theta_0$   $\theta_\pi$   $\theta_x$   $\theta_\omega$ ): STR model with Base Spread

Coeff.	Emp. Bayesian Priors	Posterior mean	Std. Deviation	CDI-Lower	CDI-Upper	Prob. Posterior	Post. ODD Ratio
$\theta_0$	10.48	10.7981	0.4684	9.8793	11.7170	1	-
$\theta_\pi$	0.65	0.7101	0.0509	0.6103	0.8100	1	-
$\theta_x$	-2.07	0.1505	0.8966	-1.6083	1.9094	0.56	-
$\theta_\omega$	-1.07	-1.3878	0.1715	-1.7241	-1.0514	0.00	$6.15 \times 10^{-11}$

Notes: Posterior results under empirical Bayesian priors; CDI- refers 95% credibility intervals, and Probpos – probability posterior.

Table 4-6 Summary of Posterior Distribution for the coefficients ( $\theta_0$   $\theta_\pi$   $\theta_x$   $\theta_\omega$ ): STR model with Risk premium

Coeff.	Emp. Bayesian Priors	Posterior mean	Std. Deviation	CDI-Lower	CDI-Upper	Prob. Posterior	Post. Odd Ratio
$\theta_0$	4.89	4.8840	0.2483	4.3969	5.3711	1	-
$\theta_\pi$	0.53	0.4765	0.0425	0.3931	0.5599	1	-
$\theta_x$	-0.17	-0.2136	0.6752	-1.5382	1.1110	0.37	-
$\theta_\omega$	2.99	3.5128	0.1906	3.1388	3.8868	1	$3.36 \times 10^{-44}$

Notes: Posterior results under empirical Bayesian priors; CDI- refers 95% credibility intervals, and Probpos – probability posterior.

In Table 4-5, the posterior mean for base spread is -1.3878 percent this is higher than the -1.8600 percent obtained under theory informed priors in Table 4-2. Similarly, the results in Table 5-6 show that risk premium is estimated with positive marginal effects in the STR model. Using these results, we can infer that there is evidence to suggest that SARB systematically reacts negatively to credit spread and based spread in the Spread-adjusted Taylor rule. Our empirical results are theoretically consistent when we used credit spread as a measure of spread in the STR model. The appropriateness of credit spread in STR is probably explained by the fact that credit spread is a leading indicator which increases when financial instability deteriorates and decreases when the financial stability conditions prevail. Furthermore, 95% symmetric credibility intervals and probability posterior obtained clearly indicate that the monetary policy committee reduces the target when credit spread increases by one percent.

#### 4.4.3 Sensitivity Analysis and Robustness check

We examined how sensitive our results are to the changes in our informative priors. Firstly, for the priors in Table 4.1 we changed the prior belief for inflation from 1.5 to 0.5 percent.

This change is motivated by the fact that some central banks attached equal probability weights on inflation and output in the standard Taylor rule. It means that the monetary policy committee expresses equal preference to penalise inflation and output fluctuations to achieve price stability. After re-estimation, the posteriors' means from this sensitive analysis exercise are  $\theta_0=7.5346$ ,  $\theta_\pi=0.5880$ ,  $\theta_x=0.6729$ , &  $\theta_w=-0.5502$ . Since the posterior means are the same we conclude that our results are not sensitive to changes in inflation prior. Secondly, we changed the prior mean for credit spread from -0.5 to -1 percent. This change implies that when credit spread increases by one percent, monetary policy committee reduces the interest rate target by 1 percent to induce financial stability. Similarly, our results from this robust analysis are similar to the results presented in Table 4-1; hence, we conclude that these results are not sensitive to changes in informative priors.

