

DETERMINANTS OF MONEY SUPPLY IN RWANDA

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DECLARATION

This is my original work and has never been presented for any degree award in any other university.

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This research paper has been submitted with our approval as university supervisors.

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Signed.......... Date: 22/09/2011..

Dr. Nelson W. Wawire

DEDICATION

To my late father,

To my mother, brothers and sister for their support.

ACKNOWLEDGMENT

My deepest gratitude goes to our Almighty God for enabling me to achieve this step in my academic life.

My foremost appreciation goes to the University of Nairobi for allowing me to undertake the Masters of Arts in Economics and to the African Economic Research Consortium (AERC) for offering me a scholarship. I will always be indebted

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ACRONYMS AND ABBREVIATIONS

2SLS	: Two Stage Least Squares
3SLS	: Three Stage Least Squares
ADF	: Augmented Dickey Fuller
AIC	: Akaike Information Criterion
BOP	: Balance of Payments
ECM	: Error Correction Model
Fed	: Federal Reserve Bank
GDP	: Gross Domestic Product
IMF	: International Monetary Fund
NBR	: National Bank of Rwanda
NDA	: Net Domestic Assets
NFA	: Net Foreign Assets
OLS	: Ordinary Least Squares
PP	: Phillips Perron
RWF	: Rwandan Francs
SIC	: Schwarz Information Criterion
UK	: United Kingdom
VAR	: Vector Autoregressive
VEC	: Vector Error Correction
VECM	: Vector Error Correction Model

OPERATIONAL DEFINITIONS OF VARIABLES

Balance of payments: is equal to the inflows of foreign exchange from commodity exports, capital inflows, dividend, interest and unilateral transfer inflows minus the foreign exchange outflows for commodity imports and capital outflows.

Broad money supply (M_2): is the sum of currency outside banks, demand deposits other than those of the central government, and the time, savings, and foreign currency deposits of resident sectors other than the central government.

Currency ratio: is calculated as a ratio of currency in circulation over total demand deposits.

Domestic credit to government: refers to credit from central bank to the government.

Fiscal deficit: is the difference between government total cash flow expenditures and fiscal revenue.

Monetary base: is the sum of currency in circulation and banking system reserves held in the vaults of the central bank.

Money supply: is the quantity of money available in a given economy and is usually measured via several aggregates namely currency in circulation, monetary base M_1 , M_2 and M_3 .

Net domestic credit to banks: refer to net domestic credit from NBR to other financial institutions of the rest of the economy excluding the government.

Net Foreign assets: are the sum of foreign assets held by monetary authorities and deposit money banks, less their foreign liabilities.

Reserve ratio: is measured as a ratio of total banks reserves over total deposits.

Total banks loans: is measured as the sum of credits from commercial banks to private sector.

ABSTRACT

Before mid 1990s economic reforms, the National Bank of Rwanda had the task of implementing monetary policy and supporting government policies including financing government debt. Since the implementation of reforms, the financial sector has evolved and the National Bank of Rwanda has adopted an indirect monetary policy. Whether the National Bank of Rwanda can exogenously determine money supply and what are the main determinants of money supply in Rwanda, are empirical questions. The main objective of this study was to investigate the main determinants of money supply in Rwanda. The specific objectives were to determine the effects of domestic credit to government on money supply, examine the effect of net foreign assets on money supply; and test for endogeneity/exogeneity of money supply in Rwanda. Using monthly data from January 1995 to September 2009, results from cointegration analysis revealed that net domestic credits to banks, net foreign assets and domestic credit to government have a significant positive influence on M_2 . Moreover, results from Granger causality test and cointegration technique confirmed the Post Keynesians endogenous money hypothesis in the short run while in the long run results were mixed between Monetarists' exogenous money hypothesis and Post Keynesians endogenous money hypothesis. Generally the findings show that the banking sector is a key player in money supply process and a more effective monitoring of financial institutions is needed to ensure an efficient money supply management in Rwanda.

CHAPTER ONE

INTRODUCTION

1.1. Background

The money supply determination in a given economy has been a subject of research in economic sciences. The importance of money supply in an economy resides in its capacity to influence several economic variables such as inflation, exchange rate and output. According to Miyao (2004) there are two potential roles of money supply. The first is its role as an intermediate target in monetary policy given its relationship with policy goals (prices, income) and the second as an information variable when it has predictive content for subsequent movement in income and prices. The control of money supply is usually assigned to the central bank and this is fulfilled through the conduct of monetary policy

All along, it has been agreed by economists (Mishkin, 2004; Dornbusch and Fischer, 1994) that the central bank can influence money supply by manipulating the elements in its balance sheet included in the monetary base. Nevertheless, this view is not shared by all economists as some post Keynesians (Moore, 1979; Goodhart, 1989) have pointed the issue of endogeneity of money supply where decisions of private economic agents determine the overall money supply; the central bank sets short term interest rate and the changes in quantity of money supply is market determined as an outcome of the loans-deposits supply process (Hoermans and Moore, 2009). The endogenous money theorists argue that central banks have very limited power to impose any quantitative constraints over changes in the stock of money via the monetary base multiplier (Fontana and Palacio-Vera, 2002).

Yet, in developing countries especially in Africa, central banks have been using the money multiplier approach in controlling the money supply via manipulation of the base money (Hauner and Di Bella, 2005). Since mid 1980s, the financial liberalization has led to noticeable mutations and development in the macroeconomic environment notably in the financial sector and payment system. These developments affect the variables in the money multiplier including the currency ratio (Russell, 1975 cited in Miller, 1982). The money multiplier approach has been subjected to

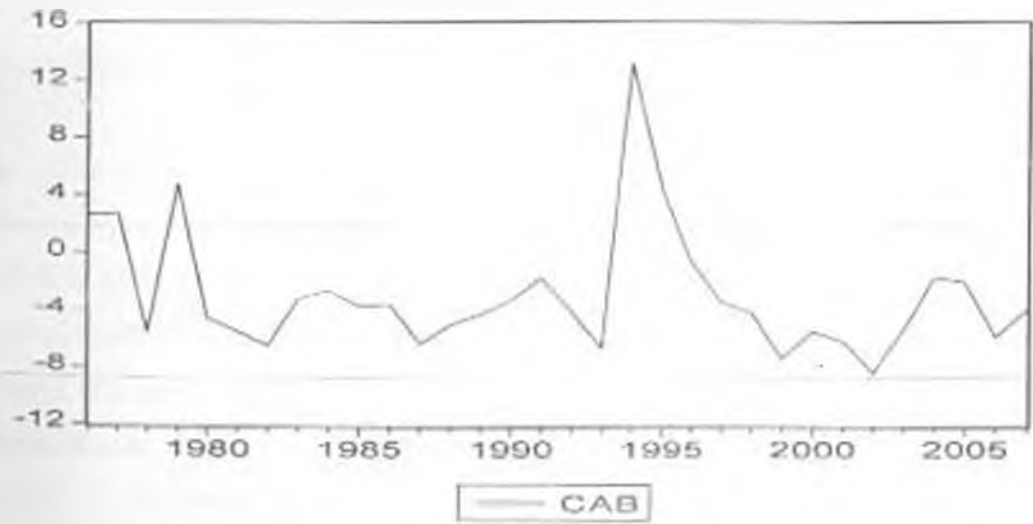
several criticisms especially concerning the stability and predictability of the money multiplier which is the key element for the central bank to exert full control on money supply when it is committed to monetary targeting.

Besides, whether the central bank can fully control money supply has been uncertain, given the problems of recurrent large fiscal deficits, relative independence of central banks, commodities booms or balance of payments problems which especially characterize African economies (Honohan and O'Connell, 2008; Sowa, 2008).

In developed countries, central banks have progressively shifted from controlling the money stock via monetary base to targeting the credit market by the use of short term interest rate. However, according to Hauner and Di Bella (2005), targeting reserves aggregate remains prevalent in low income countries given that in these countries, the financial markets are less developed and the estimated interest rate elasticity of money demand is more uncertain.

The Rwandan case is not very different from other developing countries. Rwanda has experienced large fiscal deficits and balance of payment problems. The figure 1.1 and figure 1.2 below show the evolution of current account balance and budget balance

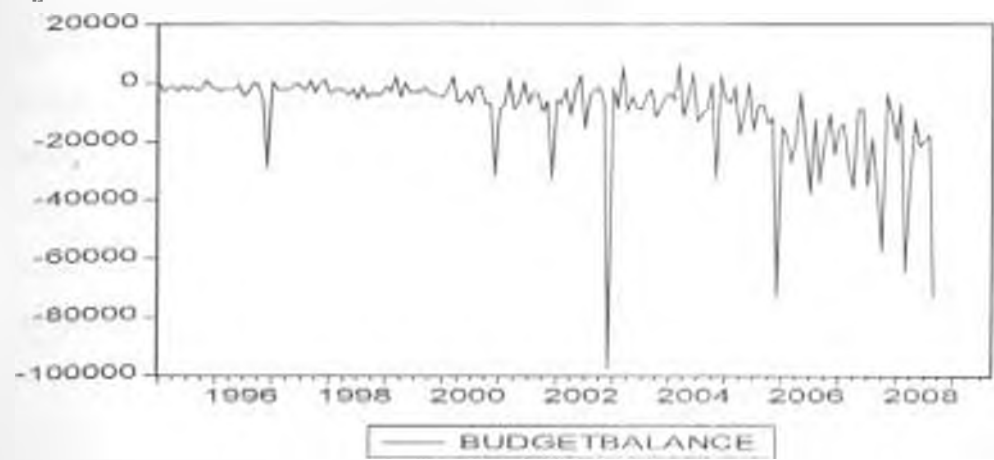
Figure 1.1: Current account balance as percentage of GDP



Source: World Bank African Development Indicators (2010).

From figure 1.1 it is obvious that from 1977 the current account balance as a percentage of GDP has been mostly negative except in 1979 and 1995 where the trade balance was still negative but a huge increase in net transfers especially in 1995 improved the current account balance. Note that the main exports products in Rwanda have been coffee and tea which international prices have been fluctuating thereby affecting the current account balance.

Figure 1.2: Budget balance in Billions (RWF)



Source: National Bank of Rwanda (2011).

Figure 1.2 above shows that budget balance has been in deficit since 1995. This deficit has worsened especially in years 2002, 2005, 2007 and 2008 due essentially to an upsurge in current expenditures which exceeded remarkable improvement in revenue collection.

In addition, the independence of the National Bank of Rwanda (NBR) which is the Rwandan Central Bank has been an issue (International Monetary Fund, 2005). Since the establishment of NBR in 1964 till 90s prior to the implementation of structural adjustments programs from the International Monetary Fund (IMF). The NBR implemented a direct monetary policy and had to support the economic policies of the government which were not always in accordance with its main objectives. The conduct of monetary policy shifted from direct to indirect in 1990s as a result of implementing a structural adjustment policy imposed by IMF and World Bank (Rutayisire, 2010). "Direct control of money supply, interest rate and prices were gradually abandoned in favor of prices determined by market forces" (Sayinzoga and Simson, 2005, p.67).

1.2. Brief overview of monetary policy in Rwanda

The conduct of monetary policy is assigned to the NBR since its establishment in 1964 as the central bank of Rwanda. By that time, its principal missions were to formulate and implement monetary policy to protect the value and ensure the stability of the Rwandan currency and to manage state portfolio at its disposal and execute financial transaction on behalf of the State.

The NBR had to finance the budget deficit by money creation in several occasions thereby complicating its money supply management. Moreover, the NBR had to control directly the financial sector in Rwanda. This was achieved through direct control of supply of credit by banks to their customers (this includes reserve requirement ratio, control of banks' free reserves, credit extension ceiling and requirement of NBR authorization for a credit exceeding a certain amount), determining how the volume of credit would be shared out by banks and by sectors given the government policies and priorities and setting the level of interest rates (Rutayisire, 2010).

During that period prior to structural adjustment reforms, direct control of the banking sector made easier the control of money supply in the economy although with the support of government social policies, the NBR could not achieve the desirable level of money supply compatible with its monetary policy. In addition, direct control led to misallocation of financial resources available at that time resulting in lower investment and growth.

The structural adjustment reforms led to elimination of direct control of money supply and interest rates. These reforms were implemented gradually in order to favor a smooth transition to a market-based financial system where money supply and interest rates are market-determined.

In fact, from 1990 Rwanda started to implement enhanced structural adjustment programs under the advice of IMF and World Bank. Several reforms in the financial sector were initiated including liberalization of banking activities by removing direct control of credit, credit rationing, interest rates setting and requirement of authorization from NBR to grant credit, budget deficit financing via the market, introduction of a posteriori control of financial intermediation replacing a priori control, introduction of flexible exchange rate in 1995 although the NBR intervenes sometimes

to keep exchange rate on a smooth path, promulgation of the new banking law in 1999 giving to NBR more power to determine monetary policy and adoption of indirect control instruments to conduct monetary policy (Sayinzoga and Simson, 2006; Rutayisire, 2010).

Under IMF and World Bank advices, the NBR adopted a medium term inflation target as its ultimate objective. To achieve that ultimate target, the NBR adjust its intermediate target M_2 via manipulation of its operating target which is the base money (Sayinzoga and Simson, 2006). The framework in which money supply is controlled is the money multiplier. The NBR uses indirect instruments in its management of money supply. It is believed that NBR can control the base money as its components (currency in circulation and reserves) are liabilities in the NBR balance sheet. In that money multiplier framework, manipulations of the monetary base H are transmitted to M_2 through the relationship $M_2 = mH$ where m is the multiplier and H the base money.

