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MODELING THE DETERMINANTS OF THE DEMAND FOR MONEY IN RWANDA

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ABSTRACT

This study models the demand for money in Rwanda and its determinants for the period 1996 to 2013 using the autoregressive distributed lag (ARDL) framework. It investigates the relationship between monetary aggregates M_2 and M_3, and real final consumption expenditure, real gross capital formation and real exports, inflation rate, interest rate, exchange rate and financial innovation. The study uses disaggregated components of GDP as scale variables to separate their effects on money demand. Furthermore, the study investigates the stability of the money demand function in Rwanda using the CUSUM and CUSUM Squared tests. The calculated F-statistic for the M2 model is 4.835 which is above the upper bounds of the critical values of the bounds test at all levels of significance while the F-statistic for the M3 model is 3.885 and above the upper bounds at 5% significance level. These empirical results prove the existence of a cointegrated relationship between M2 (M3) and the explanatory variables real final consumption expenditure, inflation, exchange rate and financial innovation. The study finds that the long-run elasticities of real final consumption expenditure, inflation, financial innovation and the exchange rate are positive. The coefficient of 1.028 for final consumption expenditure is highly elastic and shows that final consumption expenditure is a key driver of the demand for M2. On the other hand, an exchange rate long-run elasticity of 1.068 indicates that a shock of Rwanda's exchange rate has a more than proportionate impact on the demand for M3. A positive exchange rate coefficient shows the dominance of the wealth effect over the substitution effect in situations of exchange rate depreciation. A positive long-run semi-elasticity of the inflation rate proves the importance of the transactions motive to economic agents' portfolio decisions. Financial innovation has not yet offered Rwandans alternative financial assets as indicated by its positive influence on money demand. The results of the CUSUM and CUSUMSQ tests reveal that the M2 and M3 money demand functions are stable between 1996 and 2013. Thus, M2 is still an appropriate target for monetary policy in Rwanda while M3 can also be targeted with equivalent effectiveness. Complimentary fiscal policies that focus on final consumption expenditure are needed since final consumption expenditure is a key driver of money demand in Rwanda.

Keywords: Gross Domestic Product, Consumer Price Index, Ordinary Least Squares

CHAPTER 1: GENERAL INTRODUCTION

1.1 Introduction

The existence of a well-specified and highly predictable money demand function is a necessary precondition for monetary policy to exert a significant effect upon the economy (Goldfield and Sichel 1990).A stable money demand function helps monetary authorities to predict policy effects on ultimate target variables through shocks on monetary aggregates. Thus, analyzing the money demand function is a central concern for monetary policy authorities. Demand for money investigates what motivates people to hold cash balances instead of other assets. Deducing from the estimations of money demand equations, the monetary authority can decide which monetary policies are most suitable to implement under different economic conditions.

The National Bank of Rwanda (BNR) Law requires the BNR to conduct monetary policy in a way that delivers price stability. According to Law no 55/2007 of 30/11/2007, the National Bank of Rwanda is assigned three roles namely: to ensure and maintain price stability; to enhance and maintain a stable and competitive financial system without any exclusion; and to support Government's general economic policies, without prejudice to the other two missions. To achieve its mandate of maintaining low inflation, the National Bank of Rwanda "currently operates in a flexible monetary targeting framework with the monetary base as operating target, broad money aggregate as an intermediate target and inflation as the ultimate goal (BNR 2015). The necessary condition for effective monetary aggregate targeting is the existence of a stable long-run and short-run relationship between the monetary aggregate.

1.2 Background

Post-independence Rwanda can be divided into two main economic epochs. From 1962 to 1989 Rwanda was a highly controlled economy but beginning in 1990 the country transitioned into a market-based economy (Rutayisire 2008). The momentum to become a free market economy gathered considerable pace after the genocide of 1994. Rwanda's long-term development goals are defined in a strategy entitled "Vision 2020". The strategy seeks to transform the country from a low-income agriculture-based economy to a knowledge-based, service-oriented economy with a middle-income country status by 2020.

In order to achieve these long-term development goals, the government of Rwanda formulated medium-term strategies ,the first and second Economic Development and Poverty Reduction Strategy (EDPRS 1 and 2). The overarching goal of the EDPRS is growth acceleration and poverty reduction through four thematic areas: economic transformation, rural development, productivity and youth employment, and accountable governance. The EDPRS 2 aims to achieve the following goals by 2018: raise gross domestic product (GDP) per capita to $1,000, have less than 30% of the population below the poverty line, and have less than 9% of the population living in extreme poverty. These goals build on remarkable development successes over the last decade which include high growth, rapid poverty reduction and, since 2005, reduced inequality. Table 1 shows Rwanda's GDP growth between 1996 and 2015.

Table 0.1: Rwanda's GDP Growth (%)

YEAR	GDP Growth Rate
1996	12.7
1997	13.8
1998	8.9
1999	7.6
2000	8.3
2001	8.7
2002	13.5
2003	1.5
2004	6.9
2005	6.9
2006	9.2

2007	7.6
2008	11.2
2009	6.3
2010	7.3
2011	7.9
2012	8.8
2013	4.7
2014	7.0
2015	6.9

Source: World Bank, 2017

Rwanda's GDP growth averaged 8.28 % from 1996 to 2015 which is quite phenomenal.
The period covered by this study witnessed the liberalization of the financial services sector. Prior to the deregulation of the financial services sector, Rwanda's economy was dominated by three commercial banks namely Bank Populaire du Rwanda, Bank of Kigali and Cogebanque. There were no foreign banks. The 2005 World Bank/IMF Financial Sector Assessment Program described Rwanda's financial sector as "narrow, shallow with an oligopolistic banking sector and low penetration of insurance services as well as undiversified financial products" (Rusagara 2008). Since 2005, the Rwandan economy has undergone a number of important structural and institutional changes which included the liberalization of the external trade and payment systems, substantial degree of financial deepening and innovations in the banking sector, the adoption of a managed float exchange rate system, the dismantling of price and interest rate controls and the reliance on market determined indirect instruments of monetary policy.

As part of its financial sector reforms, the country privatized banks to reduce financial repression and encourage market determination of prices of financial services. The country also encouraged the entry of international players into the banking market in order to enhance competition. Increased competition has heightened innovation in the financial services sector. These developments may have altered the relationship between money, income, prices and other key economic variables, and may have caused the money demand function to become structurally unstable. Consequently, determining whether the financial reforms undertaken have impacted the money demand relationship may bear significant meaning to the present and future conduct of monetary policy in Rwanda.

1.3 Statement of the Problem

A good understanding of the determinants of real demand for money in the economy is essential because effective monetary policy relies on an economy's ability to identify a stable money demand function. Previous studies on money demand in Rwanda such as Nachega (1999), Rusuhuzwa (2001, 2014), Hauna and Di Bella (2005) and Rutayisire (2008) all used real GDP as a scale variable. The use of such a single aggregated income variable assumes that various components of real income (GDP) have the same effect on money demand. However, Tang (2007) criticizes this approach, arguing that different components of aggregate real income might affect money demand differently. Thus, the use of such a single real income variable is bound to cause aggregation bias. There is need for a study that separates out the effects of various income components on money demand by disaggregating the real income variable (GDP) into components like real gross capital formation, real final consumption expenditure and real exports. Different elasticities of GDP components may provide different policy lessons and necessitate different policy interventions.

Since 1996, monetary policy in Rwanda has moved away from the employment of command strategies to the use of market determined policy instruments. Furthermore, the years since 2005 have seen an upsurge in financial innovation with respect to new and faster payment systems, internet banking, and new financial products in both the domestic and international markets and the increased use of mobile banking services. These changes might have affected the velocity of money and hence the demand for money in Rwanda. The developments may also have altered the relationship between money, income, prices and other key economic variables, and may have caused the money demand function to become structurally unstable (Arau etal 1995). Consequently, determining whether financial innovation and monetary policy changes have impacted the money demand relationship is important to the effective formation and implementation of monetary policy in Rwanda.

1.4 General Objective of the Study

This research aims to model the determinants of the demand for money in Rwanda.

1.5 Specific Objectives

1. To investigate the relationship between the demand for M_2 and real gross capital formation, real final consumption expenditure, real exports, inflation rate, interest rate, exchange rate and financial innovation in Rwanda.
2. To investigate the relationship between the demand for M_3 and real gross capital formation, real final consumption expenditure, real exports, inflation rate, interest rate, exchange rate and financial innovation in Rwanda.
3. To assess the stability of the money demand function for Rwanda.

1.6 Hypotheses

The following hypotheses are made:

$H_0$1: There is a cointegrating relationship between the demand for M2 and real gross capital formation, real final consumption expenditure, real exports, inflation rate, short term interest rate, foreign exchange rate and financial innovation.

$H_0$2: There is a cointegrating relationship between the demand for M3 and real gross capital formation, real final consumption expenditure, real exports, inflation rate, short term interest rate, foreign exchange rate and financial innovation.

$H_0$3: The money demand function for Rwanda is stable.

1.7 Significance of the Study

The centrality of a stable money demand function to the conduct of monetary policy is generally accepted in literature. The factors that determine money demand in any economy change as a result of changes in the political, regulatory and economic environments. Globalization and internationalization of financial markets have been partly blamed for triggering events like the East Asian financial crisis (1997-1998) and the global financial crisis (2005). These changes, coupled with acceleration of financial innovation, have caused traditional approaches to the conduct of monetary policy less effective through their effect on the money demand function. Rwanda has seen many structural changes in the economy and innovations in the financial sector since 1994. These developments may have altered the relationship between money, income, prices and other key economic variables, and may have caused the money demand function to become structurally unstable. Thus, it remains an empirical question whether targeting money supply remains relevant in the conduct of monetary policy. A study of the money demand function for Rwanda and a test of its stability will inform the monetary authorities on the best monetary policy stance to adopt for the present and the future.

1.8 Scope of the Study

The study will focus on the relation between the demand for money in Rwanda and its determinants Rwanda covering the period 1996 to 2013.

1.9 Organization of the Study

This study is organized into five chapters. Following this introductory chapter, chapter two presents the review of the literature on money demand functions theoretically and empirically. Chapter three discusses the methodological issues and the econometric modeling. In this chapter, the choice of variables is explained and econometric techniques that are used in the study are discussed in detail. Chapter four analyzes the data using the methods that are explained in chapter three. It further discusses and interprets the results. Finally the last chapter gives conclusions of the study and provides recommendations.

1.10 Limitations of the Study

The research wanted to separately identify the effects of disaggregated components of GDP on money demand. Due to problems of multicollinearity, the variables real gross capital formation and real exports expenditure were dropped from the model. Therefore, their effects on money demand have not been conclusively established or not identified at all (in the case of real export expenditure).

The researcher was keen to find out if interest rates have an effect on money demand in Rwanda. The considerable changes that occurred in the financial sector since 1994 particularly concerning the use of market determined interest rates might have changed the relationship between money demand and interest rates. Two reasons led to the dropping of interest rate. First, the TB rate was highly correlated with other explanatory variables. Secondly, the ARDL model works with variables of equal sample size (Hamilton 1994). TBs were introduced in Rwanda in 2006 and so the variable had only 32 data points out of 72 for all other variables. The effects of interest rates still need to be investigated.

Post estimation diagnostics show that exogenous variables had high multicollinearity as indicated by high variance inflation factor values of 7.71 (M2) and 6.83 (M3).This might have been caused by the conversion of nominal values of GDP components into real values which meant that elements of inflation rate got inputted into all real values. Although the multicollinearity was within tolerable levels, the results still have to be treated with caution.

Generally, quarterly data tended to be noisy. However, the researcher could not revert to the use of annual data because that would have reduced the sample size to too small levels.