Finally, we used quarterly data with quarterly real GDP replacing industrial production index (PPI) in the STR model. These results are presented in Table A.4.1 in the appendix. It is certain that the expected average target and marginal effects of inflation are positives while marginal effects from spread given the data remain negative. The posterior mean for output is estimated at -0.1560 percent. This shows that the marginal effects' output on the target is negative while the credibility interval includes both positive and negative values, and the probability posterior gives conflicting conclusions. We find that both PPI and quarterly real GDP produced inconclusive results in our estimations. However, the marginal effects of credit spread are negative and this is supported by the credibility intervals in conjunction with the probability posterior.

#### **4.4.1 Summary**

In all, we obtained important results about empirical Spread-adjusted Taylor rule through the Bayesian method. Spread-adjusted Taylor rule is a monetary policy rule augmented with spread to address simultaneously the price stability and financial stability goals. There is now widespread understanding that price stability does not always guarantee financial stability. Thus, the new consensus monetary policy framework should be amended to explicitly and systematically react to financial conditions to achieve these goals. McCulley and Toloui (2008), Taylor (2008) and Woodford and Curdia (2009) proposed the inclusion of the spread as one of the systematic components to which central banks should react in order to adjust the policy target downwards when spread rises. This strategy will dampen the effects of higher spreads and thus, counter the effects of financial instability in the economy.

Using the monthly data from SA, our results show that the average expected repo rate-target (i.e. the intercept), inflation rate and spread form part of the systematic factors that enter the simple Spread-adjusted Taylor Rule. We find that under the theory, informed priors, empirical Bayesian priors and non-informative priors, the mass of posterior densities for these factors are concentrated either on the negative or positive values of the distribution. These results show that there is clear-cut evidence that shows that the mean target, marginal effects of rate of inflation and spread are significant factors that explain monetary policy target in SA. However, this estimation could not find conclusive evidence about the marginal effects of output in the STR model. Credibility intervals and probability posterior criteria both give conflicting results. The probability posterior suggests that there is a 73 percent chance that a marginal effect of output is positive, but at the same time the 95% credible interval includes zero. Finally, the STR model with credit spread shows that whether we use theory-motivated priors, empirical Bayesian priors, or non-informative priors, the posterior means of credit spread obtained are negative and have magnitudes between 0 and 1 in absolute terms. Finally, we find evidence showing that the Spread-adjusted Taylor rule is preferred to the standard Taylor rule without spread. The results for the posterior odd ratios are all in favour of the Spread-adjusted Taylor rule.

## Appendix D

### Appendix 4-1 Robustness analysis results

Table D.4-1. Summary of Posterior Distribution for the coefficients ( $\theta_0$   $\theta_\pi$   $\theta_x$   $\theta_\omega$ ): STR model 1993:01-20011:04

Part A	Coeff.	Prior Informative	Posterior mean	Std. Deviation	CDI-Lower	CDI-Upper	Prob. Posterior	Post ODD Ratio
	$\theta_0$	5.5	8.3383	1.2315	5.9191	10.7575	1	
	$\theta_\pi$	1.5	0.5612	0.1105	0.3441	0.7782	1	
	$\theta_x$	0.5	-0.1560	0.1665	-0.4831	0.1710	0.1729	
	$\theta_\omega$	-0.5	-0.4243	0.1875	-0.7926	-0.0560	0.0122	

Part B	Coeff.	Prior Non-Informative	Posterior mean	Std. Deviation	CDI-Lower	CDI-Upper	Prob. Posterior	Post ODD Ratio
	$\theta_0$	-	8.3802	1.2656	5.8938	8.8896	1	
	$\theta_\pi$	-	0.5577	0.1132	0.3353	0.7546	1	
	$\theta_x$	-	-0.1604	0.1700	-0.4945	0.1737	0.17	
	$\theta_\omega$	-	-0.4258	0.1933	-0.8055	-0.0460	0.01	

Notes: Part A contains posterior results under Informative priors, while Part B contains results based on non-informative priors. CDI- refers 95% credibility intervals. Probpos –probability posterior.