The NBR try to maintain harmony between M_2 demand and supply given the level of inflation targeted and M_2 is defined according to IMF rules. Given the forecast GDP growth, NBR uses its models of M_2 to set the level of M_2 consistent with its inflation target. The NBR monitors regularly the evolution of M_2 and uses the base money to forecast future level of M_2 . From this forecasts, the NBR decides on its intervention on the money market via open market operations in order to mop up or inject excessive liquidity given its policy objectives. From May 2008, NBR has replaced weekly auction and overnight deposit facility by repos operations (NBR, 2009). Now the NBR instruments include open market operations where NBR accepts surplus liquidity from banks in exchange of eligible securities as collateral and both parties agree to reverse the operations at a future point in time. At that time the central bank will pay the loan plus interest. Repos maturity varies from 1 to 14 days and they are carried out depending on the forecasts of banking sector liquidity. Other instruments are the reserve requirement as an instrument to control the monetary base and the discount window facility where a penalty rate is applied to limit the access of NBR funds to commercial banks (NBR, 2009; IMF, 2005).

1.3. Statement of the problem

In order to conduct effectively its monetary policy, the central bank should be able to know accurately how money supply is determined so that it can assure its control. The NBR uses money multiplier framework to influence overall money supply via monetary base manipulation. Nevertheless, the use of monetary base as a policy tool depends on the extent of central bank's control over its components (Killick and Mwegu, 1990). Besides, the money multiplier contains endogenous variables such as the currency ratio or the excess reserve ratio which are influenced by private agents' behaviors namely the public and commercial banks although the NBR monetary policy can relatively influence them too. Whether the NBR is still determining money supply exogenously or private banks or non bank public are playing the major role is an empirical issue.

Rwanda is a small open economy which has been characterized by recurrent fiscal deficit, balance of payment problems and less developed financial sector. Previous literature has emphasized that increase in fiscal deficit affects monetary base (Aghevli and Kahn, 1978) while large capital movements complicates the task of the central bank in monetary management (Kahn, 2003). With financial sector liberalization, capital movements between Rwanda and the rest of the world have continued to increase and commercial banks have gained more freedom in their portfolio allocation and subsequently more influence in money supply process. All these developments raise serious questions about Rwandan fiscal deficits and foreign assets effects on money supply and the extent to which the NBR is able to control changes in money supply. Therefore, the main research questions of this study are as follows;

- i. What is the influence of the domestic credit to government on money supply in Rwanda?
- ii. What is the effect of net foreign assets on money supply in Rwanda?
- iii. To what extent NBR controls total bank loans and money supply?

1.4. Research objectives

The main objective of this study is to investigate the main determinants of money supply in Rwanda. The specific objectives are to

- i. Determine the effect of domestic credit to government on money supply in Rwanda;
- ii. Examine the effect of net foreign assets on money supply in Rwanda;
- iii. Test for endogeneity/exogeneity of money supply in Rwanda.

1.5. Significance of the study

This study contributes in understanding money supply process in Rwanda by identifying factors and actors responsible for changes in money supply and devising appropriate policies to control money supply. For policymakers, it is vital to identify the main determinants of money supply so that they can be able to take appropriate actions to be undertaken and assess their effects with accuracy. Moreover, it is important for NBR to assess how non bank public and commercial bank respond to its actions and the impact of their behavior on money supply. This study tries to address those issues. This study indicates to what extent certain variables affect money supply so that any policy actions would be undertaken with predictable effects.

1.6. Scope of the study

This study covers the period from January 1995 to September 2009. The choice of this period was guided by the availability of data. Monthly data are used.

CHAPTER TWO

LITERATURE REVIEW

2.1. Introduction

This chapter includes theoretical literature on the debate on money supply determination between monetarists and Post Keynesians, measurement of money supply, money supply, monetary policy and the multiplier approach to modeling money supply with an empirical literature on developed and developing countries.

2.2. Theoretical literature

2.2.1. Money supply determination: exogeneity vs. endogeneity

The theory on money supply determination distinguishes Monetarists and Post Keynesians views. In Monetarists view, money supply is exogenously determined by the central bank via the monetary base and multiplier process. Friedman and Schwartz (1963 cited in Moore, 1979) distinguished three determinants of money stock namely; high powered money, reserves deposit ratio and currency money stock ratio. The money stock varies directly with high powered money and inversely with currency money stock ratio and reserve ratio. Friedman and Schwartz employed the money multiplier framework to analyze the cause of changes in money supply (Walsh, 2003). According to Boermans and Moore (2008) the belief that monetary changes are exogenous is a historical legacy that date back to profligate royal borrowers even before the gold standard. In brief, exogenous money supply hypothesis implies that the central bank determines money supply by exerting a full control on the monetary base via multiple instruments such as open market operations, with the stability of the link between monetary base and money supply known as the multiplier assured so that by changing the monetary base via open market operations, the central bank will determine various monetary aggregates.

On the other side, the Post Keynesians support the endogenous money hypothesis which postulates that the central bank is not able to control the change in money supply; rather changes in money supply are result of normal economic agents. The ancestors of this theory are in the contributions of the banking school and writings of Keynes, Kalecki, Robinson, Schumpeter, Wicksell, Davidson, Kaldor, Moore and Threadgold (Fontana, 2002). According to Fontana and Palacio-Vera (2002), the basic tenet of the endogenous money theory is that at any given time, changes in the money stock in a country are the outcome of loans deposits supply process. Besides, monetary aggregates are considered as inappropriate target of monetary policy; the central bank has limited power to impose any quantitative constraints over changes in money stock via monetary base manipulation.

Briefly the endogenous money theory can be explained as follows: when commercial banks grant loans, the supply of banks deposits increases assuming no changes in the demand by the depositors to save. In other words, the supply of bank deposits is determined by borrowers demand for credits and consequently these have an impact on banks demand for reserves. Thus the central bank can no longer control the monetary base as the changes in monetary base are influenced by changes in deposits which are ultimately determined by demand for credit.

Moore (1991) distinguished two theories of endogenous money supply within post Keynesian literature. Both theories agree on endogeneity of money supply but diverge essentially on factors determining interest rate and assets prices, the behavior of financial institutions and whether they are constrained by availability of reserves supplied by the central bank and the supply price of finance to banks (Palley, 2008). On one hand there is accommodative money supply endogeneity where the central bank has to accommodate demand for reserves at the discount window, meaning that there are no effective quantity constraints on banks reserves needs. On the other hand, the structural position maintains that central bank exerts a quantity constraint on reserves availability but that constraint can be more or less offset via innovative bank liabilities management practices (Moore, 1991). Finally there is liquidity preference view which considers the significance of money demand in loans deposit creation process and bank lending. This is based on Keynes' liquidity preference theory which suggested three motives of holding money namely, transaction, precautionary and speculative. According to liquidity preference

considerations from non public bank and banking sector can influence both the demand for money and banks portfolio positions and these may have a feedback effect on bank lending and money supply (Palley, 1991). In summary the accommodationist view supports unidirectional causality from bank credit to money supply and monetary base and a bidirectional causality between monetary base and money supply. The structuralist view supports bidirectional causality between bank credit to money multiplier and monetary base and bidirectional causality between money multiplier and money supply. Lastly, liquidity preference view supports bidirectional causality between bank credits to money supply (Palacio-Vera, 2001; Nell, 2000).

2.2.2. Measurement of money supply

The quantity of money supply in economy is usually measured using different monetary aggregates. Their definitions have been changing overtime due to financial innovations and financial sector development all over the world. As a result there have been debates about which financial assets should be included in which monetary aggregates.

In measuring money supply, the several aggregates are usually distinguished basing on their liquidity. Mishkin (2004) classifies them as M_1 or the narrow money, its components are currency in circulation, demand deposits, traveller's cheques and other checkable deposits, M_2 or broad money, its components are M_1 plus small denomination time deposits and repurchases agreement, saving deposits, money markets deposits accounts and non institutional money market mutual fund shares and M_3 which is M_2 plus large denomination time deposits and repurchases agreement, institutional money market mutual fund shares and Eurodollars. This classification is from Federal Reserve Bank (Mishkin, 2004). The narrowest aggregates is the monetary base which is made up by elements in the balance sheet of the central bank namely currency in circulation and reserves. Each of those aggregates can be used by policymakers.

2.2.3. Monetary aggregates as targets in monetary policy

The importance of money supply defined here via various monetary aggregates in the conduct of monetary policy has evolved overtime, and it is not given the same importance in monetary

policy implementation across different countries. The issue about to control quantities versus rates had been present in central banking (Bindsell, 2004). On one side there were monetarists from St Louis school and Milton Friedman who favored monetary aggregates as the best target given the stability, predictability and shorter lags in the relationship between money aggregates and aggregate demand (Handa, 2000). In developed countries especially in the west, monetary aggregates were used during 70s and 80s but were abandoned in 90s (Woodford, 2006, Walsh, 2003; Borio, 1997) due to various factors among them the instability of functional relationship between monetary variables and nominal incomes or the rate of inflation (Goodhart, 1989; Handa, 2000). Interest rate sensitivity of multipliers also affected their stability (Rasche, 1972).

In order to emphasize the relative role of various monetary aggregates in monetary policy, it is worthy to look at how monetary policy is conducted, its goal, targets and instruments. Like any other policy, monetary policy has its own goal(s). In fact goals of monetary policy have differed in time and space. The most known and pursued across countries have been the low rate of inflation, low unemployment, stable exchange rate and output growth. All central banks in the world have not pursued all these goals at the same time; depending on many factors such as level of development, economic and political philosophy, crisis, business cycles. Central banks have been shifting their focus on different goals.

The central bank can achieve its goals by using various instruments at its disposal and through operating and intermediate targets. Handa (2000), Mishkin (2004) and Walsh (2003) highlighted various monetary policy instruments including open market operations which are the purchase or sale of financial securities by central bank in the financial markets and used to control the monetary base, the discount bank rate which is the interest rate on reserves borrowed from the central bank (Walsh, 2003), the overnight loan rate which is the rate at which banks and other participants in the money market make loans to each other (Handa, 2000) and lastly, the reserves requirement ratio which determine the level of reserves that banks must hold against their deposit liabilities (Walsh, 2003).

To achieve its goal(s), the above instruments are used to influence its operating target. The operating target is a variable which the central bank can control directly or fairly directly through

the instruments at its disposal (Mishkin, 2004, Handa, 2000) Operating targets are mainly monetary aggregates and/or interest rate. The most preferred operating target is one which has a more predictable impact on the most desirable intermediate target (Agénor and Montiel, 2008, Mishkin, 2004). "Intermediate targets are variables whose behavior provides useful information in forecasting goals variables" (Walsh 2003, p.439). They must be measurable, controllable and have predictable effect on goal (Mishkin, 2004). They are indirectly influenced by the central bank via operating targets. They are mainly monetary aggregates, interest rate and aggregate demand.

Monetary aggregates can be either operating or intermediate target. The operating target is usually the monetary base and it is believed that the central bank can control it using the instruments aforementioned. The intermediate target can be either M_1 , M_2 or M_3 depending on its ability to influence the ultimate goals. Interest rates can be chosen as target of monetary policy as well. The choice between monetary aggregates and interest rates as targets depends essentially upon the policy objective and the structure of the economy (Camen, Neube and Senbet, 2008, Handa, 2000). In other words the choice between monetary aggregates or interest rate is justified by the ability of the targets to achieve goals.

The monetary policy explained in this section is indirect. According to Camen, Neube and Senbet (2008) under indirect monetary policy, the central bank influences the balance sheet of commercial banks by manipulating items on its own balance sheet while under direct monetary policy; the central bank influences directly items on balance sheet of commercial banks.

In the period covered in this study, NBR implemented indirect monetary policy. It started with mid 1990's economic reforms. Furthermore, NBR has always applied monetary targeting. The present study takes that into account.

2.2.4. The multiplier approach

Money multiplier approach is one of the approaches which try to explain the money supply process. According to Coats and Khatkhate (1979) the stock of money is the outcome of the

behavior of the public, the financial sector, the ministry of finance and the central bank. The money multiplier concept helps to understand this interrelationship and the role of the central bank in it. The multiplier approach equations are not always identical. For empirical reasons the equations can be more complex and include more variables. In its basic form, the most known is one developed by Friedman and Schwartz in 1963 and Cagan in 1965 (Stauffer, 2006), it assumes that banks are the only financial institutions accepting deposits and only demand deposits (Papademos and Modigliani, 1990).

The starting point is the central bank balance sheet particularly its liabilities side where there are components of the monetary base including currency in circulation and total reserves holding of banks. To understand linkages between monetary base and various measures of money supply is to express broader measures of money supply as a product of monetary base and a money multiplier (Walsh, 2003). These will be derived in the next chapter.

The money multiplier includes several variables. The main one are the currency ratio which reflects the demand for currency by the public and depends on individual preferences in light of cost and benefits of holding cash rather than demand deposits (Handa, 2000), the ratio of reserves held to deposits required by the Central bank to maintain minimum cash reserves in proportion to their deposit (Goodhart, 1989) and the ratio of reserves in excess of those required

Changes in component variables of the money multipliers affect the value of the multiplier and ultimately the money supply. Factors like increase in currency ratio which cause a systematic absorption of the central bank reserves in the process of credit deposit creation generated by an increase in the monetary base will reduce the magnitude of the multiplier (Papademos and Modigliani, 1990). Similarly, an increase in reserve ratio and excess reserves reduce the multiplier. Hence, higher currency ratio and reserve ratio damper money creation process and consequently decrease money supply

Components of the money multiplier namely the currency ratio, the reserve ratio, excess reserve ratio and time deposit ratio are behavioral as they depend on the behavior of non bank public and banks though the central bank policies can indirectly influence those ratios (Walsh, 2003)

Rasche, 1972). The currency ratio is the public demand for currency relative to demand deposit and is a major source of fluctuations in money supply (Handa, 2000). Because of uncertainty on frequency of withdrawals, loan repayment or fluctuations on yields from various assets, the commercial banks also determine their demand for reserves against the demand deposits given the required reserve ratio (Papademos and Modigliani, 1990; Handa, 2000). Various factors influence the portfolio choices of commercial banks and the public. Starting with the latter, different authors outlined the main determinant of the public demand for currency. For Papademos and Modigliani (1990), they are interest rate on demand and time deposit, interest rate on government securities, income and wealth. Handa (2000) added charges on demand deposit. The theory postulates a negative relationship between the public demand for currency and the interest rate on alternative assets. Besides empirical evidences suggest a negative relationship between real income and the currency ratio (Papademos and Modigliani, 1990), yet Handa (2000) suggested a positive relationship since an increase in real income lead to an increase in transaction.