CHAPTER: 2 LITERATURE REVIEW

2.1 Introduction

This chapter reviews both the theoretical literature on money demand functions and empirical literature that focuses both on money demand functions and their stability. It is divided into three sections. In section 2.1, the theoretical debate on money demand and its determinants is tackled from four main perspectives namely the classical view, the Cambridge School approach, the Keynesian view and monetarism (as championed by Milton Friedman). Section 2.2 discusses the concept of financial innovation while Section 2.3 discusses empirical literature on money demand functions beginning with a few studies from across the world before devoting more space and energy to prior studies on the demand for money in Rwanda.

2.2 Theories of the Demand for Money

Economic literature abounds with empirical works on the demand for money and there is widespread agreement that the demand for money is primarily determined by real cash balances. Numerous approaches are used to group the main theoretical ideas on money demand. Some theories emphasize the role of money as a medium of exchange (transaction-based theories) while others emphasize its role as an asset (asset-based theories) and yet others see the demand for money as driven by the degree of risk aversion by economic agents (risk-aversion models). The theories selected for discussion in any study will depend on the discretion of the researcher guided by the demands of the problem at hand.

2.2.1 The Classical View of the Demand for Money

According to classical economists, money is required entirely as a medium of exchange, that is, for transactions purposes. The most basic "classical" transaction motive can be illustrated with reference to Irvin Fischer's (1914) Quantity Theory of Money. According to the equation of exchange,

$$MV = PY, \qquad (2.1)$$

where M is the stock of money, V is its velocity P is the price level and Y is real income. Consequently, PY is nominal income or in other words the number of transactions carried out in an economy during a period of time. Rearranging the above identity and giving it a behavioral interpretation of money demand we have,

$$M^d = P \frac{Y}{V} \qquad (2.2)$$

Or, in terms of demand for real balances

$$\frac{M^d}{P} = \frac{Y}{V} \qquad (2.3)$$

Hence in this simple formulation, the demand for money is a function of prices and income, as long as its velocity is constant. Therefore, Fisher's quantity theory of money suggests that the demand for money is purely a function of income, and interest rates have no effect on the demand for money. Fisher came to this conclusion because he believed that people hold money only to conduct transactions and have no freedom of action in terms of the amount they want to hold. The demand for money is determined by the level of transactions generated.

2.2.2 The Cambridge School and the Demand for Money

A group of classical economists in Cambridge, England, which included Alfred Marshall, A.C. Pigou and John Maynard Keynes (before he came up with his *Liquidity Preference Theory*), developed a theory of money at the same time Fisher was developing his. Their ideas first appeared in Pigou (1917) and later in Keynes (1923). In spite of using a significantly different approach, their analysis led them to an equation similar to Fisher's money demand equation. However, in the Cambridge model the demand for money is influenced not only by the level of transactions but also by the institutions that affect the way people conduct transactions. Accordingly, the Cambridge approach did not rule out the effects of interest rates on the demand for money.

The classical Cambridge economists postulated that money is held both as medium of exchange and as a store of wealth. Cambridge economists agreed with Fisher that demand for money would be related to the level of transactions and there would be a transactions component of money demand proportional to nominal income. As far as money functions as a store of wealth, the Cambridge economists suggest that the level of people's wealth also affects the demand for money. As wealth grows, an individual needs to store it by holding a larger quantity of assets one of which is money. Thus, the Cambridge economists argued that a certain portion of the money supply will not be used for transactions; instead, it will be held for the convenience and security of having cash on hand. This portion of cash is commonly represented as *k*, a portion of nominal income (the product of the price level and real income.). Although, the Cambridge economists also thought wealth would play a role, wealth is often omitted from the equation for simplicity. The Cambridge equation is thus:

$$M^d = k\,PY, \qquad (2.4)$$

where k is the constant of proportionality.

If the economy is at equilibrium, the demand for money will equal money supply (M^d=M), Y is exogenous, and *k* is fixed in the short run, the Cambridge equation is equivalent to Irvine Fisher's equation of exchange with velocity equal to the inverse of *k*:

$$M \times \frac{1}{k} = P \times Y \qquad (2.5)$$

Although the Cambridge economists often treated as k as constant and agreed with Fisher that nominal income is determined by the quantity of money, the Cambridge approach allowed individuals to choose how much money they wished to hold. This approach allowed for the possibility that k could fluctuate in the short run because the decisions about using money to store wealth would depend on the yields and expected returns on other assets that also function as stores of wealth.

2.2.3 The Keynesian View of the Demand for Money

Keynes (1936), in his Liquidity Preference Theory of money demand, postulates three motives for holding real money balance namely transactions, precautionary and speculative motives. The transactions motive gives rise to the transactions demand for money which refers to the demand for cash by the public for making current transactions of all kinds. This is inextricably linked with the use of money as the medium of exchange in a monetary economy. Keynes' transactions motive for holding cash agrees with classical reasoning that economic agents hold some cash balances for transactions purposes. Keynes believes that the amounts which economic agents hold for transactions purposes are positively related to the level of income.

Digging deeper than classical analysis, Keynes recognizes that in addition to holding money for current transactions, people hold money as a cushion against an unexpected future need. This he called the precautionary demand for money and it is a product of uncertainties of all kinds. Life is full of unplanned occurrences such as a child falling sick, a business vehicle getting involved in an accident and many other unexpected bills. People often hold money as a precaution for just such occurrences. The precautionary motive compels economic agents to hold money to provide for contingencies requiring sudden expenditure and for unforeseen opportunities of advantageous purchase. Keynes believes that the amount of precautionary money balances people want to hold is determined primarily by the level of transactions that they expect to make in the future and that these transactions are proportional to income. Therefore, he proposes that the demand for precautionary money balances is proportional to income (Mishkin 2004).

Laidler (1977) points out that the most important innovation in Keynes' analysis is his speculative demand for money. If money were demanded only for transactions and precautionary motives, income would be the only important determinant of the demand for money and the Keynesian approach would not be very different from the classical approach. However, departing from classical reasoning, Keynes takes the view that money is a store of wealth and calls this reason for holding money the speculative motive which he believes would be related to income and the return on money called the interest rate. The primary result of the Keynesian speculative theory is that there is a negative relationship between money demand

and the rate of interest. That is, in a period of high interest rate, people hold less cash and probably make more saving.

Keynes (1936), in laying out speculative reasons for holding money, stresses the choice between money and bonds. If economic agents expect the future nominal interest rate (the return on bonds) to be lower than the current rate they will then reduce their holdings of money and increase their holdings of bonds. If the future interest rate does fall, then the price of bonds will increase and the agents will have realized a capital gain on the bonds they purchased. This means that the demand for money in any period will depend on both the current nominal interest rate and the expected future interest rate (in addition to the standard transaction motives which depend on income.

The fact that the current demand for money can depend on expectations of the future interest rates has implications for volatility of money demand. If these expectations are formed, as Keynes argues, by "animal spirits" they are likely to change erratically and cause money demand to be quite unstable.

Related to the above is the distinction between active and idle balances made in the Keynesian literature. The active balances are defined as balances used as means of payments in national income- generating transactions. The rest are called idle balances. The distinction is useful to explain how changes in the income velocity of money come about and how the same quantity of money can support higher or lower levels of money expenditure when idle balances are converted into active balances or vice versa.

Keynes put the three motives for holding money balances together into a demand for money equation called the liquidity preference equation. He distinguished between nominal quantities and real quantities. He reasoned that money is valued in terms of what it can buy and thus people want to hold a certain amount of real money balances (the quantity of money in real terms). The amount held would be related to real income Y and to interest rates i. Keynes wrote down the following demand for money equation, known as the liquidity preference function, which says that the demand for real money balances Md/P is a function of (related to) i and Y:

$$\frac{M^d}{P} = f(\underset{-}{i}\ \underset{+}{Y}) \qquad (2.6)$$

The minus sign below in the liquidity preference function means that the demand for real money balances is negatively related to the interest rate ***i***, and the plus sign below ***Y*** means that the demand for real money balances and real income ***Y***are positively related.

In the original equation of exchange by Fisher's interest rates can have no effect on the demand for money. In Keynes' theory the function for velocity is $\frac{M^d}{P}$ which implies that velocity is not constant, but instead fluctuates with movements in interest rates.

The liquidity preference equation can be rewritten as:

$$\frac{P}{M^d} = \frac{1}{f(i,Y)} \qquad (2.7)$$

Multiplying both sides of this equation by Y and recognizing that M^d can be replaced by M because they must be equal in money market equilibrium, we solve for velocity:

$$V = \frac{PY}{M^d} = \frac{Y}{f(i,Y)} \qquad (2.8)$$

The demand for money is negatively related to interest rates; when I goes up, f (i, Y) declines, and therefore velocity rises. In other words, a rise in interest rates encourages people to hold lower real money balances for a given level of income; therefore, the rate of turnover of money (velocity) must be higher. This reasoning implies that because interest rates have substantial fluctuations, the liquidity preference theory of the demand for money indicates that velocity has substantial fluctuations as well. When recessions occur, the velocity of money falls or its rate of growth declines. The liquidity preference theory indicates that a rise in interest rates will cause velocity to rise also.

2.2.4 Milton Friedman and the Demand for Money

Building on the work of earlier scholars, including Irving Fisher, Milton Friedman (1956) improved on Keynes's liquidity preference theory by treating money like any other asset. He concluded that economic agents (individuals, firms, governments) want to hold a certain quantity of real, as opposed to nominal, money balances. Because inflation erodes the purchasing power of the unit of account, in times of high inflation, economic agents will want to hold higher nominal balances to compensate, to keep their real money balances constant. The level of those real balances, Friedman argued, was a function of permanent income (the present discounted value of all expected future income), the relative expected return on bonds and stocks versus money, and expected inflation. More formally, the demand for money can be calculated by the following formula:

$$\frac{M^d}{P} = f(Y_p <+>,\ r_b - r_m <->,\ r_s - r_m <->,\ \pi^e - r_m <->) \qquad (2.9)$$

where $\frac{M^d}{P}$ = demand for real money balances (M_d = money demand; P = price level), *f* means "function of" (not equal to), Y_p= permanent income, $r_b - r_m$ = the expected return on bonds minus the expected return on money, $r_s - r_m$ = the expected return on stocks (equities) minus the expected return on money, $\pi^e - r_m$ = expected inflation minus the expected return on money, <+> = increases in and <−> = decreases in.

In Friedman's view, the demand for real money balances rises when permanent income increases and declines when the expected returns on bonds, stocks, or goods increase relative to the expected returns on money. Friedman argues that the velocity of money is highly predictable and that the demand for money function is highly stable and insensitive to interest rates. This implies that the money demand function can be used to accurately predict the quantity of money demanded in an economy.

2.3 The Concept of Financial Innovation and the Demand for Money

Innovation is defined as a process that leads to the creation of a new phenomenon; this phenomenon may be a new material or spiritual product, (the new service or new techniques). In fact, innovation is an analysis or combination of some concepts and creating new thinking and/or a concept that was not previously available (Kao 2001).

Financial innovation refers both to technological advances which enhance access to information, facilitate trading and improve means of payment, and to the emergence of new financial instruments and services, new forms of organizations and more developed and complete financial markets (Sanchez 2008). Thus, generally speaking, financial innovation consists of any way in which finance and the financial system are modernized. This notion encompasses new or transformed financial instruments, institutions, practices, and markets.

Because of their large scope, any list of historical financial innovations can be both very long and necessarily in exhaustive. Going back far in history one can find important building blocks underlying today's financial system. For example, ninth century China introduced the world's paper money, a bill of exchange developed by merchants and the predecessor of government-issued fiat money. Medieval Europe witnessed the establishment of organizations specializing in deposits and the lending of money and the creation of generally spendable IOUs, all essential functions of modern banking. More recent progress includes widely used instruments such as debit and credit cards and derivatives, services like ATMs, clearing houses, and electronic payments and processes such as credit scoring models. This dynamic modernization has taken place because, among other factors, people have sought to satisfy new needs, address agency and other information problems, reduce transaction costs, administer risks, and exploit profit opportunities. Obviously, a specific financial innovation can pursue more than one end.