## **Conclusion, Contributions and Policy Recommendations**

### **Summary of Empirical Findings**

This thesis has empirically investigated three interrelated concepts: the monetary policy transmission mechanism, interest rate spreads seen as a conduit of monetary policy effects and the Spread-adjusted Taylor Rule. The thesis started with reviews of monetary theory in chapter one, followed by three empirical chapters that examined: the effectiveness of monetary policy in Namibia; unit root process with structural breaks and determinants of spreads; and finally, we estimate the Spread-adjusted Taylor Rule (STR), which is a monetary policy augmented with interest rate spread.

Chapter one details the background of the study by examining the monetary theories in the mainstream and post-Keynesian paradigms. This chapter summarises the nature and roles of money and monetary policy. It then points out how the mainstream and post-Keynesian paradigms influence the new consensus monetary policy framework, and how monetary policy effects are assessed in contemporary times. In this chapter we learnt that: there is now a prevailing consensus that money is endogenous, and it plays a role only as an information variable in the new macroeconomic consensus. Walsh (2010, p. 330) clearly spells out this consensus by saying that ‘most central banks today use short-term nominal interest rate as their monetary policy instrument for implementing monetary policy. The nominal quantity of money is endogenously determined to achieve the desired nominal interest rate.’ This idea is supported by Chadha and Holly (2012, p. 22) who pointed out that ‘money itself does not enter the objective function of central banks and sits somewhere as part of the information set on which interest rate paths are predicted.’ Nowadays, central banks set or ‘peg’ the nominal interest rates and use it as a lever for stabilisation of output and inflation in the long-term. It is also undoubted that the changes in the level of policy instrument start the monetary policy transmission mechanism. First, these monetary changes are identified through structural shocks with a systematic component accounting for endogeneity of monetary policy instrument in the SVAR. The impacts of such interest rate changes are measured through the structural impulse response functions of GDP, inflation, credit and other variables of economic interest.

Although we find consensus among economists that ‘money is endogenous’ and the assertion that ‘interest rate is the policy instrument’, we also find that the reasons for the later as advanced by mainstream and post-Keynesian approaches are remarkably different. Mainstream uses interest rate as the policy instrument because the money demand is unstable and the link between money inflation is broken down; furthermore,

there is disagreement on the appropriate monetary aggregate definition to be used as the target and the fact that monetary aggregate definitions are also periodically redefined. It argued that the nominal interest rate provides clarity of monetary policy stance and good controllability, which lacks the money-growth targeting approach. Meanwhile the post-Keynesian approach recommends interest rate as the monetary policy instrument because central banks cannot control money as a result of the inevitable fact that it is endogenously determined by aggregate demand. In addition, some post-Keynesian economists argue that enforcing strict control on money supply to achieve monetary targets is difficult to reconcile with the mandates of central banks as the lender of the last resort.

Across the schools of thought, we find that there is acknowledgement that monetary policy in relation to weight inflation and output fluctuation does not guarantee financial stability. Therefore, economists within and outside the mainstream suggest that monetary policy should explicitly and systematically react to financial conditions in order to realise the goal of financial stability. This must come in some form of asset prices, exchange rate augmented monetary policy rule, individual credit policy over and above policy rate or an adjustment like the Spread-adjusted Taylor rule.

In chapter two, after using data from Namibia and identifying the repo rate as the monetary policy instrument that generates the transmission mechanism, we showed that monetary policy through the repo rate is effective in stabilizing inflation and output in Namibia. The results from SVAR substantiated that interest rate shocks in the domestic repo rate significantly reduce quarterly real GDP, inflation and private credit in Namibia. In addition, we find that private credit shock increases the quarterly real GDP and inflation at impact. Furthermore, results from the variance decomposition analysis show that credit channel is relatively stronger than the interest rate channel and that domestic monetary policy shock seems relatively stronger and persistent compared to monetary policy effects from the SA's repo rate. This evidence argues against the idea that BoN does not need to change the level interest rate independently from SA because such changes are not necessary and they do not significantly differ from the changes in the foreign interest rate in the anchor country.