On the other side, commercial banks can hold reserves in excess of the legally required ones, and can borrow from other banks or the central bank. The demand for reserves depends on the required reserve ratio, the return on reserves or return of substitutes, the frequency of withdrawals and the risks associated with banks assets. The desired level of excess reserves is negatively related to the rate of return on bank assets and positively related to the rate of return on bank's reserves and the discount rate (Papademos and Modigliani, 1990). The frequency of withdrawals and other risks associated with uncertainties on banks assets are positively related to demand for excess reserves.

In relation to this study, money supply is managed via money multiplier framework in Rwanda. This approach highlights the interaction between the central bank, commercial banks and non bank public in money supply process though it assumes that the central bank determine money supply exogenously. This study borrows from the above theory to identify the main determinants of broad money supply.

2.3. Empirical literature

2.3.1. Empirical studies using multiplier approach

Empirical studies which used this approach have not followed the same methodology. Some analyzed the determinants of behavioral components of the multiplier along with components of monetary base whereas others focused on either components of the multiplier alone or determinants of monetary base alone. This review begins with studies in developed countries and look at studies in developing countries thereafter

In the case of United States, Teigen (1964) analyzed empirically the money supply process using two stages least squares (2SLS) on quarterly data in pre war (1924-1941) and post war (1946-1959) and found negative relationship between interest rate and money supply whereas GDP exerted a positive relationship on money supply. Besides, Gibson (1972) improved on Teigen approach and revised the measurement of quarterly data from 1947 to 1958 by using quarterly averages, results obtained after 2SLS estimation indicates a significant positive relationship between money stock and reserves. The coefficients of the discount rate and commercial paper rate were positive but not significant.

A more encompassing study was conducted by Baghestani and Mutt (1988) on money supply process from 1970 to 1968. The study investigated money supply process under three alternative operating procedures by estimating a general money supply function combining two well known money supply function namely Teigen-Gibson money supply function which relates the quantity of money supplied to reserves, short term interest rates and discount rate and Tatom money supply function which relates changes in money supply to adjusted monetary base through partial adjustment process. In order to identify the difference considering the various operating procedures of the Fed in the period under study, the models were estimated using quarterly data separately for the periods I/1970 to III/1979, IV/1979 to III/1982 and IV/1982 to IV/1986. Results from 2SLS estimation showed that in the first sample period, neither the short term interest rate nor the discount rate did significantly affect the quantity of money supply. Gibson (1972) had obtained also these results on quarterly data from 1947 to 1958. In the second sample

period, results suggest that money supply was sensitive to changes in short term interest rate and discount rate whereas in the third sample period money supply was responsive to movement of adjusted bank reserves and discount rate. This study concluded that changes in Fed's operating procedures led to changes in money supply process but under the same money supply process the Fed control of money was not altered.

Nevertheless, some studies have focused solely on the determinants of the multiplier assuming that monetary base is exogenous and controlled by monetary authorities. From that perspective, Beenstock (1989) examined the determinants of money multiplier in United Kingdom (UK). The study estimated the multiplier in terms of its components; those are the currency ratio, the time deposit ratio and the reserve ratio using annual data from 1950 to 1984. Due to the fact that explanatory variables such as interest rate and money supply were treated as endogenous, equations were estimated using 3SLS. All coefficients in the currency ratio equation were statistically significant and had expected signs. Variables including GDP at constant price, rate of interest on sight deposit and the ratio of money supply to private disposable income were negatively related to the currency ratio whereas return on long date gilt and the differential between the return on building society share accounts were positively related with it. About the time deposit ratio, all coefficients were statistically significant. GDP at constant price, rate of interest on time deposit, ratio of money supply to private disposable income and dummy variable had a positive relationship with the time deposit ratio while as expected, the rate of interest on sight deposit was negatively related with the time deposit ratio.

The reserve deposit ratio was modeled using a logistical model as it should always be between 0 and 1. All coefficients were statistically significant and the coefficients of lagged reserve ratio, cash ratio, the ratio of penalty assistance to total assistance (PEN) had a positive sign implying a positive influence on reserve ratio. The rate of interest had a negative sign meaning that banks take advantage of more lucrative lending. The positive sign of variable PEN suggests that high penalties led to an increase in reserve ratio as banks were keen on avoiding penalties. Beenstock (1989) concluded that in general money multiplier in UK was mainly sensitive to interest rate and economic activity. Similarly, Hauner and Di Bella (2005) employed the same model in the case of Rwanda. Nevertheless the results obtained were slightly different as the variable PEN

was not statistically significant. Other results were in line with results obtained in other countries as the change in time deposit in total deposit ratio had a negative impact on demand for reserves while the change in the discount rate had a positive influence on demand for reserves.

As the money multiplier approach to money supply process requires the stability of the multipliers which link the monetary base to various broader monetary targets, the issue of multiplier stability was addressed empirically by Sahinbeyoglu (1995) for the Turkish case. Using cointegration technique on monthly data from January 1986 to 1994 of the following variables: M_1 , M_2 , M_3 plus foreign exchange deposits, two monetary base aggregates namely central bank money and reserve money and finally 6 multipliers relating those variables. ADF unit root test and Johansen maximum likelihood procedure were employed and the results confirmed that money supply and monetary base aggregates were cointegrated except for the case of M_1 and reserve money relationship. In general the multipliers were stable.

Among several studies conducted in developing world, Khatkhate, Galbis and Villanueva (1974) used money multiplier approach in the case study of Venezuela as an open developing economy with fixed exchange rate. Behavioral equations related currency ratio and demand for excess reserves to their explanatory variables. OLS estimation results for the sample periods 1950-1970 and 1950-1972 revealed that domestic interest rate and GDP influenced negatively the variation in the currency ratio as expected. In addition both domestic and foreign interest rate influenced negatively the change in demand for excess reserves.

For Ghana, Sowa (1993) used different methodology in analyzing money supply from 1957 to 1988. Money supply function was specified in one equation as a log linear function where M_2 was function of monetary base, discount rate, currency ratio and reserve ratio. 2 SLS estimation in the first regression with monetary base non detrended revealed that monetary base had a significant positive influence on M_2 whereas the currency ratio and reserve ratio had a negative relationship with M_2 . In the second regression with detrended monetary base, only the discount rate coefficient was significant and positively related to M_2 .

The case of Botswana was attempted by Sibonge (1997) in order to identify factors influencing variations in money supply and evaluate the forecast ability of the multiplier approach and the flow of fund approach. Using OLS on time series data from 1976 to 1995, the multiplier model estimated had five equations relating the endogenous variables broad money, currency ratio, reserve ratio, net foreign assets, net government deposit and excess reserve ratio to their explanatory variables. Results obtained revealed that the reserve deposit ratio and net foreign assets are the main determinants of broad money supply. The reserve ratio had a negative impact whereas net foreign assets had a positive impact. The currency ratio had no significant impact. The discount rate and GDP were found to be the main determinants of the currency ratio and had a negative relationship with it. Meanwhile, the reserve deposit ratio was mainly determined by required reserve ratio and discount rate. The relationship was positive for the former and negative for the latter. This is in accordance with the case of Rwanda where Hauner and Di Bella (2005) found that the discount rate had a positive influence on demand for reserves. Furthermore, current account balance and net capital inflow were the main factors behind changes in net foreign assets. Lastly, using simulation method and calculating mean absolute percentage errors for both models, the multiplier model exhibited the best forecast ability.

Similarly, Afriyie (1999) used the multiplier approach model for Ghana which had several equations with the following endogenous variables; the currency ratio, reserve ratio, net credit to the public sector and net foreign assets. The use of OLS on annual data from 1970 to 1997 was motivated by the fact that individual equations in the model were recursive. The results obtained indicated that variables which influence money supply components significantly were inflation, required reserve ratio, fiscal deficit, lagged net foreign assets and overall balance of payment. In the second model, central bank credits to the government as well as net foreign assets were the main factors of change in money supply in Ghana. As in previous case of Botswana where the required reserves and net foreign assets exert a big influence, in Ghana too both variables are among the main factors influencing money supply.

Kasekende and Atingi-Ego (2008) analyzed the broad money supply in Uganda through the analysis of factors affecting the supply of the money base. Those variables which affect net domestic assets and net foreign assets are the Treasury bill rate, the net issuance of treasury bills,

net government position with Bank of Uganda, intervention by Bank of Uganda in the foreign exchange market and the inflation level. To estimate the long run equation and determine the variables which are strongly exogenous to be used as policy variables by monetary authorities, Dickey Fuller and Sargan Bhargava Durbin Watson tests were used to investigate properties of monthly data from January 1990 to December 1995 and VAR formulation to express the partial system as conditional model and discuss its properties. The results from the long run base money supply equation showed that there was unique cointegrating vector between base money supply, treasury bill rate, net saving by the government and levels of interventions on foreign exchange market. In the long run, the intervention on foreign exchange market has the strongest impact on the supply of base money and it is positive while the Treasury bill rate and net saving by the government have a negative impact. In the short run net saving by the government has a significant negative impact on changes in base money supply whereas the intervention on foreign exchange market has a significant positive impact. The remaining variables have a slight effect on base money supply. Previously, in the case of Kenya, Killick and Mwega (1990) had found that changes in real high powered money was positively correlated with changes in real income probably through changes in net foreign assets and negatively correlated with changes in the multiplier

2.3.2. Empirical studies on the endogeneity of money supply

Endogeneity or exogeneity of money supply has been a topic of debate among economists as mentioned in the theoretical literature, for that reason that debate has attracted interest of researchers. Rath (1999) examined money supply process in the Indian context. His objective was to use Indian data to find the appropriate approach to money supply process in India among the following three competing approaches; the money multiplier approach from monetarists on one hand and on the other hand the pure loan demand approach and the mixed portfolio loan approach in the endogenous money framework from Keynesians. Using monthly data from April 1980 to March 1998, ADF and Phillips Perron tests showed that all variables were integrated of order 1. The broad money and the reserve money were found to be cointegrated for the period before liberalization (1990) implying the stability of the broad money multiplier. For the whole

period of study the cointegration was absent meaning that the broad money multiplier was not stable. In order to find the appropriate model in the Indian context, Granger non causality test in trivariate VAR framework were employed and bidirectional granger causality from bank credit to reserve money and broad money was found. Thus this study concluded by supporting mixed portfolio loan demand model for India.

Neil (2000) analysed money supply process over the period from 1966 to 1997, in order to determine the exogenous or endogenous nature of South Africa money supply. The period of study was divided into two to distinguish the period of direct control in monetary policy (1966-1978) and the period of more market oriented monetary policy (1980-1997). To determine whether money supply was endogenous or not, three empirical hypotheses namely the accommodationist, structuralist and liquidity preference view were tested using Granger causality test to detect short run causality and cointegration analysis for long run causality. The autoregressive distributed lag model from procedure developed by Shin and Pesaran was used. Empirical results revealed that during the period of direct control monetary policy, there was bidirectional causality between monetary base and bank credit implying that South Africa Reserve Bank exerted some direct control on M_1 . Besides, there was unidirectional causality from bank credit to M_1 multiplier suggesting that from the point of view of the banking system, credit was exogenous, meaning that the monetarist view of money supply exogenously determined by the central bank could be rejected. Other results support the endogenous money hypothesis of Post Keynesians as a unidirectional causality from bank credit to money supply M_1 and bidirectional causality between money income and M_1 were found. These support both accommodationist and structuralist view. Empirical results under indirect control also confirmed the endogenous money hypothesis for South Africa, with unidirectional causality running from bank credit to monetary base, from bank credit to M_1 multiplier, from bank credit to M_2 and from money income to M_1 .

Also the same procedure was followed used by Palacio-Vera (2001) in examining the endogenous money hypothesis in Spain. After unit root test, Granger causality tests were run with five different lag length for the autoregressive distributed lag relation on the following variables in logarithms: monetary base, M_1 money multiplier, M_2 money multiplier, M_3 money

multiplier and loans. Monthly data from 1987 to 1998 were used. To make series stationary, the monetary base and the multipliers for M_1 and M_2 were detrended whereas loans and M_1 multiplier were differenced once. Granger causality test indicated that the causality was running from bank loans to all remaining variables, meaning that money supply was endogenous in Spain. In fact this was in line with both structuralist and accommodationist view.

For Malaysia, the endogenous money hypothesis was examined by Shanmugam, Nair and Li (2003). As in the previous case of South Africa, the central Bank of Malaysia was using M_2 as its monetary target. Non parametric Phillips Perron unit root test and cointegration and error correction model proposed by Engle and Granger to test for Granger causality were used on quarterly data from 1985 to 2000. Only money income and M_1 were cointegrated. In the long run the results confirmed the presence of bidirectional causality between money income and M_1 while in the short run the causality was from money income to M_1 . For other variables which were not cointegrated, the standard Granger procedure was used and results indicated bidirectional causality between total bank loans and M_1 implying that money supply was endogenous in Malaysia. Besides, the long run bidirectional causality between money income and M_1 supply support the accommodationist view and liquidity preference view.