Sources of financial innovations can be grouped into two broad categories namely changes in information technology and environmental changes. The first set includes products and services based on new technological possibilities that lower the cost of acquiring and processing information and make financial transactions more efficient. Clear examples of this type of innovation are automated underwriting systems, mobile banking, and electronic trading platforms for foreign exchange, capital and derivatives products. The second category arises from changes in market and regulatory conditions faced by economic agents and consist of derivatives, such as futures, forwards, swaps and options, now widely used in most countries.
To be successful, financial innovation must either reduce costs and risks or provide an improved service that meets the particular needs of financial system participants.

Arguments for the inclusion of a role for financial innovation or technological change in the demand for money have a long history in the money demand literature (Arrau et al, (1995)). The demand for money is seen as a function of the prevailing institutional and technological arrangements and is thus sensitive to changes in these underlying forces. According to McCallum and Goodfriend (1987), both the quantity of money demanded in any economy and the set of assets that are regarded as money are dependent upon the prevailing institutions, regulations, and technology.

2.4 Empirical Literature

Most of the studies on the demand for money are concerned with developed countries. Examples are Brand and Cassola (2000) and Holtemöller (2004b) for the Euro area; Arize and Shwiff (1993), Miyao (1996) and Bahmani-Oskooee (2001) for Japan; Drake and Chrystal (1994) for the UK; Haug and Lucas (1996) for Canada; Lim (1993) for Australia and Orden and Fisher (1993) for New Zealand.

According to Sriram (1999), recent years have witnessed phenomenal growth in the number of studies analyzing the demand for money in developing and emerging countries. This shift in interest towards developing economies results from growing concern among central bankers and researchers around the world about the impact of the adoption of flexible exchange rate regimes, globalization of capital markets, ongoing financial liberalization, innovation in domestic markets, and the country-specific events on the demand for money. Some studies of money demand from developing countries are analyzed below:

Bahmani-Oskooee and Malixi (1991) analyze the demand for money function in 13 developing countries. They estimate the demand for money as a function of inflation, real income and the real effective exchange rate. They conclude, among other things that depreciation in real effective exchange rate results in a fall in the demand for domestic currency.

Kallon (1992) investigates the stability of the Ghanaian money demand function for the period 1966 to 1986. The study finds that the demand for real money balances is structurally stable. It produces evidence which suggests that foreign interest rates have no significant effect on the demand for money in Ghana. Further, the study also finds evidence of the nominal adjustment specification as the appropriate short-run adjustment mechanism for the demand for real M1 balances in Ghana.

Simmons (1992) investigates the demand for narrow money for five African countries (Democratic Republic of the Congo, Cote d'Ivoire, Mauritius, Morocco and Tunisia) within an Error Correction Modeling framework. The study emphasizes the role of opportunity cost variables such as the domestic interest rate and expected exchange- rate depreciation in influencing the demand for money. The results of the study indicate that the domestic interest rate is an important determinant of the demand for money functions for three of the five countries. However, external opportunity cost variables such as foreign interest rates and exchange rate depreciation are significant for only one of the others. He also finds that in four out of five cases inflation plays an extremely significant role in determining the demand for money.

Nachega (2001) applies a cointegration analysis and error correction modeling to analyze the behavior of broad money demand in Cameroon over the period 1963 to 1994. The cointegrated VAR analysis identified a stable money demand function and an excess aggregate demand relationship for Cameroon. Further empirical analysis provided support for both purchasing power parity (PPP) and an international Fisher parity between Cameroon and France.

Mohsen and Charikleia (2005) examine the stability of the demand for monetary aggregates M1 and M2 in Greece using quarterly data for the period 1975 to 2002. The research employs the cointegration analysis approach and the cumulative sum (CUSUM) and cumulative sum of squares (CUSUMSQ) tests for the stability of the money demand function. The model includes a vector of interest rates and the real income as the determinant factors. The study results show that both monetary aggregates are cointegrated with income and interest rate. The income elasticity is positive while the interest rate elasticity is negative. However, the stability tests reveal that M1 is a stable function but M2 is not stable.

Qayyum (2005) models the dynamic demand for money (M2) function in Pakistan by employing cointegration analysis and error correction mechanism. The parameters of preferred model are found to be super-exogenous for the relevant class of interventions. The study also finds that the rate of inflation is significant determinant of money demand in Pakistan. The analysis reveals that the rates of interest, market rate, and bond yield are important for the long-run money demand performance.

Ranani (2007) estimates the demand for money in Iran using the autoregressive distributed lag (ARDL) approach to cointegration analysis. The empirical results show that there is a unique cointegrated and stable long-run relationship among M1 monetary aggregate, income, inflation and exchange rate. The study also finds that the income elasticity and exchange rate coefficient are positive, while the inflation elasticity is negative. The results of the cumulative sum (CUSUM) and CUSUMSQ tests carried out reveal that the M1 money demand function is stable from 1985 to 2006. Recently, empirical results of Inoue and Shigeyuki (2008) indicate that an equilibrium relation in money demand exists only for M1 and M2, not for M3.

Shigeyuki (2008) analyzes the money demand function in Sub-Saharan Africa, and his empirical results revealed that there is a cointegrating relationship of the money demand function in the Sub-Saharan African region. In other words, there is a close relationship between the money demand and its determinants in the long term, and monitoring money supply promises to play an important role in stabilizing the level of prices in this region.

There are a few studies of the Rwandese money demand function which have addressed determinants of demand as well as stability issues. Rusuhuzwa (2001) uses data of the period 1975-1998 on three variables namely annual data on income, price and official exchange rate to estimate a demand for nominal balances in Rwanda with M1 and M2 aggregates. Using the Johansen's (1998) procedure, he establishes a cointegration relationship between these variables and an error –correction model is also estimated. The research findings show that the interest rate and the exchange rate of the Rwandan Franc were not significant variables in the demand for money function in Rwanda. The study also show income elasticity was significantly less than unity , while the adjustment coefficient in the short run model was equal respectively to –0,24 and –0,17 for M1 and M2 aggregates.

Nachega (1999) uses quarterly data for the period 1980-1998 to estimate the money demand function for Rwanda. The researcher finds a cointegration relationship with Johansen procedure between income, change of exchange rate, deposit interest rate and nominal balances of M2 aggregate. The demand for nominal balances with M2 was positively affected by income and interest rate, while the effect of the variation of the exchange rate was negative. Moreover, the study showed that the income elasticity was not significantly different from unity.

Hauner and Di Bella (2005) examine first the behavior of the money multiplier in Rwanda. They establish by the cointegration technique a long run relationship between income, exchange rate and M1 monetary aggregate. A short run model is also estimated. The findings reveal that the money multiplier was predictable although its determinants were volatile. In the demand for money function, the income affected positively the demand for real balances while the effect of the exchange rate was negative. A particularly interesting finding in this study was that, despite political instability and economic reforms that occurred in the sample period (1980-2003), the results of the study were consistent with economic theory and contained useful information for policy purposes.

Rutayisire (2008) carried out an empirical analysis to estimate the long and short run demand for money in Rwanda. Using the Johansen (1988) procedure, the research concluded that there was a stable long run relationship between the demand for money and its determinants, which are income, rate of return on foreign financial assets (Libor) and expected depreciation of the domestic currency (Rwanda franc or Rwf). He found that the income elasticity coefficient in the demand for money in Rwanda was significantly higher than unity. This, according to the research was an indication of the importance of the transactions motive in the absence of financial assets; it also reflected the rapid monetization of the Rwandese economy and the preference for liquidity.

The research also established that foreign interest rates and the expected depreciation of domestic currency (Rwf) were important external determinants of the demand for money in Rwanda. The different interest rates were not significant in the estimated demand for money function in Rwanda, a result Rutayisire rightly attributes to that fact that during most of the period covered by his research the interest rates in Rwanda were administratively controlled.

The dynamic model applied in the analysis pointed to the existence of a stable relationship between the demand for money and its determinants in the short run. Lastly, the research found that the period of adjustment of the demand for money to its long run equilibrium position after short run deviations due to external shocks was approximately three years, pointing to persistence of monetary disequilibrium in Rwanda.

Rusuhuzwa (2014) undertook research to assess the stability of the money multiplier in Rwanda using data from 2000 to 2014.The research sought to establish the relationship between broad money and reserve money after taking into consideration possible impact of recent changes in monetary policy framework and developments in financial sector. To achieve this objective, Rusuhuzwa uses the Engle and Granger (1987) two stage model and Gregory and Hansen (1996) cointegration techniques to take into consideration possible structural breaks. The research concluded that there was a long run stable relationship between broad money and reserve money with the implication that the Central bank may influence the development of money supply though the control of the base money. Because of his focus on money multiplier stability, the research never considered the determinants of money demand.

2.4.1 Summary

Most of the available studies on Rwanda have estimated the money demand function using data from the era prior to the deregulation of the financial market. Consequently, they did not capture the effects of structural changes and innovation in the financial sector to the money demand function. The latest study by Rusuhuzwa tested the stability of the money multiplier without investigating the determinants of the demand function. There is also a lack of consensus on the effect of interest rates and exchange rates on real income. As Rutayisire (2008) rightly points out, this was because most of the data used in these studies including his was from the period when interest rates in Rwanda were directly controlled.

2.5 Research Gap

The lack of consensus on the real determinants of money demand in Rwanda by prior studies , particularly on the effects of interest rates and exchange rate means that additional enquiry into the area is needed. Moreover, all previous studies applied the Johansen cointegration technique to establish the short and long run relationships between money demand and its determinants. This method assumes that the cointegrating vector remains constant during the period of study. In reality, it is possible that the long-run relationships between the underlying variables change.

The reason for this might be technological progress, economic crisis, changes in people's preferences and behaviour, policy or regime alteration and institutional development. This is especially the case if the sample period is long.

Considering the political turmoil that Rwanda went through in the early 1990s and the resulting economic challenges as well as the bold restructuring measures taken after 1994, the use of the Johansen approach will give spurious correlation unless tests for cointegration with one and two unknown structural breaks are used (Gregory and Hasen1996)). In all the prior studies of the money demand function for Rwanda only Rusuhuzwa (2014) catered for the structural breaks by applying an error correction model (ECM) but then his focus was only on the stability of the money multiplier without consideration of what determines money demand. This study applies the Autoregressive Distributed Lag (ARDL) to estimate the money demand function for Rwanda using data from 1996 to 2013. Pesaran and Shin (1995) and Perasan et al. (2001) introduced the ARDL method of testing for cointegration which has the advantage of avoiding unit root pre-testing.

2.6 Conceptual Framework

The study examines money demand relationships between monetary aggregates, M_2 and M_3, in the National Bank of Rwanda definitions, expenditure components of GDP, the nominal exchange rate, the interest rate and the inflation rate as the opportunity cost of holding money variables and financial innovation. Expenditure components of GDP are identified as real gross capital formation, real final consumption expenditure (both private and government) and real export expenditure. Tang (2007) uses a similar research framework to investigate stability of money demand in five Southeast Asian countries. The approach was also used in South Africa by Ziramba (2007) and Mutsau (2013). In this study their framework is modified to include financial innovation. Figure 2.1 below shows the conceptual framework for this project.