In the third chapter, we investigated the concept of 'interest rate spreads' (IRS), which is seen as the transmitting belts of monetary policy effects to the rest of the economy. Literature on the topic shows that interest rate spreads are very important because they determine the actual cost of borrowing. It is argued in the literature that good macroeconomics fundamentally improves the risk perceptions which, as a result, minimise

the size of spread in the economy. However, we find that there is lack agreement on how to empirically model interest rate spreads. This is due partly to the fact that there are many definitions of interest rate spreads, and spreads exhibit unit root process with structural breaks. Thus, chapter three first examined the unit root and structural breaks in spreads and other fundamentals in Namibia. Next we investigated whether there are significant relationships between ex-ante spreads -  $\Delta$ base spread,  $\Delta$ retail spread and the changes in macroeconomics fundamentals realized in the country. Firstly, results from descriptive tests show that the sample averages of interest rate spreads investigated in this study are significantly different from zero; thus, indicating that, on average, the size of these spreads were statistically significant over the sample period. Second, spreads exhibit unit root with several endogenous structural breaks over the sample period from 1992:01 to 2011:12. Lanne, Saikkonen, & Lutkepohl (2002) unit root test for processes with structural breaks show that most significant structural breaks coincide with the 1998 East Asia financial crisis period while the global financial crisis only caused a significant structural break in quarterly GDP. Third, using the OLS, TSLS and GMM we found that, whether we use the  $\Delta$ base spread or  $\Delta$ retail spread definitions, these fundamentals – inflation rate, unconditional inflation volatility, economic growth, changes in bank rate, SA's base spread and risk premium – are some of the significant factors that determine large changes in the spreads in Namibia. In addition, both equations of  $\Delta$ base and  $\Delta$ retail spread statistically produced stable and significant stationary residuals, which indicate that these equations represent important stable economic linear relationships. From these results we conclude that there is enough empirical evidence showing that macroeconomic fundamentals play an important role in determining the size of spreads in Namibia.

Finally, in chapter four, we estimated the simple Spread-adjusted Taylor Rule (STR). As summarised in chapter one, most researchers nowadays agree that price stability does not always guarantee financial stability; therefore, the new consensus monetary policy must respond systematically to financial shocks. Chapters three also confirm that it is all about spreads and spreads are important. One popular solution to this problem is the so-called Spread-adjusted Taylor Rule. We applied the Bayesian method on the monthly data from South Africa (SA) in order to estimate the posterior distributions of parameters in the STR model. Empirical results from this estimation show that the standard Taylor Rule can be augmented with credit spread to caution against tight credit conditions and thereby realise the goals of price and financial stability simultaneously. We find that, on average, a higher credit spread is associated with the probability that the policy target will be adjusted

downward by 55 basis points in response to a marginal increase in credit spread. The posterior mean for credit spread lies between -79 and -30 basis points with 95% credible intervals. In addition, we find that an increase in inflation above the target by one percent is associated with the probability that interest rate targets will be raised by an amount within 41-75 basis points, while little can be said about the marginal increase in output. These posterior means are consistent with fixed parameter values calibrated by Curdia and Woodford (2009) and McCulley and Tuloui (2008).