2.4. Overview of empirical literature

The first thing noticeable after reviewing the above studies is the differences in methodology used in studies which had almost similar objectives. This remark concerns especially the studies which aimed to identify factors which explain changes in money supply. Basing on methodology used, these studies can be distinguished in three forms. First studies including Leigen (1964), Gibson (1972), Baghestani and Mott (1988), for United States and Sowa (1993) for Ghana, modeled money supply in a single equation. The common explanatory variables used in those studies were notably high powered money, interest rate, discount rate. The estimation method in the case of United States was two stage least squares because of the issue of endogeneity. Secondly, many studies in developing world especially in Africa used a model with several structural equations. Studies by Sihange (1997), Afiyie (1999) employed behavioral equations

relating the currency ratio, reserve ratio and time deposit ratio to their explanatory variables and other equations relating components of the monetary base (NIA, NDA) to their explanatory variables and an equation relating money supply to the components of the multiplier and the monetary base. The estimation method employed was OLS. Sihonge study had a shortcoming of ignoring the possible problem of endogeneity of some variables in the model. Lastly, other studies on factors influencing money supply changes dealt with determinants of multiplier components only (Beenstock, 1989) or determinants of monetary base only (Kasekende and Atingi-Ego, 2008).

On the other side, studies on endogeneity of money supply have used almost the same methodology that is Granger causality test. All studies confirmed the Post Keynesians hypothesis of endogenous money supply. Besides, they distinguished among view of money supply endogeneity; for South Africa, Nell (2000) supported both accommodationist and structuralist views. The same result was obtained by Palacio-Vera (2001) in Spain. For Malaysia, results confirmed the accommodationist and liquidity preference view whereas for India, Rath (1999) supported the mixed loan demand portfolio model.

The present study tries to take a more encompassing approach by investigating determinants of money supply and testing the endogeneity/exogeneity of money supply in Rwanda. The reviewed studies didn't focus on both aspects and the sole study conducted in case of Rwanda focused only on the analysis of multipliers and their components. Nevertheless changes in monetary base also affect significantly broad money supply as shown in the empirical literature. Besides, economic reforms have encouraged mutations and innovations in financial sector. That is why this study takes a different approach in order to look at the issue of endogeneity/exogeneity of money supply and analyze the influence of components of both multiplier and monetary base on money supply, using appropriate econometric techniques to detect short and long run relationship. The following chapter introduces the methodology used.

CHAPTER THREE

METHODOLOGY

3.1. Introduction

This chapter presents the theoretical framework of the multiplier model which includes also the specification of the model, the estimation techniques and data type and sources.

3.2. Theoretical framework

Stauffer (2006) credits Friedman and Schwartz as well as Cagan to expand the concept of the deposit multiplier to money multiplier. The money multiplier model is well understood by looking at the balance sheet of the central bank particularly its liabilities part. The main components of the liabilities part of the central bank balance sheet are the currency held by non bank public and reserves' holding of the banking sector (Walsh, 2003). The sum of these two major components is the narrowest monetary aggregates usually called monetary base or base money or high powered money. Hence the following identity can be derived

$$H = C + R \dots \dots \dots (1)$$

Where H is monetary base, C is currency in circulation and R is reserves holding of the banking sector. From the above narrowest aggregates, broader aggregates are defined. Those are narrow money M_1 which is the sum of currency in circulation and demand deposits, broad money M_2 which is the sum of M_1 and time deposits (quasi money). From here the following identities are derived:

$$M_1 = C + D \dots \dots \dots (2)$$

$$M_2 = M_1 + T \dots \dots \dots (3)$$

Where D stands for demand deposits, T stands for time deposit. According to Walsh (2003) a traditional approach to understand linkages between monetary base and various measures of

money supply is to express broader measures of money supply as a product of monetary base and a money multiplier. Hence the main equation of the multiplier framework is:

$$M = mH \dots \dots \dots (4)$$

Where M is broader monetary aggregate, m is the multiplier and H is the monetary base. According to Coats and Khatkhate (1979) the monetary base is usually adjusted to remove effects of changes in reserves requirement ratio from the multiplier to the base and remove effects of commercial banks borrowing from the base to the multiplier; any adjustment to the base requires a comparable adjustment to the following definition of the multiplier:

$$m = \frac{M}{H} \dots \dots \dots (5)$$

Depending on which monetary aggregate considered, money multiplier can take different forms. Assume here that M is the broad money M_2 and assume the presence of excess reserves ER . The new definition of monetary base H and broad money M_2 are:

$$H = C + R + ER \dots \dots \dots (6)$$

$$M_2 = C + D + T \dots \dots \dots (7)$$

Where new variable T is time deposits and ER is excess reserves. The currency deposit ratio, the reserves deposit ratio and excess reserves deposit ratio can be derived as follows:

$$cr = \frac{C}{D} \dots \dots \dots (8)$$

$$r = \frac{R}{D + T} \dots \dots \dots (9)$$

$$t = \frac{T}{D} \dots \dots \dots (10)$$

$$er = \frac{ER}{D} \dots \dots \dots (11)$$

Where Cr is the currency deposit ratio, r is the reserve ratio, t is time deposit ratio and er is excess reserve ratio. The above equations imply that:

$$C = crD \dots \dots \dots (12)$$

$$R = r(D + T) \dots \dots \dots (13)$$

$$T = tD \dots \dots \dots (14)$$

$$ER = erD \dots \dots \dots (15)$$

Substituting C, R and ER from equations 8, 9 and 11 into equation 6.

$$H = crD + r(D + T) + erD \dots \dots \dots (16)$$

Manipulating 16.

$$H = crD + r(D + tD) + erD$$

$$H = (cr + r + rt + er)D$$

$$H = [cr + r(1 + t) + er]D \dots \dots \dots (17)$$

Equation 17 implies that,

$$D = \frac{1}{cr + r(1 + t) + er} H \dots \dots \dots (18)$$

Considering equations 12 and 14, equation 18 allows us to write

$$C = \frac{cr}{cr + r(1 + t) + er} H \dots \dots \dots (19)$$

$$T = \frac{t}{cr + r(1 + t) + er} H \dots \dots \dots (20)$$

The sum of the above three equations is the broad money M_2 . Hence,

$$M = \frac{1 + cr + t}{cr + r(1 + t) + er} H \dots \dots \dots (21)$$

The term multiplying H is the money multiplier m.

Assume that the all reserves (required and excess) are included in R the above equation become:

$$M = \frac{1 + cr + t}{cr + r(1 + t)} H \dots \dots \dots (22)$$

If deposits are lumped together in variable D, the result is the multiplier in its basic form as follows:

$$M = \frac{cr + 1}{cr + r} H \dots \dots \dots (23)$$

It is evident that among the components of the above multiplier, there are behavioral variables.

The currency deposit ratio Cr is determined by the behavior of non bank public. The reserve ratio

is determined by banks decisions and central bank policy on discount lending (Hunda, 2000; Walsh, 2003). From the equations above, changes in monetary base, currency deposit ratio, time deposit ratio and reserve deposit ratio are the major factors influencing changes in broad money supply.

3.3. Model specification

3.3.1. Money multiplier model

The model specification is based on money multiplier framework. It relates broad money supply to the components of monetary base and multiplier; the equation to be estimated in this model is the following broad money supply equation adapted from Sibonge (1997).

$$M_2 = \alpha_0 + \alpha_1 NFA + \alpha_2 CGOVg + \alpha_3 NCBANKS + \alpha_4 Cr + \alpha_5 r + \varepsilon_t \dots \dots \dots (24)$$

The choice of the aggregate M_2 is guided by the fact that it is targeted by NBR in monetary policy implementation. M_2 , net foreign assets (NFA), domestic credit to government (CGOV) and net domestic credit to banks (NCBANKS) are measured in Rwandan francs. According to the theory, $\alpha_1, \alpha_2, \alpha_3$ are positive. The increase in net foreign assets stimulates domestic credit (Ogun & Adenikinju, 1995) and with liberalization, an inflow of foreign funds increase monetary base (Rath, 1999). Hence the broad money supply also increases. The same goes to domestic credit to government which also boosts domestic credit, monetary base and broad money supply. Moreover, an increase in net domestic credit to banks improves the lending capacity of banking sector, consequently increases broad money supply.

Meanwhile, α_4 and α_5 are negative. An increase in public demand for currency happens at the expenses of deposits in banks and leads to an increase in currency deposit ratio. This decreases the lending capacity of the banking system and broad money supply. Similarly, an increase in reserve deposit ratio reduces the lending capacity of the banking system thus the broad money supply decreases.

3.3.2 Endogenous/exogenous money model

The test of endogeneity/exogeneity of money supply is one of the objectives of this study. The issue here is not to go far by testing whether money supply process in Rwanda is in accordance with the different views in endogenous money hypothesis namely accommodationist or structuralist view. The sole aim is to test whether money supply process in Rwanda follows the Monetarists view of exogenous money supply where causality runs from the monetary base and broad money to total banks loans or follows the Post Keynesians view of endogenous money where causality runs from total banks loans to the monetary base and broad money. Therefore variables used are total banks loans, monetary base and broad money M_2 all measured in Rwandan francs. Granger causality test is employed to test for endogeneity/exogeneity of money supply in Rwanda. This study considers the following Autoregressive distributed lag procedure already used by Palacio-Vera (2001) for Spain.

$$y_t = \alpha_0 + \sum_{i=1}^p \delta_i y_{t-i} + \sum_{i=0}^q \beta_i x_{t-i} + \varepsilon_t \dots \dots (25)$$

Where y and x stands for variables total banks loans, monetary base and broad money and ε is the error term. The optimal lag length p and q is determined by Akaike information criterion and Schwartz Bayesian criterion.

To detect the long run causality, following Zell (2000) cointegration analysis and error correction model is used. The long run relationship is given by:

$$y_t = \beta_0 + \beta_1 x_t + u_t \dots \dots (26)$$

Residuals from this equation (26) are utilized in the following error correction model

$$\Delta y_t = \delta_0 + \sum_{i=1}^r \delta_i \Delta y_{t-i} + \sum_{i=0}^s \delta_{i+1} \Delta x_{t-i} + \alpha u_{t-1} + \varepsilon_t \dots \dots (27)$$

Where u_{t-1} is the lagged error term derived from equation (26) ϵ is the short run random error term. If the variables are found to be cointegrated, the statistical significance of error term is helpful to detect long run causality by determining whether a given variable is weakly exogenous. As put by Granger (1988 cited in Nell, 2000) if variables are cointegrated, causality must exist at least in one direction.

3.4. Definitions and measurement of variables

The currency deposit ratio (Cr): is calculated as a ratio of currency in circulation over total demand deposits.

The reserve deposit ratio (r): is measured as a ratio of total banks reserves over total deposits.

Broad money supply (M_2): is the sum of currency outside banks, demand deposits other than those of the central government, and the time, savings, and foreign currency deposits of resident sectors other than the central government.

Domestic credit to government (CGOV): refers to credit from NBR to the government. It is measured in Rwandan francs

Net domestic credit to banks (NCBANKS): refer to net domestic credit from NBR to other financial institutions of the rest of the economy excluding the government. It is measured in Rwandan francs.

Net foreign assets (NFA): are the sum of foreign assets held by monetary authorities and deposit money banks, less their foreign liabilities. They are in Rwandan francs.

Total banks loans: is measured as the sum of credits from commercial banks to private sector and is measured in Rwandan francs.

Monetary base: is the sum of currency and banks reserves. It is measured in Rwandan francs.

3.5. Data types, sources and collection

Monthly data from January 1995 to September 2009 were obtained from the National Bank of Rwanda. This covered essentially the period after structural adjustment reforms which were implemented from 1990. Since 1995 the financial sector in Rwanda is liberalized.

3.6. Data analysis

3.6.1. Time series properties

Monthly time series data from January 1995 to September 2009 are used in this study. To apply standard estimation or testing procedures in a dynamic time series model, the stationarity of variables is required (Verbeek, 2004). Hence for the first model (money multiplier model) the stationarity test is conducted using Augmented Dickey Fuller (ADF) and Phillips Perron (PP) tests in order to test for unit root in variables. For the second model (endogeneity/exogeneity), aforementioned stationarity tests are conducted and variables converted into stationary series before proceeding with Granger causality test. Data analysis is performed using Eviews 5

3.6.2. Estimation techniques

According to Engle and Granger (1987, p.251) "If each element of a vector of time series x_t first achieves stationarity after differencing, but a linear combination $\alpha'x_t$ is already stationary, the time series x_t are said to be co-integrated with co-integrating vector α " therefore, in the

first case of money multiplier framework model, after stationarity tests, cointegration technique and error correction modeling are used to capture both long run and short run relationships

To test the existence of that long run stable relationship, two main approaches are usually used. Firstly there is Engle and Granger approach which is appropriate in the case of a single equation with not more than 2 variables, one being weakly exogenous. In the case of more than two variables, there might be more than one cointegration vectors and the multivariate VAR approach developed by Johansen (1988) is more appropriate (Harris, 1995). Therefore, this study uses Johansen approach.

The Johansen approach is based on the following unrestricted vector autoregressive model,

$$X_t = A_1 X_{t-1} + \dots + A_k X_{t-k} + \mu + D_t + \varepsilon_t$$

Where X_t is an $(n \times 1)$ vector, A_i is an $(n \times n)$ matrix of parameters, n is the number of endogenous variables, k is the number of lags, μ is the constant and D is a vector of deterministic variables and ε is the error term.