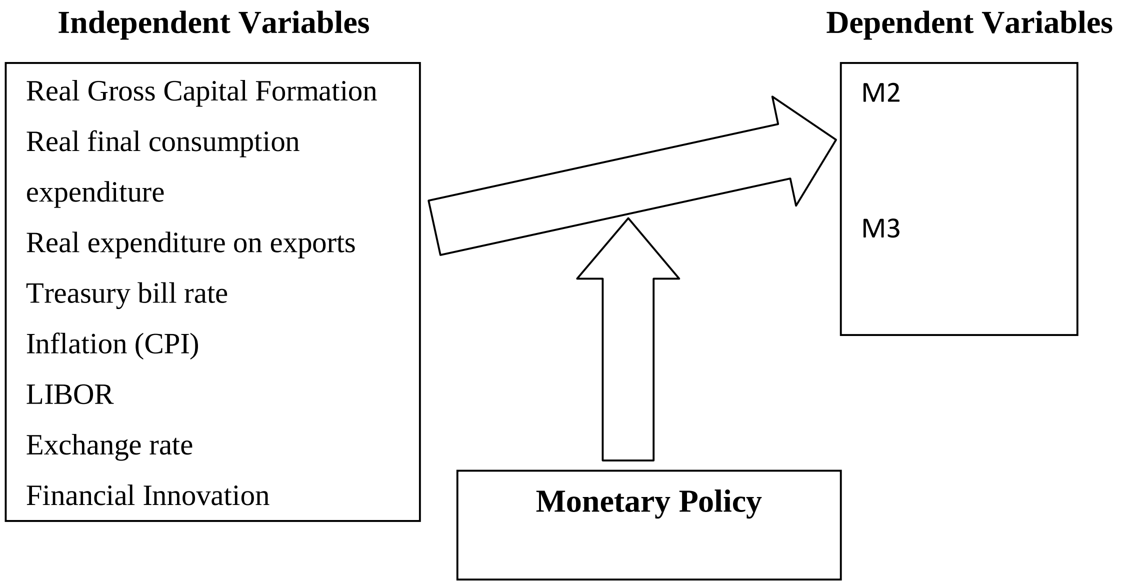


Figure 0.1: Conceptual Framework of the Study

The National Bank of Rwanda defines M2 as consisting of currency in circulation, demand deposits as well as time deposits. In the Rwandan context, M3 is the broadest monetary aggregate composed of M2 plus foreign currency deposits (World Bank 2013). The monetary aggregates are used to represent the demand for money because under equilibrium the supply of money (money stock) equals the demand for money.

CHAPTER: 3 RESEARCH DESIGN AND METHODOLOGY

3.1 Introduction

This section is devoted to the study's design and methodological aspects. It presents a description of the study sample and explains how data for the study are to be obtained as well as the statistical characteristics of the data. Next the chapter defines the variables selected for study and describes how they are going to be measured before presenting the basic money demand model adopted in this research. The choice to use the Autoregressive Distributed Lag cointegration techniques to model the demand for money function in Rwanda is also explained. The chapter ends by explaining how the study hypotheses are going to be tested.

3.2 The sample

The study uses quarterly time series data for Rwanda of monetary aggregates, M2 and M3; GDP disaggregated by its components of gross capital formation, final consumption expenditure and exports; inflation rate, Treasury bill rate to represent short term interest rates, exchange rate, the London Inter-Bank Offered Rate (LIBOR) and a measure of financial innovation for the period 1996 to 2013. Therefore, the sample has 72 observations. The ARDL model used in this study is suitable for dealing with small data samples such as this.1996 is chosen as the starting point of this study for two reasons. First, the data for 1994 and 1995 was very untypical. Because of the tragedy of genocide, Rwanda's nominal GDP plummeted by approximately 50% and inflation reached 64% in 1994. Immediately after the genocide horror, GDP climbed by an astronomical 32% in 1995 (Rutayisire 2008). Including data with such untypical figures might bring bias into the study.

Second, 1996 heralded the beginning of a new monetary policy regime for Rwanda. The National Bank of Rwanda started to use demand determined monetary instruments such as reserve ratio requirements and open market operations. Before 1994, a complex quantitative and qualitative control mechanism governed the distribution of credit. The BNR determined the overall volume of credit and its breakdown by bank and sector. Certain financing was subject to a prior authorization from BNR under a provision allowing the authorized credit limits to be exceeded for certain applications and the amounts granted in this framework varied according to whether the applicant was an individual or an organization, a Rwandan citizen or a foreigner. Interest rates were also set by the National Bank of Rwanda. In 1996, BNR completely liberalized interest rates, the money market came into effect in 1997 and the central bank discount rate was introduced in 2005.

Recent years have also seen a lot of innovations in the financial services sector especially with regard to the liberalization of the sector and the emergency of new financial technologies and instruments. The money demand function is expected to behave differently under the command style monetary regime of the past and the free market dispensation that currently obtains in Rwanda.

3.3 Data Collection

The study entirely depends on quarterly secondary data covering the period 1996 to 2013. The variables in the model are real money demand (represented by monetary aggregates M2 and M3), real gross domestic product disaggregated into Real Gross Capital Formation (RGCF), Real Final Consumption Expenditure (RFCE) and Real Expenditure on Exports (REX), Treasury bill rate (TB), inflation (CPI), Libor rate, exchange rate (EX) and financial innovation (FININ). The time series data of GDP components will be collected from the International Monetary Fund's World Economic Outlook database and the World Bank websites while the data for the inflation rate (CPI), TB rate and exchange rate will come from the National Bank of Rwanda. GDP data are only available on annual basis. The study uses the interpolation technique proposed by Gandolfo (1981) to generate quarterly data.

3.4 Definition and Measurement of Variables

Various factors are considered as determinants of the money demand function. The general agreement in the literature is that a money demand equation should contain a scale variable to measure the level of transactions in the economy and variables representing the opportunity cost of holding money. Diagrammatically, it can be represented as follows:

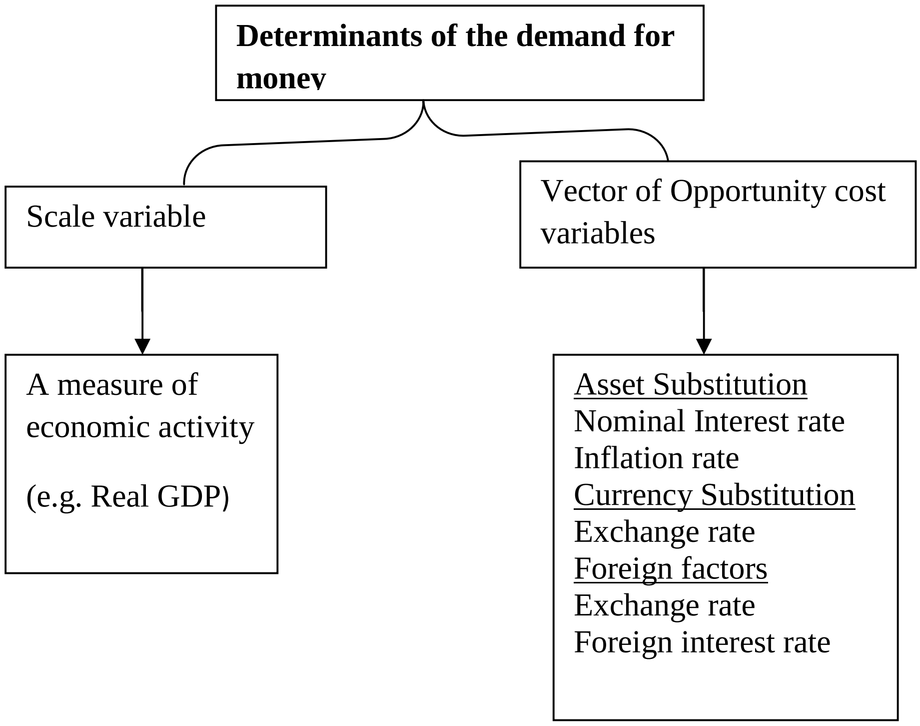


Figure 0.1: The Determinants of Money Demand Function

Adapted from *Al-Samara (2010)*

The vector of opportunity cost variables has an array of variables to measure the asset substitution effect, the currency substitution effect and the impact of foreign factors on money demand.

3.4.1 Choice of Monetary Aggregates

The monetary aggregates to be used in this study are M2 and M3.

According to Boughton (1992), definitions of money stock are expected to vary across countries owing to either institutional characteristics or arbitrary decisions. Nevertheless, two broad categories namely narrow and broad money are generally acknowledged. These though have different sub-categories in different countries. For economic agents, whose sole motive of holding money is for transactions purposes, money demand is reflected through narrow definitions of money stock such as M0 and M1. Money demand by asset holders is measurable through broader definitions of money such as M2 and M3. According to Laidler (1993), it is the onus of empirical researchers to establish the correct definition of money stock in various economic settings. Hence, there is no unanimity in what definition of money stock to use in empirical work for estimating money demand in both developed and developing countries.

In the Rwandan definitions of money stock already alluded to, the narrowest definition of money is M0, which consists of notes and coins in circulation plus deposits at the central bank, M1 would then include demand deposits not included in M0. M2 is made of M1 plus time deposits at commercial banks and other financial institutions plus foreign currency deposits. The National Bank of Rwanda defines M3 as consisting of M2 plus institutional money market funds and short-term repurchase agreements.

Ericsson and Sunil (1996) argue that narrower definitions of money are less useful in policy issues because their relationship with nominal income appears subject to considerable variability while broader definitions are more stable relative to nominal income and hence more amenable to control. This is one of the reasons why this study will use the monetary aggregates M2 and M3 as the dependent variables. The other reason is that M2 is what the National Bank of Rwanda is targeting in its monetary policy and the results of this study might have an immediate direct input into the country's monetary policy direction.

3.4.2 The Scale Variable

Prior studies of Rwanda's money demand function used either the nominal GDP or real GDP as the scale variabl**e.** In fact, globally the most used scale variable is the real income (real GDP). The following empirical works spanning both developing and developed countries all used either nominal GDP or real GDP as a scale variable: Achsani (2010); Atta-Mensah (2004); Calza & Zaghini (2008); Capasso Choi & Cook (2007); Omotor & Omotor (2010); Bahmani-Oskooee (2000, 2001, 2005); Munoz (2006); Halicioglu & Ugur (2005); Kumar, Webber & Fargher (2011); Todani (2007); Tlelima & Turner (2004) and Zuo and Park (2011). The use of GNP is mostly motivated by the extensive availability of data across both developing and developed countries.

However, recent research has advocated the disaggregation of real income into expenditure components to explain money demand. Tang (2002, 2004, and 2007) estimates demand for M2 in South-east Asian countries using disaggregated expenditure components. Ziramba (2007) and Mutsau (2013) disaggregated real income to estimate money demand for all the conventional money stock definitions of South Africa. The same approach is adopted in this study in order to separate the effects of real GDP components on the demand for money.

Real Gross Domestic Product components of real final consumption expenditure (RFCE), real gross capital formation (RGCF) and real export expenditure (REX) are used as scale variables in this study.

3.4.2.1 Gross Capital Formation

Gross capital formation is made up of outlays on additions to the fixed assets of the economy plus net changes in the level of inventories. Fixed assets include land improvements (fences, ditches, drains, and so on); plant, machinery, and equipment purchases; and the construction of roads, railways, and the like, including schools, offices, hospitals, private residential dwellings, and commercial and industrial buildings. Inventories are stocks of goods held by firms to meet temporary or unexpected fluctuations in production or sales, and "work in progress." Net acquisitions of valuables are also considered capital formation. Data for Rwanda in local in local currency were downloaded from the World Bank national accounts data, and International Monetary Fund's World Economic Outlook database.

3.4.2.2 Final Consumption Expenditure

This is a sum of final consumption by households and general government purchases excluding total intermediate consumption. General government final consumption expenditure includes all government current expenditures for purchases of goods and services (including compensation of employees). It also includes most expenditure on national defense and security, but excludes government military expenditures that are part of government capital formation. Data for Rwanda in local in local currency were downloaded from the World Bank national accounts data, and OECD National Accounts data files and from IMF's World Economic Outlook database.

3.4.2.3 Exports of Goods and Services

The series are measured in real terms and measurable in volumes against 1995 base year prices. Rwanda was the 155th largest export economy in the world and the 87th most complex economy according to the Economic Complexity Index (ECI) in 2014.The data for Rwanda's exports were obtained from IMF's World Economic Outlook database and World Bank database.

3.4.3 Opportunity Cost of Money Variables

Due to absence of well-developed financial markets in most developing countries, most empirical demand for money studies use the inflation rate, π, as a proxy for the opportunity cost. The Treasury Bill rate, TB, is used to represent short term interest rates in the domestic market while the Libor rate, LIBOR, represents relative return of foreign currency denominated assets. This study will adopt the same approach.