### **Contributions to the Literature**

The thesis has gone some way towards enhancing our understanding of the theoretical evolution of monetary policy and practical evidence of monetary policy transmission mechanism in Namibia. It extends our knowledge that monetary policy of changing the level of interest rate is effective in the stabilisation of inflation and output fluctuations. However, we also find that that SA's monetary policy effects rarely dominates as suggested by the literature on monetary policy within the fixed exchange rate economy. We found that domestic monetary policy actions caused more significant impact on output, inflation and credit, while SA monetary policy effects barely significant and slow as compared to domestic monetary policy. Further, we showed that a interest rate channel is relatively stronger than the credit channel. In addition, empirical findings in this thesis provide rarely known evidence that spreads in Namibia exhibit unit root with structural breaks. Further, the most significant breaks are associated with 1998 East Asia financial crisis rather than global financial crisis. This is explained by the fact that the former crisis was sudden and sharp, while the global financial crisis was gradual which gave the government enough time to prepare for the loss of revenue. This thesis provides new understanding about fundamentals that seem to explain major spreads in Namibia. There is a fundamental link between the spreads and the prevailing macroeconomic picture, as presented by risk indicators such as unconditional volatility, inflation, economic growth, changes in perceived risk and policy rate. At least, we now know that statistically the averages of major spreads over this sample period were significantly different from zero; secondly, spreads exhibit unit root with structural breaks and the order of integration does not depend on the presence structural breaks. Finally, our thesis contributes empirical Bayesian evidence, which shows that monetary policy can be augmented with interest rate spread in order to address the problem of financial instability. We showed that a one percent marginal increase in the credit spread in STR will make monetary policy committee to reduce the target by 55 basis points. The posterior odd ratio, which compares the marginal likelihood from the standard Taylor Rule and the Spread-adjusted Taylor

Rule, is significantly less close to zero. This indicates that the results from the Bayesian estimation are favour of the Spread-adjusted Taylor Rule rather than the standard Taylor Rule without spread. These empirical findings are practically helpful in the revision of monetary policy framework at the Bank of Namibia. Our finding about spreads will inform the Namibia Financial Charter, which aims to improve the efficiency, financial depth and inclusion of the financial sector.

### **Policy Recommendations and Suggestions for Future Research**

We recommend that the central bank should keep the current monetary policy framework which advocates for the use of domestic repo rate to stabilize inflation and improve domestic short and long term macroeconomic conditions. We also recommend re-examination of the role SA's monetary policy effects in the domestic inflation. This will help to understand whether the positive relationship between domestic inflation and SA monetary policy is an outcome of real economic factors or it was wrong result from our structural VAR model. Next, our results therefore suggest an important question as to whether this evidence can be replicated at the disaggregate level? While our empirical evidence fills the gaps about transmission mechanisms in Namibia, we recommend that further research should aim to provide evidence about the interest rate and credit transmissions to individual sectors such as mining, manufacturing and tourism.

In this thesis, we recognised the important roles of various spreads in the economy. Hence, we recommend that central banks should explicitly account for the variation of average spreads in the monetary policy framework. Specifically, we suggest that the central bank should remain focused on the base spread and macroeconomics as well as the financial fundamentals in order to keep the size of average spread small in the long run. We believe that minimising the lead spread (i.e. base spread) will exert much influence on other intermediation spreads, reduce uncertainty and consequently enhance monetary policy transmission mechanisms from markets to households. Overall, we recommend that government should take steps to improve the macroeconomic picture in order to reduce the risk perceptions in the financial sector.

Finally, a number of limitations have to be considered. As it is a common case in many studies on issues in developing countries, this thesis also encountered some limitations because of the lack of data while some individual institutions were not willing to share their data. Firstly, the most important limitation is that we could not obtain all of the data we wanted for the investigation of determinants of spreads in chapter three. The current investigation was limited by a lack of data at micro level and the fact that the population

size of banks is very small. Alternative sources such as the bank scope database were not helpful either because it has only five years of recorded observations for the five banks in Namibia. Another limitation came from the fact that the Statistic Act in Namibia does not permit the Namibia Statistics Agency (NSA) and the Bank of Namibia (BoN) to share individual firms' data with another third party, which we believe could have solved the problems related to micro level data.

## **Conclusion**

Retuning to our main objectives now it is possible to confidently assert that monetary policy in terms of changing the level of interest rate (i.e. the repo rate) is effective in relation to the stabilisation of inflation and output fluctuations in Namibia and that interest shocks account for more variation in output compared to the credit shocks. Spreads are significantly different from zero, and they have unit root with structural breaks. There is a significant relationship between changes in macroeconomic realised in the country and changes in the spreads. Finally, there is empirical evidence that supports the appropriateness of the Spread-adjusted Taylor Rule monetary policy framework.

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