The previous equation can be reformulated into the following vector error correction form (VECM):

$$\Delta X_t = \Gamma_1 \Delta X_{t-1} + \dots + \Gamma_k \Delta X_{t-k} + \Pi X_{t-k} + \varepsilon_t$$

Where $\Gamma_i = (I - A_1 - \dots - A_i)$, $(i=1, \dots, k-1)$ contains information on short run adjustment to changes in variables in vector X , and Π is $-(I - A_1 - \dots - A_k)$ and contains information on long run relationship among variables in the model and can be split into $\Pi = \alpha\beta$ where α contains short term adjustment coefficients and β is a matrix of long run coefficient such that $\beta' X_{t-k}$ represents up to $n-1$ cointegration relationships (Harris, 1995). The rank of matrix Π , is r and determine the number of cointegration vector. In this approach, Trace test statistics and Maximum eigenvalue test statistics are used to test for reduced rank in Π , that is whether r is between 0 and n ($0 < r < n$).

In the second model, to test for endogeneity exogeneity of money supply, standard Granger procedure will be used to detect short run causality and cointegration analysis using Engle Granger approach to detect long run causality between broad money, monetary base and total bank loans.

3.6.3. Diagnostic tests

To determine whether the model is acceptable, several diagnostic tests are performed to check for normality, autocorrelation and heteroscedasticity of the residuals. Autocorrelation LM test is carried out to check for residuals serial correlation. Jarque-Bera test for normality is performed to check for normality and White heteroscedasticity test to check for heteroscedasticity.

CHAPTER FOUR

EMPIRICAL RESULTS

4.1. Introduction

This chapter presents the empirical results of this study. It includes the stationarity tests of all variables, cointegration and error correction model results for the money multiplier model, its diagnostic tests and results from causality tests for the endogenous/exogenous money model. Following the objectives of this study, determinants of money supply are identified with emphasis on the effects of domestic credit to government and net foreign assets on money supply.

4.2. Stationarity analysis of variables

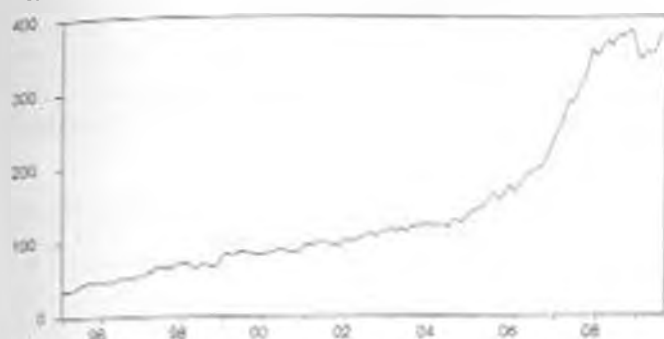
The use of time series in empirical analysis requires studying statistical characteristics of variables in order to examine if the series are stationary. Several difficulties arise when data contain unit roots. The use of such non stationary series is problematic as the econometric estimations leads to spurious regression, whereby the results suggest the existence of statistically significant relationship between variables in the model while in fact it is contemporaneous correlation rather than meaningful causal relation (Harris, 1995). That is why it was crucial to analyze the time series properties of all variables used in this study before proceeding to estimation.

4.2.1. Graphical analysis

In this section, graphs of variables broad money supply, credit to government, net credits to banks, reserve ratio, net foreign assets, currency ratio, broad money supply in logarithm, monetary base in logarithm and total banks loans in logarithm used in both models, are depicted

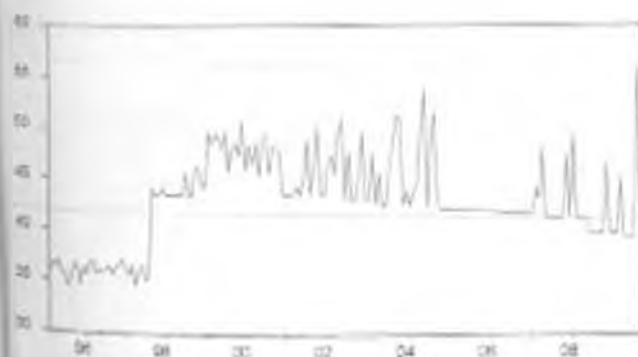
to check for possible trends and structural breaks in data. On vertical axis there are values in billions of RWF except for variables in logarithm, currency ratio and reserve ratio. On the horizontal axis there are years.

Figure 4.1: Broad money supply in RWF billions.



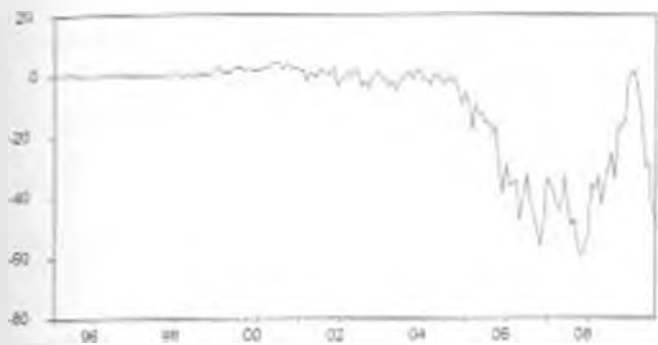
The figure above shows an upward trend in broad money supply from 1995 to 2009. From 1995 to 2006 the increase was steady and this was due mainly to financial sector liberalization which started in 1995 and an inflow in net foreign assets especially budget support from donors. From 2007 with the advent of microfinance institutions, the rate of increase shot up due to domestic credit from financial institutions as well as budget support from donors although in 2009, broad money supply declined slightly in the aftermath of the global financial crisis.

Figure 4.2: Credit to government in RWF billions



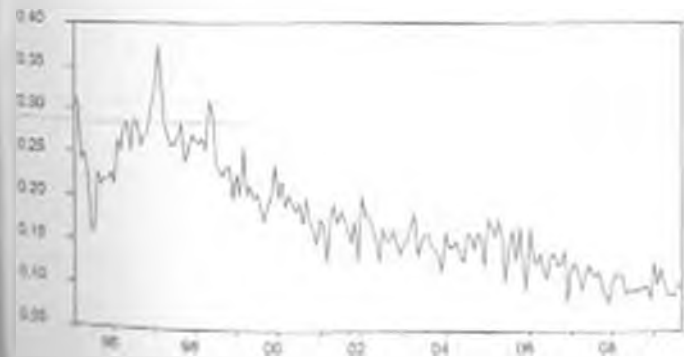
Domestic credit to government does not show any clear trend: from 1995 to mid1997 it was stable around 35 billions RWF, toward the end of 1997, there was an upsurge as public expenditures went up due to the massive return of refugees. From 1998 it has been fluctuating around 45 billions RWF despite a permanent increase in revenue collected. The delay in disbursement of funds from donors is the main cause for those fluctuations.

Figure 4.3: Net credit to banks in RWF billions



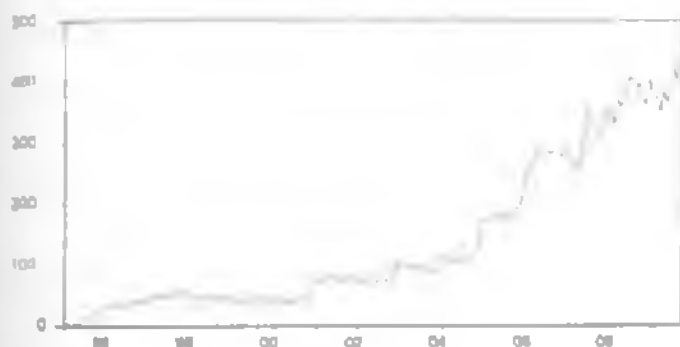
The figure above illustrate that there have been no significant change in net credit to banks from 1995 to 2004. From 2004 to 2007, the improvement in banking sector liquidity and establishment of interbank market caused a sharp decline in net credit to banks. However from 2008, net credit to banks increased as the NBR was trying to support the financial sector during the crisis to ensure banking system liquidity

Figure 4.4: Reserve deposit ratio.



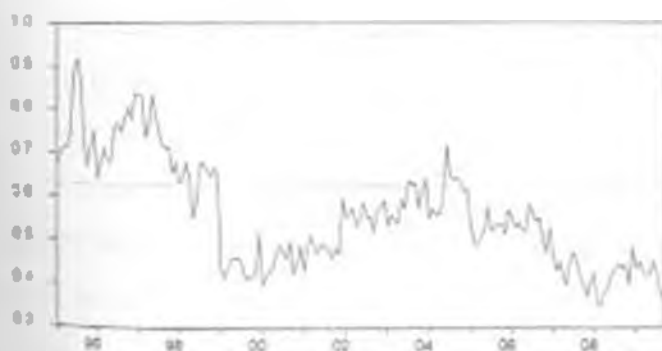
The reserve deposit ratio has a downward trend. This has been due to many factors such as the improvement in banking system liquidity, establishment of interbank market and a decrease in legal reserves requirement where in 1997 and 1998 the rate was reduced from 14% to 10%. All these factors have reduced risks in banks liquidity management and consequently banks demand for reserves have declined overtime although that decline was not smooth as banks continued to hold fluctuating excess reserves for precautionary reasons

Figure 4.5: Net foreign assets in RWF billions



Net foreign assets show an upward trend. The reasons behind are among others the increase in net transfers from abroad, improvement in exports, tourism and foreign investment inflows

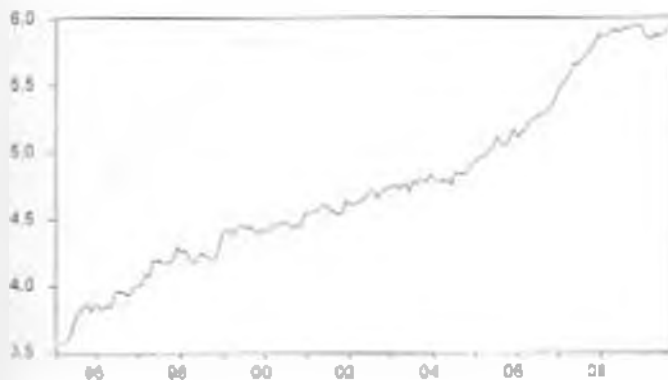
Figure 4.6: Currency deposit ratio.



The currency ratio graph does not show any clear trend. In fact it increased sharply in 1995 in the aftermath of 1994 genocide and civil war as at that time, the banking sector was still ruined and the degree of urbanization was still low. In 1997 the currency ratio was still higher and dropped sharply in 1999 due an increase in deposits as banking activities were expanding. From 1999, the currency ratio continued to fluctuate around 0.5 till 2007 when it started to decline again as the reach out of financial institutions was improving with the arrival of microfinance institutions.

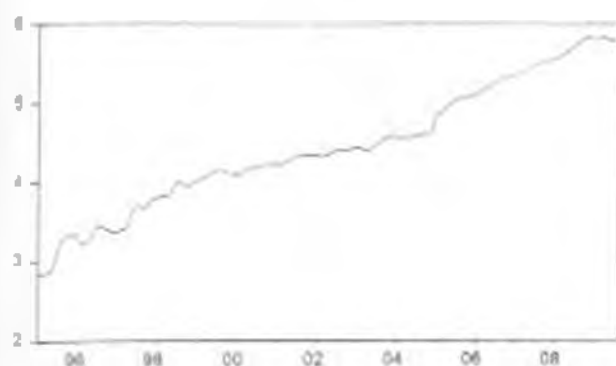
Apparently, there are no common structural breaks in the series, even though in case of domestic credit to government, the graph displays a sudden upsurge around year 1998. These graphs give the impression that these variables are not stationary especially net domestic credit to banks, net foreign assets and broad money supply. The graphs of variables in the endogenous exogenous money model are displayed below.

Figure 4.7: Broad money supply in logarithm



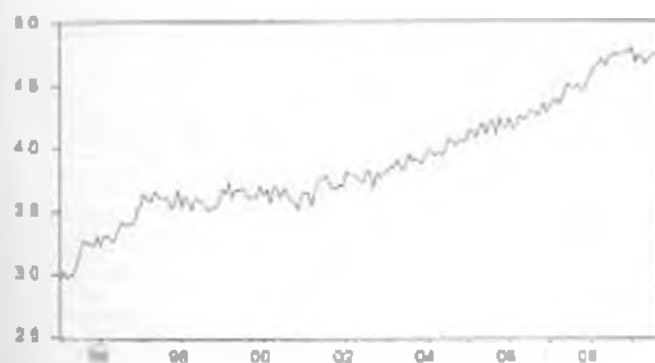
The figure above illustrates the evolution of broad money supply in logarithm. It is obvious that the broad money supply has been increasing from 1995 to 2009 as the graph shows a clear upward trend given that deposits in banking system and banks loans were increasing overtime. However there were some slight fluctuations, like in 2009, where broad money supply declined slightly because of the global financial crisis.

Figure 4.8: Total banks loans in logarithm.



Total banks loans show an upward trend from 1995 to mid 2008 as in that period, the financial system was developing as a result of financial liberalization. However, from mid 2008 to 2009 there has been a slight credit crunch in the aftermath of the global financial crisis.

Figure 4.9: Monetary base in logarithm.



Monetary base in logarithm also shows upward trend. This is due to an increase in its components (net foreign assets and net domestic assets) overtime.

It is clear that all the three graphs depicted above trend upward and it seems that they don't show any structural break. The presence of trends may suggest non stationarity.