In the context of an open economy such as that of Rwanda, a variable such as exchange rate, EX or foreign interest rate reflecting the relative returns of foreign money vis-a-vis domestic money can be included in the money demand equation to reflect the impact of currency depreciation on domestic money demand.

3.4.4 Financial Innovation

The true measure of financial innovation remains an empirical issue. Financial innovations may be viewed as financial sophistication or financial depth. If we consider the definition provided by Koðar (1995), that financial sophistication is brought about by financial innovations and that these innovations affect the nature and composition of monetary aggregates, it is reasonable to measure financial innovation by the ratio of M1 to M0. In Rwandese Central Bank definitions M0 refers to the sum of currency in circulation plus deposits in the central bank. Financial innovation is characterized by introduction of credit cards, e-banking, more use of checking accounts and all these are embodied in M1. Liu et al (1994) notes that as the ratio of M1 to M0 increases, the more the technological improvements in banking system.

Financial depth has been defined as the level of financial development in the economy. Many researchers have simply used the ratio of monetary aggregates (M1, M2 or M3) to GDP as a proxy of financial depth, depending on the level of financial development of a country. This view is inspired by the work of Levine (1997) in which financial depth was defined as the ratio of liquid liabilities to GDP. Consistent with this view, Hassan and Jung-Suk (2007) used the ratio of M3 to GDP as a proxy of financial depth. They argue that other monetary aggregates like M1 and M2 may be poor proxies in economies with less developed financial systems, where a high ratio of money to GDP exists because money is used as store of value in the absence of other attractive alternative financial assets.

A strong argument against the use of broad money as measure of financial depth has been provided by Firdu and Struthers (2003) who assert that with financial liberalization, capital inflows add to the funds available for credit expansion by banking system. However, these foreign funds do not increase money supply since they are excluded from it by definition. Therefore, increase in credit expansion, which is a good indicator of financial depth, may not be reflected in the movements of the money supply in financially deregulated economies with important capital inflows. In addition, domestic borrowing by government from the banking system to finance a budget deficit reduces the amount of credit available to domestic private sector and may have a strong negative effect on economic performance but this will not be reflected in the trends of money supply. This study adopts the ratio of narrow money, M1 to GDP as a measure of financial innovation.

3.5 Transformation of Variables

Gross capital formation, final consumption expenditure and export expenditure are converted to real variables using Rwanda's GDP deflator with 1995 as the base year. Monetary aggregates are changed to real balances using the consumer price index. The monetary aggregates and real expenditure components as well as the exchange rate are then transformed into logarithms to normalize them and enable the interpretation of the coefficients as elasticities. TB rates, LIBOR, inflation rate and financial innovation are already in ratio form and so are regressed as they are.

3.6 Model Specification

Empirically, the choice of money demand model specification is determined by the problem to be modeled and the variables to be investigated. Particularly, policy makers are increasingly interested in understanding not only what happens to a particular variable when its determinants change but also on the stability of the relationship amongst the variables. More generally, however, money demand functions normally take the following form:

$M_t^d = f(s, O)$ (3.1)

where M_t^d equals the demand for money at time *t*, *s* stands for a scale variable while *O* stands for opportunity cost of money variables.

Equation 3.1 shows that real money demand depends on a scale variable reflecting the level of transactions in the economy and *a* single or vector of opportunity cost of money variables. Real income or wealth can be used as a scale variable while an opportunity cost variable can be a single opportunity cost variable such as inflation or a representative interest rate or both. The exchange rate and a foreign interest rate may be incorporated to capture foreign influences on the money demand function for an open economy.

The equation 3.1 can be extended in empirical money demand equations to include a lot of other explanatory variables. Mundell (1963) extends equation 3.1 and comes up with a model that postulates that the demand for money is a function of a real income, a representative interest rate on alternative assets as an opportunity cost of holding money and the exchange rate.

$M_t^d = f(Y, r, Ex)$ (3.2)

Equations 3.1 and 3.2 are both susceptible to aggregation bias: they are premised on the assumption that expenditure components of aggregate real income have a uniform influence on money demand. This is refuted by Tang (2002; 2004), Ziramba (2007) and Mutsau (2013) who argue that disaggregated expenditure components of real income have different influences on money demand. This study takes the stance taken by the later group. However, unlike the specification estimated by Ziramba (2007) and Mutsau (2013), financial innovation is introduced as an explanatory variable to capture its effect on the demand for money in Rwanda.

Like in an earlier study of money demand in Rwanda by Rutayisire (2008), inflation is used as an opportunity cost variable to capture the opportunity cost of holding money in the long-term and the TB rate as the opportunity cost of holding money in the short-term. The 91TB rate is included as a proxy for the own rate of return on money. The Libor rate is used to show the impact of foreign interest rates on money demand in Rwanda. The exchange rate (real or nominal) captures the impact of the Rwandan Franc fluctuations on the foreign exchange market.

This study develops an augmented money demand function by extending Mundell's model and re-specifying it in semi-log linear form as follows:

$\text{Log } M_t^d = \sim_0 + \alpha_1 \text{ Log } M_{t-1}^d + \sim_2 \text{log\_RGCF} + \sim_3 \text{Log\_RFCE} + \sim_4 \text{ log\_REX} + \alpha_5 \text{log\_EX} + \alpha_6 TB_t + A_7 LIBOR_{t+} \alpha_8 CPI + \alpha_9 FININ + u_t$ (3.3)

where,

M_t^d= demand for real money, *RGCF* = real gross capital formation (a proxy for expenditure on investment goods), *RFCE=* is real final consumption expenditure, *REX*= real expenditure on exports, CPI= Inflation rate ,*TB*= Treasury bill rate,(a proxy for short term interest rates) to represent the opportunity cost of holding cash balances in the short-run, *LIBOR*= London Interbank Offered Rate to represent foreign interest rates, *EX*= the exchange rate, FININ= financial innovation and u_t = a stochastic disturbance term, satisfying all the classical assumptions and a white noise process.

Based on conventional economic theory, estimates of coefficients of components of real income α_1, α_2, α_3 and α_4 are expected to be positive implying that money demand is positively affected by its past values and that higher income leads to an increase in money demand while estimates of α_6, α_7 and α_9 are expected to be negative andα_5 is indeterminate. According to Arango and Nadiri (1981), estimates of α_5 could be negative or positive. Since the exchange rate, EX is defined as number of units of domestic currency per US dollar, a depreciation of the domestic currency or an increase in EX raises the value of the foreign assets in terms of domestic currency. If this increase is taken as an increase in wealth, then the demand for domestic money increases yielding a positive estimate of α_5. However, if an increase in EX induces an expectation of further depreciation of the domestic currency, public may hold less of domestic currency and more of foreign currency. In this case, an estimate of α_5 is expected to be negative.

The coefficient α_6 is expected to be negative since the increase in the TB rate is supposed to increase the opportunity cost of holding money and negatively affect the volume of credit and hence money demand in general. The sign of coefficient α_7 is anticipated to be negative because Libor represents the rate of return on foreign financial assets. Its increase leads to a higher demand for foreign financial assets to the detriment of the demand for domestic currency. The coefficient of inflation α_8 is expected to be negative (Bahmani-Oskooee and Gelan 2008) since high inflation may lead to low demand for money because economic agents will tend to substitute and hold more real assets than money. Improved technology/financial innovation entails reduced demand for cash balances and thus α_9 could be negative.

An ARDL model of the demand for money demand can be specified to display both short-run dynamics and the long-run relationships between real money demand and its determinants in levels. Hence the ARDL representation of 3.3 can be expressed as:

$$\Delta \log M_t = \alpha_0 + \sum_{i=1}^{n} \alpha_{1i} \Delta_{\log} M_{t-1} + \sum_{i=0}^{n} \alpha_{2i} \Delta_{\log\ t-1} RGCF + \sum_{i=0}^{n} \alpha_{3i} \Delta_{\log} RFCE_{t-1} + \sum_{i=0}^{n} \alpha_{4i} \Delta_{\log} REX_{t-1} + \sum_{i=0}^{n} \alpha_{5i} \Delta_{\log} EX_{t-1} + \sum_{i=0}^{n} \alpha_{6i} TB_{t-1} + \sum_{i=1}^{n} \alpha_{7i} LIBOR_{t-1} + \sum_{i=1}^{n} \alpha_{8i} CPI_{t-1+} \sum_{i=0}^{n} \alpha_{9i} \Delta_{\log} FININ_{t-1} + ¥ECM_{t-1} + ³_t \quad (3.4)$$

Empirical work on the demand for money function for Rwanda has applied both single equation and multivariate cointegration techniques in modeling it. Notably, the researchers have applied either the Engle–Granger methodology (Rusuhuzwa 2001) or the Johansen technique (1988) (Rusuhuzwa 2001, Nachega 1999, Rutayisire 2008) or the Johansen–

Juselius 1990,(Rusuhuzwa 2014) but none of the prior studies has used the Autoregressive Distributed Lag (ARDL) approach of Pesaran & Pesaran (1997) and Pesaran & Shin (1999). According to Mah (2000), the conventional cointegration tests like Engle and Granger (1987), Johansen (1988) or Johansen and Juselius (1990) lack reliability in small sample studies. The ARDL modeling methodology of Pesaran and Shin (1999) produces more reliable cointegration results regardless of sample size.

The ADRL–ECM approach is hailed for its robustness and ability to integrate stationary and non–stationary time series data into a data coherent equation with valid parameter estimates. Thus, it does not require stationarity pre-testing as is the case with other conventional approaches to cointegration analysis. Furthermore, Cook (2006) argues that the F-test in the ARDL framework possesses greater power than both the Engle-Granger and the GLS-based cointegration tests. Tang (2007:477) also notes that an ARDL framework allows separate identification of both long-run and short-run coefficients of explanatory variables. Its major weakness is that the ARDL procedure will crash in the presence of I (2) series. Refreshingly, economic time series data are rarely I (2).

Following the propositions of Pesaran et al., (2001) this study applies the bounds testing procedure to test the existence of any meaningful long-run relationship by establishing whether variables are cointegrated or not.

3.6 Pre-estimation Procedures
To prevent spurious or nonsense regressions, the properties of data is checked to see if there are no violations of the ordinary least squares estimation assumptions. The following tests are carried out in Stata; Skewness/Kurtosis tests for normality, multicollinearity test to check for correlations among the independent variables and the Augmented Dickey-Fuller tests for stationarity.

3.7 Bounds Testing for Cointegration
The first step of the ARDL-bounds testing procedure is to determine the lag lengths on the first differenced variables from the unrestricted models using the Akaike Information Criterion (AIC) and the Schwartz Bayesian Criterion (SBC). The results of the AIC and SBC tests determine the lag length.

In order to ascertain the presence of a long-run equilibrium relationship between monetary aggregates and determinants, a joint significance Wald-test (F-test) is conducted. The estimated coefficients of lagged level variables in equation 3.3 are tested to establish whether they are jointly equal to zero under the null hypothesis of no long-run relationship. If the F statistic is larger than the upper bounds of the critical value provided by Pesaran and Shin(2001), the null hypothesis of no relationship is rejected.

After establishing that money demand and its determinants are cointegrated, an ARDL-ECM is run to separate the variables' long-run and short-run effects on the demand for money in Rwanda. To check the accuracy of the ARDL results the following post diagnostic tests are carried out: Breusch Godfrey test for higher order serial correlation, the autoregressive conditional heteroscedasticity test, the Breusch Pagan test for heteroscedasticity, Ramsey regression estimation specification error test for form misspecification and variance inflation factor test for collinearity.