4.2.2. Unit root tests

Although there are various test of stationarity, this study considers two mostly used tests namely the Augmented Dickey Fuller (ADF) test (1981) and Phillips Perron (PP) test (1988) in order to check the presence of unit roots and identify the order of integration of variables. Data used are monthly spanning from 1995 to 2009. The graphical analysis does not indicate any structural break.

Starting with variables in the money multiplier model, a constant was included in the regression model as the true mean of the data generating process was unknown. The time trend was included in some regression when it was found to be statistically significant. In ADF test, after setting the maximum lags length at 13, the number of lags was selected basing on Schwarz Information Criteria (SIC) while in PP test, the optimal lag length was selected basing on Newey-West technique. Two tables below display the results of ADF and PP unit root test. The null hypothesis is that data contain unit root. The results are displayed in the following table

Table 4.1: ADF test for unit root in levels for variables in money multiplier model

Variables	Trend	Lags	ADF	Probability	Decision
Broad money	no	7	0.811116	0.9940	Do not reject the null
Domestic credit to government	no	2	-2.729545	0.0711*	Do not reject the null
Net domestic credit to banks	yes	0	-2.458261	0.3485	Do not reject the null
Net foreign assets	yes	8	-0.414170	0.9863	Do not reject the null
Currency ratio	yes	0	-3.415491	0.0526*	Do not reject the null
Reserve ratio	yes	1	-4.777291	0.0007***	Reject the null, I (0)

i * indicates significance at 10% level, *** indicates significance at 1% level

ii I(0) means that series are integrated of order 0 or stationary in levels.

As shown in table 4.1, basing on MacKinnon one sided p values, the null hypothesis of the presence of unit root cannot be rejected for M_2 , net domestic credit to banks and net foreign assets. Thus those series are not stationary in levels. For currency ratio and domestic credit to government, the results from ADF test also do not reject the presence of unit roots in their levels at 1% and 5% level of significance though the test reject the null at 10% level of significance. For the reserve ratio, result from the test rejects the null hypothesis of the presence of unit root. To confirm these results, PP test was conducted and the table 4.2 below exhibits the results.

Table 4.2: PP test for unit root in levels for variables in money multiplier model

Variables	Trend	Lags	PP	Probability	Decision
Money	no	0	1.729562	0.9997	Do not reject the null
Domestic credit to government	no	0	-5.818488	0.0000***	Reject the null; I(0)
Net domestic credit to banks	yes	0	-2.411146	0.3725	Do not reject the null
Net foreign assets	yes	0	-0.722124	0.9693	Do not reject the null
Currency ratio	yes	0	-3.328189	0.0651*	Do not reject the null
Reserve ratio	yes	0	-6.785025	0.0000***	Reject the null; I(0)

* Indicates significance at 10% level.

*** Indicates significance at 1% level.

I(0) means that series are integrated of order 0 or stationary in levels

Basing on MacKinnon one sided p values, PP test confirmed that the null hypothesis of the presence of unit root cannot be rejected for M_2 , net domestic credit to banks, and net foreign assets, meaning that they are not stationary in levels. Similarly, PP test confirmed the result for the currency ratio as the null was rejected only at 10% level of significance. For the reserve ratio and domestic credit to government, the null hypothesis was rejected at 1% level of significance

From the two tests performed on variables in money multiplier model, M_2 , net domestic credit to banks and net foreign assets are clearly not stationary, while the reserve ratio is stationary. For domestic credit to government, ADF test rejected non stationarity only at 10% whereas PP test rejected non stationarity at 5%. Thus this variable can be considered as stationary too and along with the reserve ratio, they are integrated of order zero (0). However, for the currency ratio, both tests could reject the null only at 10% level of significance hence the currency ratio is not stationary.

To check for the order of integration in non stationary variables in table 4.2, M_2 , net domestic credit to banks, net foreign assets and currency ratio were differenced once. The regression model of this differenced series included a constant, but no trend. The optimal lag length was chosen according to SIC in ADF test and Newey-West technique in PP test. The results are shown in the following tables.

Table 4.3: ADF test for unit root in first difference for variables in money multiplier model

Variables	Constant	Lags	ADF	Probability	Decision
Δ Broad money	yes	6	-2.812578	0.0586*	Do not reject the null
Δ Net domestic credit to banks	yes	0	-14.33397	0.0000***	Reject the null. Series is I(1)
Δ Net foreign assets	yes	7	-5.577811	0.0000***	Reject the null. Series is I(1)
Δ Currency ratio	yes	1	-12.1935	0.0000***	Reject the null. Series is I(1)

i. * indicates significance at 10% level, *** indicates significance at 1% level

ii. I(1) means integrated of order 1 or stationary in the first difference

iii. Δ is the first difference

According to MacKinnon p values, results from ADF test on variables in their first difference indicate that net domestic credit to banks, net foreign assets and currency ratio are stationary in their first difference as the null hypothesis of non stationarity is rejected at 1% level of significance. For broad money the null is only rejected at 10% level. To confirm these, the table 4.4 displays PP test results.

Table 4.4: PP test for unit root in first difference for variables in money multiplier model

Variables	Constant	Lags	PP	Probability	Decision
Δ Broad money	yes	0	-10.896	0.000***	Reject the null. Series is I(1)
Δ Net domestic credit to banks	yes	0	-14.333	0.000***	Reject the null. Series is I(1)
Δ Net foreign assets	yes	0	-14.639	0.000***	Reject the null. Series is I(1)
Δ Currency ratio	yes	0	-16.991	0.000***	Reject the null. Series is I(1)

i. * indicates significance at 10% level, *** indicates significance at 1% level.

ii. I(1) means integrated of order 1 or stationary in first difference.

iii. Δ is the first difference.

The MacKinnon one sided p values reveal that the null hypothesis of the presence of unit root in differenced series is rejected for all four variables, implying that M_2 , net domestic credit to banks, net foreign assets and currency ratio are integrated of order 1. In this case, M_2 in its first difference is found to be stationary as the null is rejected at 1% level of significance. Hence using on both ADF and PP tests, all four variables are integrated of order 1

To check for stationarity of variables in the endogenous money model, the same process was followed and the results obtained are reported in the tables below.

Table 4.5: ADF test for unit root in levels for variables in endogenous money model

Variables	Trend	Lags	ADF	Probability	Decision
Log of broad money	yes	0	-1.638572	0.7654	Do not reject the null
Log of total banks loans	yes	1	-2.978017	0.1414	Do not reject the null
Log of monetary base	yes	2	-1.985762	0.6046	Do not reject the null

For all variables in the table 4.5, the null hypothesis of the presence of unit root is not rejected according to results from ADF test. To confirm this result the PP test is conducted and its results are shown in table 4.6:

Table 4.6: PP test for unit root in levels for variables in endogenous money model

Variables	Trend	Lags	PP	Probability	Decision
Log of broad money	yes	0	-1.669487	0.7607	Do not reject the null
Log of total banks loans	yes	0	-2.625491	0.2696	Do not reject the null
Log of monetary base	yes	0	-2.778786	0.2072	Do not reject the null

The above results indicate clearly that all series are not stationary in their levels. Note that in this case, series were transformed into logarithms.

As in the previous case, the series were differenced once to determine the order of integration of all variables. The table 4.7 reports results of ADF test on differenced series;

Table 4.7: ADF test for unit root in first difference for variables in endogenous money model

Variables	Constant	Lags	ADF	Probability	Decision
Δ Log of broad money	yes	0	-13.67171	0.0000***	Reject the null Series is I(1)
Δ Log of total banks loans	yes	0	-9.155950	0.0000***	Reject the null Series is I(1)
Δ Log of monetary base	yes	1	-13.48594	0.0000***	Reject the null Series is I(1)

*** indicates significance at 1% level.

ii I(1) means integrated of order 1 or stationary in first difference

iii Δ is the first difference

Considering MacKinnon one sided p values, the null hypothesis is rejected at 1% level of significance for all variables in their first difference. Hence they are integrated of order one.

Table 4.8: PP test for unit root in first difference for variables in endogenous money model

Variables	Constant	Lags	PP	Probability	Decision
Δ Log of broad money	yes	0	-13.67193	0.0000***	Reject the null. Series is I(1)
Δ Log of total banks loans	yes	0	-9.091450	0.0000***	Reject the null. Series is I(1)
Δ Log of monetary base	yes	0	-21.65588	0.0000***	Reject the null. Series is I(1)

ii. $I(1)$ means integrated of order 1 or stationary in first difference

iii. Δ is the first difference.

PP test confirms that variables M_2 , total banks loans and monetary base in logarithm become stationary in first difference. Thus, they are integrated of order one.

4.3. Cointegration analysis

The unit root tests in the previous section have shown that four variables in money multiplier model namely M_2 , net domestic credit to banks, currency ratio and net foreign assets are integrated of order 1 whereas reserve ratio and domestic credit to government are stationary in their levels. Due to the presence of non stationary variables, long run relationships can be detected if variables are cointegrated. Engle and Granger (1987) have shown that a stable long run relationship may exist between non stationary variables.

This study uses Johansen approach. This has some implications when all variables are not integrated of order one. Nevertheless, Harris (1995) insists that cointegration can still be present when stationary variables are included in the model especially if theory suggests that such variables should be included.

4.3.1. Cointegration test

Before testing for reduced rank, the optimal lag length in the VAR model was determined basing on AIC and was set at 8 lags. In fact, the AIC and SIC gave different results about the optimal lag order (8 and 0 respectively) and 8 lags were chosen in order to reduce possible correlation. Besides, the fact that some of the variables exhibit linear deterministic trend in their levels, the

model (model 4) which allows intercept and trend in cointegration equation and VAR was chosen. Table 4.9 reports the results of the Johansen cointegration test.

Table 4.9: Johansen cointegration test for reduced rank results

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	5 Percent Critical Value	1 Percent Critical Value
None **	0.226183	151.0920	114.90	124.75
At most 1 **	0.178111	107.9483	87.31	96.58
At most 2 **	0.136242	74.99515	62.99	70.05
At most 3 **	0.126219	50.38944	42.44	48.45
At most 4 *	0.105030	27.72195	25.32	30.45
At most 5	0.052612	9.079736	12.25	16.26

*(**) denotes rejection of the hypothesis at the 5%(1%) level

The trace test indicates the presence of 5 cointegrating equations at 5% level; this number is higher due to the fact that the inclusion of stationary variables in the test increases the number of cointegrating relations. Therefore, some cointegration vectors are associated with the presence of stationary variables namely domestic credit to government and reserve ratio. This confirms that there is a stable long run relationship among variables in the money multiplier model.

With normalized cointegration coefficients the long run relationship was identified in the first cointegration equations. The results are reported in the table 4.10 below;

Table 4.10: Johansen cointegration results

	M_2	NCBANKS	NFA	r	Cr	CGOV
Normalized β coefficients	1.00000	-4.237***	-1.769***	4.82 ¹¹ ***	-1.57 ¹¹ **	-10.062***
		(0.73798)	(0.19290)	(1.5 ¹¹)	(6.7 ¹⁰)	(2.33241)
Adjustment coefficients α						
	0.023381	0.027088	0.135***	-1.34 ¹³	6.10 ¹³ **	0.0293**
	(0.0265)	(0.02619)	(0.05111)	(1.2 ¹³)	(2.3 ¹³)	(0.01461)

i Value in () are standard errors.

ii *** indicates significance at 1% level, ** indicates significance at 5% level

iii. M_2 is broad money supply, NCBANKS is net domestic credit to banks, NFA is net foreign assets, r is reserve ratio, Cr is currency ratio and CGOV is domestic credit to government

These results indicate that, in the long run, net domestic credit to banks, net foreign assets, currency ratio and domestic credit to government have a positive effect on M_2 while r has a negative impact. This is in accordance with economic theory except the sign of Cr which is positive while its influence was expected to be negative.

The coefficient of net domestic credit to banks is statistically significant at 1% level of significance and its magnitude implies that in the long run a unit increase in net credit to banks from the central bank lead to a 4.23 unit increase in M_2 . It is obvious that the financing activities of the NBR towards private banks and public sector exert a big positive influence on broad money supply in Rwanda. Given that from 1995, Rwanda had started to liberalize its financial sector, this proves that private banks are major players in the money supply process due to their increased autonomy.

Similarly, the coefficient of domestic credit to government is significant at 1% level of significance and a unit increase in credit to government leads to a 10 unit increase in M_2 in the long run. This is in accordance with the findings from other studies in developing countries as Afriyie (1999) who had found credit to government to be among the main determinants of money supply in Ghana with a positive influence. The coefficient of domestic credit to government shows that even though with reforms, the government has started to raise funds on the market, credit from NBR can still put a big pressure on broad money supply in Rwanda.

Likewise, a unit increase in net foreign assets leads to a 1.7 unit increase in M_2 and the coefficient is statistically significant at 1% level of significance. Other studies in developing countries had also concluded on a significant impact of net foreign assets on money supply; Sibonge (1997) and Afriyie (1999) identified net foreign assets as one of the main determinants of money supply with a positive impact in Botswana and Ghana, respectively.

These results prove that in the long run changes in monetary base components exert a significant influence on changes in broad money supply in Rwanda. In the past, Sowa (1993) had revealed a significant positive impact of monetary base to money supply in Ghana while in Uganda, Kasenkende and Atingi-Ligo (2008) also revealed that in the long run, intervention on foreign exchange market, net saving by the government and Treasury bill rate had a strong impact on supply of monetary base.

About the currency ratio, its coefficient is significant at 5% level of significance but its positive sign was unexpected. Actually, economic theory predicts a negative relationship with money supply and empirically, Sowa (1993) had found negative relationship in Ghana whereas Sibonge (1997) didn't find any significant impact in case of Botswana. This positive sign in case of Rwanda might be due to the fact that the public demand for currency is part of demand for money and increase with GDP and inflation. As the NBR target the monetary aggregates to keep the equilibrium between money demand and supply, the increase in money demand with cash demand would consequently result in a growth in broad money supply.

The reserve ratio coefficient is significant at 1% level of significance and its negative sign was expected according to the theory. Both Sowa (1993) and Afriye (1993) revealed the same result in Ghana, as well as Sibonge (1997) in case of Botswana.

From the above long run relationship, the influence of net foreign assets is not as big as the one of domestic credit to government and net domestic credit to banks. This suggests that NBR has managed to cope with on one hand the recurrent trade deficits and on the other hand the surge in aid and loans from bilateral and multilateral partners in the effort of reconstruction. In addition, the magnitude of the reserve ratio coefficient implies that commercial banks liquidity management has a strong impact on broad money supply in Rwanda.

4.3.2. Diagnostic tests

Diagnostic test of the parsimonious VEC model gave mixed results. There is no problem of serial correlation as the LM statistic for serial correlation at 8th lag is 47.27 and does not reject the null hypothesis of absence of serial correlation. Normality test also does not reject the null hypothesis of normality as Jarque-Bera test probability is 0.99. However, white heteroscedasticity tests show that there is a problem of heteroscedasticity. Nevertheless the parsimonious VEC model was estimated and results are in the following section.

4.3.3. Vector error correction model results

Since variables in the model were found to be cointegrated, their dynamic relationship can be specified by an error correction representation. Firstly, the general VECM was estimated including 8 lags of differenced endogenous variables and the insignificant variables were removed to get a parsimonious VECM. The estimates of general VECM are presented in the appendix. Table 4.11 reports estimates of the parsimonious VECM.

Table 4.11: Estimates of parsimonious VEC model

Regressors	Coefficients	Standard errors	T test statistics
Δ Broad money supply(-1)	-0.282165	0.07055	3.99941
Δ Broad money supply(-4)	-0.310219	0.07330	4.23218
Δ Broad money supply(-6)	0.233692	0.07471	-3.12799
Δ Broad money supply(-7)	-0.287315	0.07540	3.81056
Δ Net foreign assets(-7)	0.061898	0.03357	-1.84391
Δ domestic credit to government (-7)	0.313588	0.12599	-2.48892
Δ Net foreign assets(-8)	0.073067	0.03331	-2.19366
Observations:	168		
R-squared	0.280100	Log likelihood	-3972.532
Adj. R-squared	0.243878	Akaike AIC	47.39919
Sum sq. resid	3.40E+21	Schwarz SC	47.56654
S.E. equation	4.62E+09	Mean dependent	1.96E+09
F-statistic	7.732986	S.D. dependent	5.32E+09
i	Δ is difference		
ii	Values in () are number of lags		

The results show that in the short run, only net foreign assets, net domestic credit to banks and domestic credit to government have statistically significant positive impacts on M_2 . Besides, the general VECM indicates that the speed of adjustment of M_2 to its long run equilibrium from disturbance of net foreign assets and domestic credit to government is 13.55% and 2.9% respectively per month. Again this is another proof that the NBR has managed to cope with Rwandan balance of payments problems while in case of disturbance from credit to government, the broad money supply remains in disequilibrium for relatively longer period.

Restrictions were placed on adjustment coefficients in the full model in order to test for weak exogeneity of variables: the results indicated that at 5% level of significance, net domestic credit to banks, domestic credit to government, currency ratio and reserve ratio are weakly exogenous to M_2 with Chi square test probability of 0.39, 0.08, 0.06 and 0.39 respectively.

4.4. Effect of domestic credit to government on money supply

The magnitude of the coefficient of domestic credit to government revealed that government finances do matter, and have a strong positive influence on money supply in Rwanda. In fact, one unit increase in NBR credit to government leads to 10 units increase in M_2 in the long run whereas in the short run, the impact is rather lower as one unit increase in NBR credit to government lagged by 7 months increase M_2 by 0.31 unit. Since Rwanda national budget is still depending for almost its half on foreign financing which disbursements delay sometimes, NBR is still providing credit to the government, despite the increasing participation of the private sector especially banks in Government Treasury bills market. Thus, the funds obtained by the government from NBR are immediately injected in the economy. Compared to the effect from other components of monetary base (net domestic credit to banks and net foreign assets), credit from NBR to government puts a bigger pressure on broad money supply in Rwanda. Consequently, fiscal problems may undermine NBR's monetary management by drastically increasing money supply. Other studies in Africa (Afriyie, 1999; Sowa, 1993) identified credit to government to be among the main determinants of money supply in Ghana with a positive influence.

4.5. Effect of net foreign assets on money supply

Net foreign assets exert a positive influence on broad money supply in Rwanda as it was expected. A unit increase in net foreign assets leads to a 1.7 unit increase in M_2 in the long run, while the short run net foreign assets lagged by 7 and 8 months raise M_2 by 0.061 and 0.073, respectively. This influence is relatively lower than the one of domestic credit to government. Given the fact that Rwanda has been experiencing balance of payments problems (recurrent trade deficits, large inflows of aid, loans and capital from abroad in reconstruction efforts) and

NBR has slight control on flows in net foreign assets, this result indicates that NBR has managed to cope with that critical situation and keep money stock relatively in control. The exchange rate policy pursued by NBR also may have been a key as NBR carried out sterilization operations whenever necessary. Some of studies in Africa (Killick and Mwega, 1990; Sibonge, 1997; Afriyic, 1999) had also identified net foreign assets to be among the driving forces behind changes in money supply in Kenya, Botswana and Ghana, respectively.

4.6. Endogeneity/exogeneity of money supply

4.6.1. Short run causality analysis

In this section, endogenous money hypothesis is tested using monthly data of total banks loans (CREDESP), monetary base (MB) and broad money supply (M_2). This study does not distinguish between accommodationist, structuralist and liquidity preference views within the endogenous money hypothesis. Rather it contrasts empirically the Post Keynesian view of endogenous money where causality runs from bank loans to monetary base and broad money supply, and the monetarist view where the central bank can exogenously control the monetary base to achieve a targeted level of money supply, implying causality from monetary base to money supply and bank loans.

Before proceeding with Granger causality test, it is crucial to check for stationarity of data which is a requirement for the implementation of Granger causality tests (Granger, 1969; cited in Mario-Vera, 2001). In the previous section, stationarity analysis has shown that variables total banks loans, monetary base and M_2 transformed in logarithms were not stationary in their levels, but were stationary in the first difference.

Therefore, these series were differenced once to make them stationary and Granger causality test were conducted using five different lags on the autoregressive distributed lag model. This is a standard Granger causality test which detects short run causality. The long run causality is examined via cointegration and error correction model. But firstly, the results of standard Granger causality test are reported in the table 4.12.

Table 4.12: Standard Granger causality tests

Null hypotheses	2 Lags	3 Lags	4 Lags	8 Lags	12 Lags
Broad money supply does not Granger cause total banks loans	1.16008 (0.31595)	0.78624 (0.50317)	0.60319 (0.66087)	1.99981 (0.05005)	1.20843 (0.28309)
Total banks loans does not Granger cause broad money supply	3.36788 (0.03679)*	3.49163 (0.01703)*	3.65159 (0.00706)**	1.97407 (0.05331)	0.98493 (0.46634)
Monetary base does not Granger cause Total banks loans	0.02934 (0.97110)	0.06814 (0.97679)	0.20957 (0.93283)	0.91095 (0.50913)	1.18636 (0.29860)
Total banks loans does not Granger cause Monetary base	3.39833 (0.03573)*	3.28380 (0.02230)*	2.33991 (0.05731)	2.10493 (0.03857)*	1.63118 (0.08952)
Monetary base does not Granger cause Broad money supply	0.85579 (0.42678)	0.64281 (0.58853)	0.50266 (0.73382)	0.33195 (0.9525)	0.27785 (0.99187)
Broad money supply does not Granger cause monetary base	7.42992 (0.00081)**	4.80619 (0.00309)**	3.49232 (0.00914)**	1.17498 (0.3177)	1.04550 (0.41124)

i. * indicates that the null can be rejected at 5% level, ** indicates that the null can be rejected at 1% level.

ii. Values in () are F statistics probabilities.

The above results, based on F test, show that in 2, 3 and 4 lags, there is unidirectional causality which runs from bank loans to broad money supply M_2 . With 2 and 3 lags the null hypothesis is rejected at 5% level of significance, whereas at the fourth lag, it is rejected at 1% level of significance. For 8 and 12 lags there is no causality in either direction.

In addition, the null hypothesis that total bank loans does not Granger cause monetary base is rejected at 2, 3 and 8 lags at 5% level of significance. Thus, that result indicates a unidirectional causality from bank loans to monetary base in those three different values of the lag length as the null hypothesis that monetary base does not Granger cause total bank loans is not rejected for all five different values of the lag length. Obviously, these results suggest that the causality runs

from total bank loans to broad money supply M_2 and monetary base in short run, thereby supporting endogenous money hypothesis.

On the other side, the null hypothesis that broad money supply M_2 does not Granger cause change in monetary base, is rejected for 2, 3 and 4 lag length at 1% level of significance. Meaning that in the short run, causality runs from broad money supply M_2 to monetary base. Since the null hypothesis that monetary base does not Granger cause broad money supply is not rejected for all five values of the lag length, this evidence does not support the monetarist view of causality running from monetary base to broad money supply M_2 in the short run. Previously, results from Palacio-Vera (2001) for Spain, Rath (1999) for India and Shanmugam, Nair and Li (2003) for Malaysia had confirmed the Post Keynesian endogenous money hypothesis basing on standard Granger causality test.

4.6.2. Long run causality analysis

In order to detect the long run causality, cointegration and error correction model were applied. According to Engle and Granger (1987), if elements of vector X are integrated of order one while their linear combination is stationary, the time series X are said to be co integrated. Besides, if variables are cointegrated, causality must exists at least in one direction and the error correction term is used to test for weak exogeneity.

As reported in previous sections, variables total banks loans, monetary base and M_2 in logarithms are integrated of order one. Following Engle and Granger procedure, residuals from the linear combination of those variables were analyzed to examine whether they are cointegrated. To test for stationarity in residuals, the same procedure as in previous cases was followed where SIC and AIC determined the optimal number of lags in models without constant and trend. The table below shows the results of cointegration test on residuals based on ADF and PP tests, respectively.

Table 4.13: Residuals based cointegration analysis with ADF unit root test

Dependent variable	Independent variable	Lags	ADI	Probability	Results
LCREDESP	LM2	0	-2.509563	0.0121**	cointegrated
LM2	LCREDESP	0	-2.387792	0.0168**	cointegrated
LCREDESP	LMB	2	-2.168904	0.0293**	cointegrated
LMB	LCREDESP	2	-2.097783	0.0349**	cointegrated
LM2	LMB	2	-2.497934	0.0125**	cointegrated
LMB	LM2	2	-2.591844	0.0096***	cointegrated

* indicates significance at 5% level, *** indicates significance at 1% level

The ADF test results reported in table 4.13 indicate that all residuals are stationary at least at 5% level, implying that total banks loans and monetary base in logarithms are cointegrated. The same goes to total banks loans and M_2 in logarithms and monetary base and M_2 in logarithms as well. This is the evidence that causality between cointegrated variables exists at least in one direction. In order to confirm these results, PP tests are performed as shown in the table 4.14 below;

Table 4.14: Residuals based cointegration analysis with PP unit root test

Dependent variable	Independent variable	Lags	PP	Probability	Results
LCREDESP	LM2	0	-2.591119	0.0096***	cointegrated
LM2	LCREDESP	0	-2.471937	0.0134**	cointegrated
LCREDESP	LMB	0	-3.470469	0.0006***	cointegrated
LMB	LCREDESP	0	-3.511077	0.0005***	cointegrated
LM2	LMB	0	-4.786630	0.0000***	cointegrated
LMB	LM2	0	-4.909651	0.0000***	cointegrated

* indicates significance at 5% level, *** indicates significance at 1% level

Similarly, PP test prove that all residuals are stationary at least at 5% level. Thus variables total banks loans, monetary base and M_2 in logarithms are cointegrated and confirm the existence of causality at least in one direction.

Following Nell (2000) and Shanmugam, Nair and Li (2003), cointegration analysis is used to detect long run causality, which can be detected through statistical significance of error correction term in the ECM as these can be used as a test for weak exogeneity (Harris, 1995). Besides, Engle and Granger (1987) suggested that omitting error correction term in causality test

can lead to misspecification in the model. Therefore long run causality between total banks loans, monetary base and M_2 was tested via ECM. The optimal number of lags was determined by AIC and SIC and are reported in the table 4.15 along with long run causality results.