3.8 Stability Assessment
As is traditional practice in modern econometric empirical analysis, this study will check parameter stability. This is essential in econometric modeling due to the weaknesses of the

assumptions of the Box-Jenkins methodology that coefficients of parameter estimates are constant in different periods. In Rwanda, for instance, there are various reasons to suspect for structural changes in money demand due to so many important changes in economic spheres of the nation. Changes in monetary policy stances by the National Bank of Rwanda might have induced unknown changes in money supply. Financial liberalization and other deregulations might have impacted on expenditure components of money demand. Thus, there are different diagnostic instruments to examine structural and parameter stability in models, depending on whether the breaking points in the time series are known or not.

The cumulative sum of recursive residuals (CUSUM) and the cumulative sum of squares of recursive residuals (CUSUMSQ) tests are proposed by Brown, Durbin & Evans (1975). These are very general tests of structural change which do not require prior determination of where the structural break takes place. If this is known, the Chow test would be more powerful. But, if this break is not known, the CUSUM and CUSUMSQ provide better results. (Baltagi 2008). The CUSUM is computed through the formula:

$$CUSUM_t = \sum_{i=k}^{t} w_{i+1,i} \qquad (3.5)$$

These are plotted at 5% level of significance and the null hypothesis of stability is rejected if the CUSUM crosses the lines ±0.948 [$\sqrt{T-K}$ + 2(t - K) / $\sqrt{T-K}$ (Kramer &Sonnberger, 1986).

The CUSUM test can detect a nonzero mean of the recursive residuals due to shifts in the model parameters. Lütkepohl and Kratzig (2004) argue that the test may not have much power if there are several parameter shifts that may have compensated their impacts on the means of the recursive residuals. To check for impacts from possible simultaneous or synchronous shifts in parameters of the model, the CUSUMSQ tests are better.

The CUSUMSQ makes use of the squared recursive residuals and follows the same procedure. However, it is more applicable in situations where haphazard and sudden deviations from the constancy of the regression coefficients are suspected. The null hypothesis of structural stability is rejected if the plots cross the critical lines at 5% significance level. This study applies both the CUSUM and CUSUMSQ test to check for parameter stability in Rwanda's money demand function.

CHAPTER: 4 DATA PRESENTATION AND ANALYSIS

4.1 Introduction

This chapter describes in detail the procedure that was followed in modeling the determinants of the demand for money in Rwanda. Results from the ARDL analysis of the secondary data are presented and interpreted. Section 4.1 outlines the pre-estimation steps followed in this study; these included transformation of data into logarithmic form as well as tests for normality, multicollinearity and stationarity. The descriptive statistics about the data generated from these tests are interpreted and their implications for the study are explained.

Section 4.2 explains how the bounds testing procedure to cointegration analysis was applied. Results of the ARDL model are presented and diagnostic tests are conducted. Long-run elasticities are computed using the Bardsen (1989) methodology and interpreted. The ARDL-ECMs for M2 and M3 are estimated to examine short run dynamics and incorporating them into the long-run relationships in an attempt to measure the speed of adjustment of deviations from equilibrium. Section 4.4 deals with testing for structural and parameter stability of Rwanda's money demand function.

4.2 Statistical Properties of the Variables
Data for M2, M3, RGCF, RFCE, REX and EX are first transformed into logarithmic form to enable the interpretation of coefficients as elasticities and to normalize the time series on the respective variables. The variables of TB, Libor, FININ and CPI are already in percentage form and their coefficients are automatically interpreted as elasticities, so there is no need for logarithmic transformation.

4.2.1 Descriptive Statistics of Variables
Table 4.1 below provides a summary of the descriptive statistics of the variables used in the study.

Table 0.1: Descriptive Statistics for Variables in Logarithmic Form

	Log _M2	Log _M3	Log_ RGCF	Log_ RFCE	Log_ REX	91TB	LIBOR	CPI	FININ	Log- EX
Mean	5.86	6.02	4.99	7.18	4.37	27.12	3.34	59.98	43.06	6.18
Standard deviation	0.53	0.51	0.65	0.17	0.68	13.38	2.08	21.40	6.64	0.26
Skewness	0.06	0.01	0.18	0.74	-0.18	0.46	0.09	0.55	0.45	-0.81
Kurtosis	1.92	2.00	1.58	3.71	1.63	2.13	1.44	1.78	3.28	2.11

In a normal distribution, the value of skewness must be 0 and the value of Kurtosis must be 3. A Kurtosis value less than 3 indicates that the distribution is flat relative to the normal while a value greater than 3 shows that distribution is more peaked than the normal distribution. According to Mutsau (2013), positive skewness means that the distribution has a long right tail and a negative skewness implies that the distribution has a long left tail. At this preliminary stage, the variables M2, M3, RGCF, REX, TB, LIBOR and FININ show that their skewness coefficients are not significantly different from zero. Monetary aggregates, M2 and M3 are both almost perfectly symmetrical with skewness values of 0.064 and 0.0.015 respectively. The variables REX and EX are positively skewed. A proper normality test is carried out in this study as confirmation or otherwise of this preliminary analysis.

4.2.2 Test for Normality
A joint skewness/normality test was carried out to find out whether or not the data could be considered to be symmetrical. The skewness/ kurtosis test presents a test for normality based on skewness and another based on kurtosis and then combines the two tests into an overall test

statistic. This test is preferred to the traditional and popular Jacques Berra test because it is considered more efficient with small sample sizes. Table 3 below shows the results of a joint Skewness/Kurtosis test for normality carried out in Stata.

Table 0.2: Skewness/Kurtosis Tests for Normality

H0:Variables are normally distributed H1: Variables are not normally distributed					
				-----Joint------	
Variable	Obs	Pr(Skewness)	Pr(Kurtosis)	adj chi2(2)	Prob>chi2
log_m2	72	0.809	0.000	10.48	0.005
log_m3	72	0.9555	0.002	8.78	0.012
log_RGCF	72	0.512	0.000	40.73	0.000
Log_RFCE	72	0.0109	0.151	7.63	0.022
log_REX	72	0.4912	0.000	33.3	0.000
Tb	72	0.2271	0.217	3.25	0.197
Labor	72	0.7358	0.000	-	0.000
CPI	72	0.0497	0.000	20.23	0.000
FININ	72	0.1025	0.398	3.52	0.172
Log_EX	72	0.0057	0.019	10.97	0.004

The results of the joint Skewness/ Kurtosis normality test show that the skewness of all variables except Log_RFCE, CPI and Log_EX are consistent with a normal distribution. On the other hand, the kurtosis of the variables RFCE, TB and FININ are the only ones showing evidence of normality. Overall, the transformed variables except TB and FININ are significantly asymmetrical and have extreme outliers as their chi^2 adjusted probabilities of the test are significant.

The assumption of the classical regression model postulates that residuals ought to be normally distributed with a mean of 0 and constant variance. The implication of violations of this assumption is that inferential statistics of a model, such as the t-test and the F-test, are rendered less reliable. However, according to the central limit theorem, if there are a large number of independent and identically distributed random variables, then with a few exceptions, the distribution of their sum tends to a normal distribution as the number of such variables increases indefinitely (Gujarati, N.D (2004). One of the variant of this theorem is that even if the number of variables is not very large or if these variables are not strictly independent, their sum may still be normally distributed. The observations in this study are 72 [the sample is large (or >30)]. Therefore, unless this lack of normality in some variables is not combined with several other pathologies, the estimations produced in the study might not be severely impacted.

4.2.3 Test for Multicollinearity

Multicollinearity causes the coefficient of variation R^2 to be high but the individual coefficients will have high standard errors, so that the regression looks good as a whole, but the individual variables are not significant. This arises when explanatory variables are very closely related and as a consequence causing difficulty in observing the individual contribution of each variable to the overall fit of the regression. Also, the regression becomes very sensitive to small changes in the specification, so that adding or removing an explanatory variable may lead to large changes in the coefficient values or significances of the other variables. Finally, near multicollinearity will make confidence intervals for the parameters very wide, and significance tests might therefore give inappropriate conclusions, and so make it difficult to draw sharp inferences. The pair-wise correlation matrix for the study's data produced in Stata is shown in Table 4.

Table 0.3: Correlation Matrix

	log_ m2	log_ m3	log_ rgcf	log_ rfce	log_ rex	tb	libor	Cpi	finin	log_ _ex
log_m2	1.00									
log_m3	0.99	1.00								
log_RGCF	0.85	0.86	1.00							
Log_RFCE	-0.29	-0.30	-0.09	1.00						
log_REX	0.86	0.87	0.91	0.02	1.00					
TB	-0.89	-0.90	-0.92	0.36	-0.79	1.00				
LIBOR	-0.76	-0.77	-0.84	0.38	-0.64	0.93	1.00			
CPI	0.89	0.89	0.92	-0.37	0.78	-0.99	-0.93	1.00		
FININ	0.67	0.66	0.38	-0.09	0.49	-0.44	-0.24	0.44	1.00	
Log_EX	0.89	0.89	0.78	-0.39	0.73	-0.87	-0.78	0.89	0.53	1.00

The results indicate negative correlations between expenditure components and short term interest rates (TB) except RFCE which is positively correlated with TB. Libor is negatively correlated with RGCF and REX but positively correlated with RFCE. There is a positive correlation between REX and RFCE but some negative correlation between RFCE and RGCF. Financial innovation(FININ) is positively correlated with RGCF and REX but negatively correlated with RFCE.Opportunity cost of money variables are negatively correlated with each other with the following exceptions; TB rate and exchange rate, exchange rate and CPI, TB and LIBOR.

The correlation signs between variables TB and CPI are as envisaged by economic theory: Tb rates and CPI are negatively correlated. Economic theory holds that as interest rates fall, more people will be able to borrow money. The result is that consumers will have more money to spend, causing the economy to grow and inflation to increase. The opposite holds true for increasing interest rates. As interest rates increase, consumers tend to save as returns are higher. With less disposal income to spend as a result of the increase in savings, the economy slows and inflation decreases.

According to Asteriou and Hall (2007), if a correlation coefficient between variables exceeds 0.9, problems related to multicollinearity are expected to emerge. LIBOR is highly positively correlated with CPI, while CPI is also too highly positively correlated with RGCF. In conformity with theory, all expenditure variables were expected to be positively correlated but the correlation matrix is showing otherwise for RGCF and RFCE. To resolve the problem of multicollinearity the variables REX and 91TB are going to be dropped from the regression models. CPI and Log_RGCF are retained although they are highly positively correlated because dropping any of the two may lead to a misspecification error as they really belong to the model. The pair-wise correlation matrix will appear as follows after dropping the variables log_REX and 91TB:

Table 0.4: Correlation Matrix (After Dropping REX and 91TB)

	log_m2	log_m3	log_rgcf	log_rfce	libor	cpi	Finin	log_ex
log_m2	1.000							
log_m3	0.998	1.000						
log_rgcf	0.931	0.926	1.000					
log_rfce	-0.267	-0.265	-0.130	1.000				
libor	-0.725	-0.742	-0.679	0.170	1.000			
cpi	0.928	0.922	0.960	-0.339	-0.688	1.000		
Finin	0.686	0.673	0.591	-0.169	-0.349	0.634	1.000	
log_ex	0.885	0.901	0.798	-0.131	-0.774	0.744	0.448	1.000

The only remaining worrying collinear relationship which remains is that between CPI and log_RGCF which 0.96 is.

4.2.4 Tests for Stationarity

Tests of stationarity are a prerequisite before conducting most econometric works. According to Pesaran et al., (2001), the bounds testing procedure can be implemented whether or not the regressors are I(0) or I(1) and therefore does not require pre-root testing .Despite this claim, it is still important to conduct unit root tests before bounds cointegration test because the ARDL approach collapses if regressors are integrated on an order higher than one as there is no provision for I(2) in the critical values for bounds testing. This study checks the integration of the data to detect the presence of unit roots in the series and determine the order of integration of the variables and eliminate any chance of spurious regression.