Table 4.15: Causality test via ECM

Dep. variable	Ind. variable	Order of lags in ECM	Error correction term significance	Results
$\Delta LCREDESP$	$\Delta LM2$	[1,1]	-0.050525 (0.0098)***	Causality runs from LM2 to LCREDESP
$\Delta LM2$	$\Delta LCREDESP$	[0,0]	-0.040393 (0.1104)	
$\Delta LCREDESP$	ΔLMB	[1,0]	-0.039835 (0.0049)***	Causality runs from LMB to LCREDESP
ΔLMB	$\Delta LCREDESP$	[2,0]	-0.064697 (0.1450)	
$\Delta LM2$	ΔLMB	[0,0]	-0.035955 (0.1275)	Causality runs from LM2 to LMB
ΔLMB	$\Delta LM2$	[2,2]	-0.132184 (0.0117)**	

i. Values in () are t test probabilities.

ii. Values in [] are number of lags, the first is the lag length for the dependent variable and the second is for the independent variable

iii. ** indicates significance at 5% level, *** indicates significance at 10% level

iv. Δ is the first difference

From the results in table 4.15, bank loans and broad money supply were found to be cointegrated. The error correction term of -0.050525 indicated that bank loans adjust slowly to its equilibrium level and it is statistically significant. This means that bank loans adjustment to its long run equilibrium is partly due to changes in broad money supply. However, the error correction term in the broad money supply equation is not statistically significant; implying that broad money supply is weakly exogenous. In other words, results show that in the long run, causality runs from broad money supply to bank loans, even though the probability of 0.11 may indicate that bidirectional causality between broad money supply and bank loans may be

possible. This result is different from Nell (2000) who obtained a long run causality running from bank credit to money supply in South Africa. Here, it is also important to note that Nell used M_3 while the present study considers M_2 . In case of Malaysia, Shanmugam, Nair and Li (2003) found bidirectional causality between bank loans and M_1 in the short run as they employed standard Granger causality.

Similarly, results prove cointegration between bank loans and monetary base and a slow adjustment of bank loans to its long run equilibrium as the error correction term coefficient is -0.039. This coefficient is statistically significant, hence bank loans adjustment to its long run equilibrium is partly due to changes in monetary base. Nevertheless, the error correction term is not statistically significant in monetary base equation, meaning that in this case, monetary base is weakly exogenous. Thus, in the long run, the causality runs from monetary base to bank loans and this support the monetarist view of exogenous money supply. Yet, previous studies such as Nell (2000) for South Africa had revealed a bidirectional causality in the period of direct control and an unidirectional causality from bank loans to monetary base under indirect control.

Results for long run causality between monetary base and broad money supply seem to reject the monetarist view. Actually, the error correction term in broad money supply equation is not statistically significant, implying that broad money supply is weakly exogenous. Therefore, in the long run, there is unidirectional causality from broad money supply to monetary base and not the other way round.

4.7. Summary

In this chapter, determinants of money supply in Rwanda were identified via cointegration analysis of money supply equation based on Monetarists' money multiplier model. Besides, the post Keynesians endogenous money hypothesis was tested and in both case, monthly data from 1995 to 2009 were used. Briefly, cointegration analysis of the money multiplier model revealed that M_2 , net foreign assets, domestic credit to government, net domestic credit to banks, currency ratio and reserve ratio were cointegrated meaning that there exists a stable long run relationship between them. The long run relationship shows that changes in net domestic credit to banks,

domestic credit to government and net foreign assets have a significant positive impact on changes in M_2 whereas changes in reserve ratio negatively affect M_2 as expected. The unexpected result was the positive influence of currency ratio on M_2 . This positive sign might be due to the fact that the public demand for currency is part of demand for money. As the NBR target the monetary aggregates to keep the equilibrium between money demand and supply, the increase in money demand along with cash demand due to an increase in GDP and inflation, would consequently result to growth in broad money supply. In general, the findings of this study are in line with other studies conducted in developing world especially Africa such as Sowa (1993) and Afriyie (1999) for Ghana and Sihonge (1997) for Botswana, although the methodology is different.

The test for endogenous/exogenous money hypothesis in Rwanda, confirmed the Post Keynesians endogenous money hypothesis in the short run, whereas in the long run, results were mixed as the causality running from monetary base to total banks loans supported monetarists view of exogenous money while causality running from M_2 to monetary base rejected it. These findings are in accordance with previous studies (Palacio-Vera, 2001; Rath, 1999; Shanmugam, Nair and Li, 2003) at least about money endogeneity in the short run. In the long run, it seems that the influence of NBR on controlling money supply is increased.

It is somehow tricky to compare and contrast the findings from the money multiplier model and endogenous money model as the two models lean on two different schools of thought. Nevertheless one common finding in both models is the major influence of private banks in money supply process in Rwanda. In the first model, it was proved that NBR credit to banks influence significantly changes in money supply. On the other side the total banks loans were found to Granger cause broad money supply. Briefly, the lending capacity of banks here plays a major role and is its self affected partly by credit from NBR.

CHAPTER FIVE

CONCLUSION AND POLICY IMPLICATIONS

5.1. Introduction

This chapter presents the summary, conclusion and policy implications emanating from empirical findings. Besides, it provides the limitations of this study and areas for future research.

5.2. Summary

Since 1995, Rwanda has been implementing structural adjustment programs and significant reforms in its financial sector came in the second half of 1990's decade. One of major reforms was the shift from direct monetary policy to indirect monetary policy which granted private banks more freedom in their activities. Since then, the NBR has to influence indirectly elements in private banks balance sheet by manipulating its own balance sheet. In addition the advent of interbank market and reforms in the public finance sector later in the last decade brought changes in the market for funds and the whole financial sector in Rwanda.

Given all those reforms in financial sector and public finance, their effects on money supply and its control, this study aimed to identify the main determinants of money supply in Rwanda. More emphasis were put on the extent to which NBR credit to government and net foreign assets could influence money supply due to the fact that Rwandan economy had been characterized by recurrent fiscal deficits and balance of payment problems. In addition to the evolution in banking activities caused by new stance of indirect monetary policy, this study also analyzed the issue of endogeneity/exogeneity of money supply in Rwanda

The model estimated in this study was grounded on money multiplier theory where broad money supply M_2 was related to components of the monetary base (net foreign assets, domestic credit to government and net domestic credit to banks) and components of the multiplier (reserve deposit ratio and currency deposit ratio). Moreover, Post Keynesian hypothesis of endogenous money

was tested via causality test between total bank loans, M_1 and monetary base. The specific objectives of this study were to determine the effect of domestic credit to government on money supply in Rwanda, examine the effect of net foreign assets on money supply in Rwanda and test for endogeneity/exogeneity of money supply in Rwanda

Empirical results suggested that in the long run domestic credit to government has a significant positive effect on M_1 . The influence of net foreign assets on M_2 was also positive but relatively small. The graphical analysis shows that net foreign assets are increasing overtime and this is due to inflow of foreign capital, aid and loans as the trade balance is still in deficit. However, the results suggested that NBR has managed to cope with an upsurge of foreign aid and loans into the country for reconstruction efforts. Furthermore, NBR credit to banks had also a significant positive impact on M_2 .

The Granger causality test in endogenous money model indicated that in the short run, causality runs from total bank loans to M_2 and monetary base, thereby confirming the hypothesis of unidirectional causality from total bank loans to M_2 and monetary base in the short run. In the long run, findings are mixed as there is unidirectional causality from total bank loans to M_2 and from monetary base to total bank loans; thus the endogenous money hypothesis could not be rejected nor confirmed. In a nutshell, NBR influence in money supply management is more effective in the long run.

The findings from both models highlight the importance of banks in money supply process in Rwanda. It was expected that with financial liberalization, banks and other financial institutions will acquire more power and this usually happens at the expense of the central bank.

5.3. Conclusion

This study identified the main determinants of broad money supply in Rwanda. Domestic credit to government, net domestic credit to banks and the reserve ratio exert the strongest influence on money supply in the long run. The emphasis was put on the effect of domestic credit to government and net foreign assets on money supply. Empirical findings revealed that domestic credit to government has a powerful positive impact on broad money supply in Rwanda whereas the effect of net foreign assets on broad money supply is positive but relatively lower. Furthermore results revealed that in short run, changes in money supply are outcome of individuals and banks in loans deposit supply process and NBR has limited power to impose its control on money supply via monetary base manipulation while in the long run, NBR has relatively more power. Hence the Post Keynesian endogenous money hypothesis was confirmed in short run but in the long run findings could neither reject nor confirm it.

As matter of fact, the main forces behind changes in money supply namely domestic credit to government, net foreign assets are beyond NBR control and more liberalized financial sector makes that control more complex.

5.4. Policy recommendations

Since domestic credit to government has powerful impact on changes in money supply and NBR has slight influence on government fiscal policy, it is up to the government to improve its fiscal policy in order to reduce the budget deficit. This should permit the government to have less recourse to borrowing from NBR. Moreover, reforms aiming at developing financial markets in Rwanda should be enhanced so that the government can be able to finance its budget deficit on the market without crowding out the private sector.

In the perspective of the establishment of East African monetary union, it is paramount for Rwanda to have a sound fiscal sector in order to ensure a smooth transition to a stable monetary

union. Thus the Government of Rwanda needs to maintain its efforts to upgrade revenue collection and public expenditures management

The positive influence of net foreign assets on money supply is relatively less compared to the one of domestic credit to government. Nevertheless, it is essential for NBR to continue to monitor keenly the movement of net foreign assets determinants, so that it can be able to insulate the economy from possible internal and external shocks which spillover the balance of payment

Finally, since in Rwanda money supply is endogenously determined in short run and given the current stance of indirect monetary policy in an environment of increasing autonomy of private financial institutions, the power seems to shift in favor of financial institutions. Therefore, NBR needs to enhance banking supervision activities in all aspects. With an appropriate legal and technical framework, the NBR can improve its control of financial institutions management as interbank market develops. Banking supervision and control would be the key to NBR ability to hit its monetary targets.

5.5. Limitations and further research

This study tested endogenous money hypothesis but it does not transcend to distinguish between competing theories of endogenous money supply accommodationist, structuralists and liquidity preference. Further studies may extend in that direction. In addition, the future research may focus on identifying variables which can be used as monetary policy instruments and analyzing monetary policy transmission.

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APPENDICES

Appendix A. Descriptive statistics

Table A.1. Descriptive statistics of variables

	MSD (billions)	CGO (billions)	SPAR (bill.)	NC BANKS (bill.)	CGO DEFSP (bill.)	MRE (bill.)	C ₁	r
Mean	183.2912	42.88243	176.5912	19.991199	117.4588	54.21090	0.559747	0.173447
Median	104.7790	47.42964	54.41434	0.000000	78.91448	43.34216	0.443073	0.163480
Maximum	383.2754	56.02877	424.6318	4.427150	339.6016	120.0450	0.917933	0.332374
Minimum	34.99280	34.48970	1.302700	1.4070497	16.88150	19.40670	0.245701	0.061181
Std. Dev.	102.4433	14.78802	124.4074	17.48159	61.88765	26.37143	0.125492	0.042781
Skewness	1.238236	0.113630	0.977787	1.372120	1.124516	1.037905	0.604939	0.418614
Kurtosis	3.203971	2.622268	2.427224	1.406911	3.041221	3.160729	2.640040	2.188112
Jarque-Bera	45.53758	1.594895	34.20074	55.76004	37.39318	31.34597	11.69917	12.36078
Prob>chi2	0.000000	0.497854	0.000000	0.000000	0.000000	0.000000	0.002881	0.002070
Sum	24362.54	7190.367	24176.72	17084.495	20790.20	9595.328	99.07521	31.40430
Sum Sq. Dev.	1831025	3467.878	2723949	47604.88	1551422	132399.6	2.771958	0.691913
N of Valid Cases	177	177	177	177	177	177	177	177

- bill. means in billions of RWF

Appendix B. Lags length selection

Table B.1. Lag order selected by various criterions

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-14978.51	NA	9.22e+71	182.7379	182.8513*	182.7839*
1	-14920.41	111.2321	7.08e-71*	182.4684	183.2623	182.7907
2	-14884.36	66.38109	7.09e-71	182.4679	183.9422	183.0664
3	-14864.04	35.93472	8.62e-71	182.6591	184.8138	183.5338
4	-14831.33	55.45241	9.05e-71	182.6991	185.5344	183.8501
5	-14805.43	42.01593	1.04e-72	182.8223	186.3380	184.2495
6	-14757.47	74.27056	9.14e-71	182.6765	186.8726	184.3800
7	-14712.75	65.99592	8.45e-71	182.5701	187.4467	184.5498
8	-14660.23	73.65812	7.17e-71	182.3686*	187.9257	184.6246
9	-14647.40	17.04482	1.00e-72	182.6513	188.8888	185.1835
10	-14624.80	28.38628	1.25e-72	182.8147	189.7327	185.6231
11	-14598.06	31.63666	1.52e-72	182.9276	190.5260	186.0122
12	-14541.43	62.84595*	1.30e-72	182.6760	190.9519	186.0369

* indicates lag order selected by the criterion

LR: sequential modified LR test statistic (each test at 5% level)

FPE: Final prediction error

AIC: Akaike information criterion

SC: Schwarz information criterion

HQ: Hannan-Quinn information criterion

Appendix C. Regression results

Table C.1. Parsimonious VECM results

[illegible]

Region	1970-79	1980-89	1990-99	2000-09
Democracy and human rights (dhr)	1.01E+71			
Democracy and human rights (dhr)	1.11E+71			
Ecology	-1.12E+61			
Ecology	1.62E+60			
Ecology	1.01E+61			

Appendix D. VEC diagnostic tests results

Table D.1. Serial correlation test results at different lags

Lags	LM-Stat	Probability*
1	55.57267	0.0196
2	38.72438	0.3477
3	39.29389	0.3245
4	37.70580	0.3912
5	35.27696	0.5028
6	66.75697	0.0014
7	62.88565	0.0036
8	47.27060	0.0990
9	50.48727	0.0551
10	37.02382	0.4215
11	42.62541	0.2075
12	84.09144	0.0000

*Probabilities from chi-square with 36 df.

Table D.2. Normality test results

	Skewness	Kurtosis	Jarque-Bera
Statistic	-0.014	2.996	0.006
Chi square	0.006	8.03E-05	
Probability	0.93	0.99	0.99

Table D.3. Heteroskedasticity test results

	White test with cross terms
Chi square	1356.56
Degrees of freedom	924
probability	0.0000