The Augmented Dickey Fuller (ADF) test is used to determine the order of integration of the data. The stationarity tests are conducted on the null hypothesis that the data generating process has a unit root against an alternative hypothesis of no unit root. The null hypothesis is rejected if the absolute value of the t-statistic is greater than the absolute value of the critical value at the 5% level of significance. The critical values for both the ADF tests are obtained from

MacKinnon (1996) tables. These tests have been performed for the model with trend and intercept. Table 4.5 below shows the results of the ADF test conducted in Stata.

Table 0.5: ADF Test Results

H_0: Has unit root (is not stationary)

H_1: Has no unit root (is stationary)

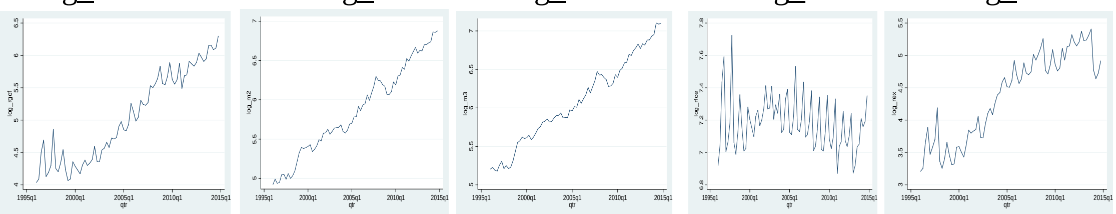
Variable	T-Statistic In Level	T-statistic in First Difference	Order of Integration
Log M2	-3.207	-9.981	I(1)
Log M3	-3.114	-9.327	I(1)
Log RGCF	-4.250	-10.216	I(0)
Log RFCE	-8.094	-10.803	I(0)
Log REX	-4.330	-9.718	I(0)
Log EX	-0.671	-3.750	I(1)
Libor	-1.434	-5.313	I(1)
TB	-1.712	-3.481	I(1)
CPI	-1.060	-4.985	I(1)
FININ	-6.023	-11.954	I(0)
Critical Values at α =0.05	-3.479	-3.480	

The variables log_RGCF, Log_RGCF, log_REX and FININ are stationary in levels at 5% significance level. All the other variables are integrated of order one, I (1). Crucially, the independent variables M2 and M3 are not stationary, a necessary requirement for the use of the ARDL methodology. It is clear from Table 6 above that at first difference all the data becomes stationary at 5% level of significance and there is no need for further differencing. This is adequate proof that all data is integrated of order 1 and not beyond, another necessary precondition for the application of the ARDL approach.

4.1.3 Graphical Descriptions of Data

The time series of variables are displayed graphically in Figure 3 as confirmatory evidence of the order of integration of variables in levels and first differences through visual inspections.

Log_M2 Log_M3 Log_RGCF Log_RFCE Log_REX



Log_EX Libor 91 TB CPI FININ

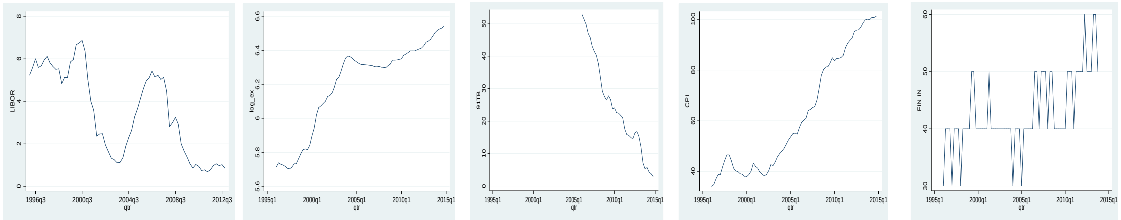
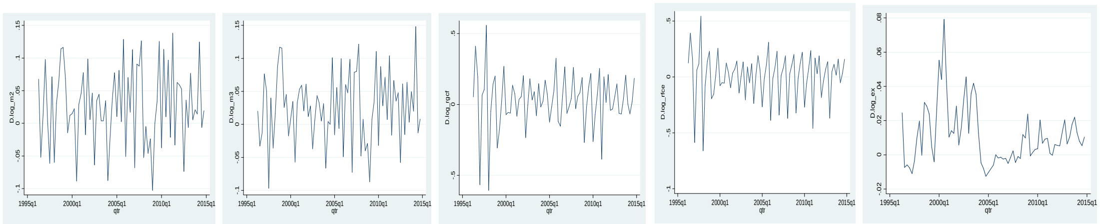


Figure 0.1: Graphic Plots of Variables in Levels

The time series graphical displays show that dependent variables M2, M3, CPI, Log_RGCF, LIBOR and TB are nonstationary at levels. The independent variables Log_RFCE, Log_REX, Log_EX and FININ show some tendency to revert to the mean and are therefore stationary 1(0).

Log_M2 Log_M3 Log_RGCF Log_RFCE Log_REX



Log_EX 91TB CPI LIBOR FININ

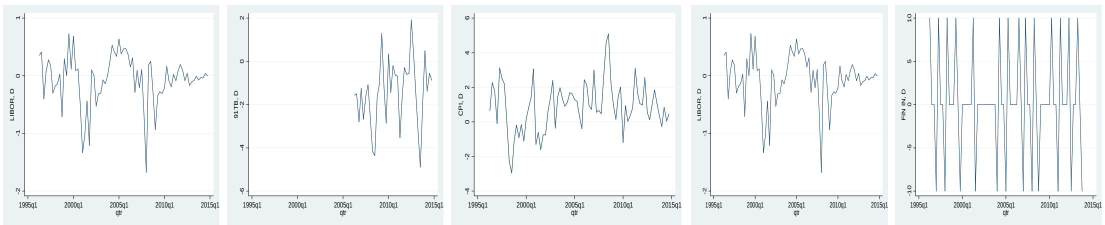


Figure 0.2: Graphic Plots of Variables in First Differences.

The graphs of differenced series show evidence of stationarity. They are displaying the tendency to fluctuate about zero; such mean reversion tendencies are consistent with behaviour of stationary series. The conclusion reached is that the data for this study are a mixture of I (0) and I (1) variables.

4.3 Bounds Testing for Cointegration

4.3.1 Determination of Lag Lengths

The first step in ARDL bounds testing is the determination of the optimum number of lags to be included in the model. This is because in economic time series data, it is possible to have persistent variables that may affect the dependent variable long into the future. Indeed the dependent variable can be affected by its past values as well. Stata has the following criteria for lag selection: the Likelihood Ratio (LR), Final Prediction Error (FPE), the Hannan Quinn Information Criterion HQC), the Akaike Information Criterion (AIC) and the Schwarz' Bayesian Information Criterion (SIC/BIC/SBIC). The AIC and SBIC criteria select lag length j to minimize: log(SSR(j)/n) + (j + 1)C(n)/n, where SSR(j) is the sum or squared residuals for the VAR with j lags and n is the number of observations; C(n) = 2 for AIC and C(n) = log(n) for BIC. The results of the lag selection tests carried out in Stata are shown in Table 7.

Table 0.6: Lag Selection Results

Sample 2006q1-2013q4

Number of Observations = 32

Lag	LL	LR	Df	P	FPE	AIC	HQIC	SBIC
0	150.541				8.90E-07	-8.28384	-8.01055	-7.45937
1	161.887	22.691	4	0.000	5.80E-07	-8.74295	-8.40893	-7.73525
2	165.184	6.5936	4	0.159	6.30E-07	-8.699	-8.30425	-7.50809
3	172.03	13.692	4	0.008	5.60E-07	-8.87686	-8.42138	-7.50273
4	177.633	11.206	4	0.024	5.50E-07	-8.97706	-8.46085	-7.41972
5	179.991	4.7161	4	0.318	6.90E-07	-8.87444	-8.29749	-7.13388
6	191.915	23.849	4	0.000	4.90E-07	-9.36971	-8.73203	-7.44593
7	230.434	77.037	4	0.000	7.10E-08	-11.5271	-10.8287	-9.42013
8	241.406	21.944	4	0.000	6.40E-08	-11.9629	-11.2037	-9.67265
9	252.662	22.513	4	0.000	6.60E-08	-12.4164	-11.5965	-9.94296
10	295.599	85.874*	4	0.000	1.3e-08*	-14.8499*	-13.9693*	-12.1933*

All the selection criteria are picking 10 lags (shown by the asterisks) as the optimal number of lags for the regression.10 lags are used in choosing the ARDL models for this study. This agrees with the rule of the thumb which says that for quarterly data the number of lags falls between 4 and 16.

4.3.2 Testing for a Level Relationship among the Variables in the ARDL Model.

To ascertain the presence of a long-run equilibrium relationship between monetary aggregates and determinants, a bounds test is conducted in Stata. The bounds test computes the F-Statistics of the coefficients of the regression model on the null hypothesis of no relationship. Specifically, the bounds test establishes whether the coefficients of regressors at level are jointly equal to zero, that is, $\alpha_1=\alpha_2=\alpha_3=\alpha_4=\alpha_5=\alpha_6=\alpha_7=\alpha_8=\alpha_9=0$ against the alternative $\alpha_1 \neq \alpha_2 \neq \alpha_3 \neq \alpha_4 \neq \alpha_5 \neq \alpha_6 \neq \alpha_7 \neq \alpha_8 \neq \alpha_9 \neq 0$. The calculated statistics are then compared with critical values of Pesaran, Shin and Smith (2001). The decision rule for F-Statistic is accept null hypothesis if F <the critical value for I(0) regressors and reject if F >the critical value for I(1) regressors. The results of the bounds test are in Table 8 below.

Table 0.7: (a) F-Statistics Tests Results

Ho: There is no relationship

H1: There is a relationship

Monetary Aggregate	F-Statistic	Conclusion
M2	4.835	F > the upper bounds at1%, 2.5%, 5% and 10% levels of significance. M2 is cointegrated with its determinants
M3	3.885	F>the upper bounds at 5% and 10% significance levels. M3 is cointegrated with its determinants.

Table 0.8 (b): Critical Values for F-Test

Critical Values (0.1-0.01), F-statistic							
10%		5%		2.5%		1%	
[I_0] L_1 2.26	[I_1] L_1 3.35	[I_0] L_05 2.62	[I_1] L_05 3.79	[I_0] L_025 2.96	[I_1] L_025 4.18	[I_0] L_01 3.41	[I_1] L_01 4.68

Source: Pesaran, Shin and Smith (2001)

From the results presented in Table 8, it is shown that there is evidence of cointegration between regressors and broad money (M2 and M3). This is the case because the bounds tests give F-statistics greater than upper bounds at all levels of significance for M2 and at 5% and 10% significance levels for M3.

4.3.3 Simple ARDL Regression

After establishing that the variables in the regression are cointegrated, the next step is to carry out a simple ARDL regression model for each monetary aggregate using Schwartz-Bayesian Information Criterion (SBIC). The SBIC is used because it is proved to be very parsimonious and consistent especially with ARDL models (Mutsau 2013). In results shown in Appendices 4 and 5, the coefficient of RGCF of 0.416 is highly insignificant for M2. The regression has an R-Squared value of 99.4% for the simple model and 66.2% for the ECM version. The lack of significance of RGCF might be a result of the high multi-collinearity between it and CPI and exchange rate. For M3 (see Appendix 6) RGCF is insignificant (0.366) and its presence brings in a lot of pathologies in the regression: low R^2 value (46, 9) and a variance inflation factor above 10. To make the model parsimonious and improve the significance of other variables, in line with general to specific methodology, the most insignificant variable RGCF is dropped and the regression is run again. This leaves RFCE as the only scale variable in the model. The results are shown in Table 10 and 11 below.

D.log_m2	Coef.	Std. Err.	T	P> | t |	[95% Confidence Interval)
log_m2 L1.	0.782382	0.0734876	10.65	0.000	0.635 0.930
log_rfce	0.223806	0.0434093	5.16	0.000	0.137 0.311
Libor	0.004987	0.0041654	1.2	0.237	-0.003 0.013
Cpi					
--.	0.001638	0.0049043	0.33	0.740	-0.008 0.011
L1.	-0.0077	0.0076809	-1	0.321	-0.023 0.008
L2.	-0.00077	0.0074765	-0.1	0.918	-0.016 0.014
L3.	0.010519	0.0043493	2.42	0.019	0.002 0.019
Finin					
--.	0.005945	0.0011153	5.33	0.000	0.004 0.008
L1.	-0.00298	0.001345	-2.22	0.031	-0.006 -0,0002
L2.	0.002703	0.0012231	2.21	0.032	0.0002 0.005
log_ex					
--.	-0.5637	0.3495679	-1.61	0.113	-1.265 0.138
L1.	0.722343	0.3291225	2.19	0.033	0.062 1.383
_cons	-1.75213	0.3717369	-4.71	0.000	-2.498 -1.006

Table 0.9: Results of the Simple ARDL Model – M2 (SBIC)

These results can be written as follows with the italicized variables being the ones that are significant:

D.log_M2= -1.75213+0.782382log_M2 (-1) +0.223806log_RFCE + 0.004987 LIBOR *+0.010519CPI (-3) +0.005945FININ - 0.00298 FININ (-1) +0.0027FININ (-2) + 0.72234log_EX (-1)* (4.1)

The results indicate that the demand for money (M2) in Rwanda is positively affected by the preceding quarter's demand for money, real final consumption expenditure, the third lag of the rate of inflation, the current and second lags of financial innovation and the first lag of the exchange rate. The first lag of financial innovation negatively influences the demand for M2. However, the influence of foreign exchange rates proxied by the London Inter-Bank Offered Rate (LIBOR) is not significant.

Table 0.10: Results for Simple ARDL Model – M3 (SBIC)

D.log_m3	Coef.	Std. Err.	T	P> | t |	[95% Confidence Interval]
log_m3 L1.	0.77437	0.05121	15.12	0.000	0.672 0.877
log_rfce	0.1361	0.03309	4.11	0.000	0.070 0.202
Libor	0.0055	0.00366	1.5	0.139	-0.002 0.013
Cpi					
--.	-0.0021	0.004	-0.53	0.595	-0.010 0.006
L1.	-0.0038	0.00673	-0.57	0.572	-0.017 0.010
L2.	-0.0003	0.00674	-0.04	0.968	-0.014 0.013
L3.	0.0094	0.00391	2.41	0.019	0.002 0.017
Finin	0.005	0.00102	4.92	0.000	0.003 0.007
log_ex	0.24119	0.06394	3.77	0.000	0.113 0.370
_cons	-1.4901	0.33078	-4.5	0.000	-2.153 -0.827

D.log_M3 = *-1.4901+ 0.77437 log_M3 (-1) + 0.1361log_RFCE* + 0.0055LIBOR+*CPI (-3) +0.005FININ + 0.24119log_EX* (4.2)

The demand for M3 is again positively affected by the preceding year's demand for money, real final consumption expenditure, the third lag of the inflation rate (CPI), financial innovation and the exchange rate. Libor's effect on money demand is insignificant.

4.4.4 ARDL Error Correction Models for M2 and M3

Having obtained long-run coefficients from the simple ARDL model, the next step is to find the long-run elasticities for the variables. Bardsen (1989) developed a technique for deriving the log-run elasticities from the simple ARDL regressions when the variables are cointegrated. To obtain the elasticities, the coefficient of one lagged level exogenous variable is divided by the coefficient of the lagged level endogenous variable multiplied by a negative sign. For example, in equation 4.1, the long-run coefficient of real final consumption expenditure (RFCE) is 0.22381 and so its elasticity = - ($\frac{0.22381}{-0.217618}$) = 1.028435. Other elasticities for long run estimates are calculated in a similar way. Stata has the ability to separate out the long-run from short-run effects automatically when an unrestricted error correction model is run. This removes the burden of calculation from the research. Consequently, the next step is to estimate the unrestricted error correction model, expressed through 3.4. The ECM results show the long-run elasticities and semi-elasticities already calculated as well as short-run elasticities. Tables 12 and 13 display the ECM results for M2 and M3 respectively.

Table 0.11: ARDL Long Run and Short-Run Estimates

Dependent Variable - M2 (SBIC)						
D.log_ m2		Coef.	Std. Err.	T	P> | t |	[95% Confidence Interval]
ADJ	Log_m2 L1	-0.217618	0.073488	-2.96	0.005	-0.365 0.070
LR	Log_RFCE	1.028435	0.440074	2.34	0.023	0.145 0.912
	LIBOR	0.022914	0.019815	1.16	0.253	-0.017 0.063
	CPI	0.0169442	0.003385	5.01	0.000	0.010 0.024
	FININ	0.0260433	0.006733	3.87	0.000	0.013 0.039
	Log_EX	0.7289924	0.24669	2.96	0.005	0.234 1.224
SR	CPI: D1	-0.002049	0.004655	-0.44	0.662	-0.011 0.007
	LD	-0.009745	0.004621	-2.11	0.04	-0.019 0.0004
	L2D	-0.010519	0.004349	-2.42	0.019	0.019 0.002
	FININ:D1	0.000278	0.001866	0.15	0.882	-0.003 0.004
	LD	-0.002703	0.001223	-2.21	0.032	-0.005 0.002
	Log_EX: D1	-0.722343	0.329123	-2.19	0.033	-1.383 -0.062
	_cons	-1.752132	0.371737	-4.71	0.000	-2.498 -1.006

Bartholomew (2011) argues that the coefficient of the lagged error correction term should be negative and statistically significant to confirm the existence of a long-run relationship between the dependent variable and independent variables. Sovannroeun (2009) and Haghighat (2012) also concur that a significant lagged error term is a more efficient way of empirically establishing cointegration. The coefficients of adjustment of both the M2 (figure 12 above) and M3 (figure 13 below) models are negative and significant.

Table 0.12: ARDL Long Run and Short-Run Estimates

Dependent Variable – M3 (SBIC)						
D.log_m3		Coef.	Std. Err.	T	P> | t |	[95% Confidence Interval]
ADJ	Log_m3 L1	-0.2256	0.05120	-4.41	0.000	-0.328 -0.123
LR	log_rfce	0.60318	0.21545	2.8	0.007	0.171 1.035
	LIBOR	0.02435	0.01649	1.48	0.145	-0.009 0.057
	Cpi	0.01400	0.00196	7.14	0.000	0.010 0.018
	Finin	0.02214	0.00513	4.31	0.000	0.012 0.032
	Log_EX	1.06894	0.17219	6.21	0.000	0.724 1.414
SR	CPI: D1	-0.0053	0.00388	-1.36	0.178	-0.013 0.002
	LD	-0.0091	0.00419	-2.18	0.034	-0.018 0.001
	L2D	-0.010519	0.004349	-2.42	0.019	0.019 0.002
	FININ:D1	0.0002776	0.001866	0.15	0.882	-0.003 -0.004
	LD	-0.0094	0.00391	-2.41	0.019	-0.017 -0.002
	_cons	-1.4901	0.33078	-4.5	0.000	-2.153 -0.827

The speed of adjustment in the M2 model is 21.6% per quarter while the M3 model corrects deviations from equilibrium at the rate of 22.6% per quarter which in both cases is fast. This implies that disequilibrium in the system is fully cleared and equilibrium is fully restored early in the first quarter of the following year (in five quarters). This contradicts Rutayisire (2008) who found a coefficient of adjustment of 8.2% for M2. That low coefficient implies persistent monetary disequilibrium in the Rwandan economy in the event of shocks which would take 12 quarters to be corrected. He attributed the slow adjustment to a poorly developed financial system and high transaction costs. The improved speed of adjustment in the current findings may be a result of improvements in the competitive structure of Rwanda's financial service sector and a reduction in transaction costs (Rusuhuzwa and Nyalihama 2015).

The long run coefficients of the variables RFCE and EX have expected signs while LIBOR, CPI and FININ have unexpected signs. All variables except LIBOR are significant. In the long run the demand for both M2 and M3 is positively affected by real final consumption expenditure, the exchange rate, the rate of inflation and financial innovation.

The results show that a 1% increase in real final consumption expenditure (RFCE) will cause a 1.03% rise in the demand for M2 and a 0.6 % increase in demand for M3. This is consistent with theoretical expectations that as incomes rise, people's demand for cash rises as well. Indeed, all earlier investigations of Rwanda's money demand function proved a positive relationship between the demand for money and the income variable(s) (Nachega 1999, Rusuhuzwa 2001, Hauna and Di Bella 2005, Rutayisire 2008).

A positive long-run elasticity of exchange rate is inconsistent with earlier findings by Nachega 1999(negative), Kigabo 2001(not significant), and Rutayisire 2008 (negative). Nachega and Rutayisire's findings imply that when the Rwandan franc depreciates, the public anticipates other depreciations and the demand for foreign currency rises to the detriment of demand for the domestic currency, a phenomenon known as the substitution effect. However, in the current study the exchange rate's highly significant long-run elasticities are positive (0.73 for M2 and 1.06 for M3).)**.** In all cases the studies spanned different periods and therefore used different data sets. The influence of the exchange rate is thus shown to be changing over time. The positive influence of the exchange rate on money demand established in this study is in support of the wealth effect argument or the positive real balance effect (Arango and Nadiri 1981) and implies that Rwandan wealth holders evaluate their asset portfolios in terms of their domestic currency. Exchange rate depreciation would increase the value of their foreign assets held and so is viewed as wealth enhancing. To maintain a fixed share of their wealth invested in domestic assets, they will convert part of their foreign assets to domestic assets, including domestic currency. Hence, exchange rate depreciation would increase the demand for domestic currency.

A fall in the value of the Rwandan Franc due to inflation was expected to cause Rwandans to prefer to hold their wealth in the form of other assets to the detriment of the demand for local currency. However, the coefficient of CPI in this study is positive and significant. This might be indicative of the fact that the transactions and precautionary motives dominate Rwandans' reasons for holding cash. A rise in inflation, therefore, naturally leads the citizens to hold large balances of money as cash. Therefore, it can be argued that this sign is not paradoxical, but empirically consistent. This also agrees with the view of Friedman (1956), who argues that economic agents (individuals, firms, governments) want to hold a certain quantity of real, as opposed to nominal, money balances. Because inflation erodes the purchasing power of the unit of account, in times of high inflation, economic agents will want to hold higher nominal balances to compensate, to keep their real money balances constant. Rutayisire (2008), the only other researcher to incorporate inflation as an explanatory variable in modeling Rwanda's money demand function, found its elasticity to be positive and insignificant.

Financial innovation was expected to have a negative effect on the demand for money as found in other empirical works such as Lungu et al (2012) for Malawi and Dunne and Kasekende (2016) for Sub-Saharan Africa. That it has a positive effect on both M2 and M3 in this study shows that financial innovations in Rwanda have not provided consumers with alternative financial assets. Rather, the innovations might have helped to facilitate easy access to cash and hence increased the demand for cash.

In the short run only the rate of inflation, financial innovation and the exchange rate negatively affect the demand for M2. The AIC optimized regression of M2 (see Appendix 11) also shows that the lagged values of M2 positively affect the demand for M2 in the short run. The demand for M3 is negatively affected by CPI and FININ in the short-run.

4.5 Post Estimation Diagnostics

To investigate if there are any pathologies which may invalidate the results of the ARDL models for both M2 and M3, the following post-estimation tests were carried out in Stata: the Breusch Godfrey Lagrange Multiplier Test for higher order autocorrelation, the Autoregressive Conditional Heteroscedasticity Test for serial correlation, the Breusch Pagan Heteroscedasticity Test, the Ramsey RESET Test and the Variance Inflation Factor (VIF) Test for multicollinearity.

4.5.1 Breusch Godfrey Test for Autocorrelation

A very popular test for first order autocorrelation in many empirical works is the Durbin-Watson test. The Durbin-Watson test for first order autocorrelation is a test that the residuals from a linear regression or multiple regressions are independent. It cannot be applied in ARDL because of the existence of lags of the dependant variable in the regression. When lagged dependent variables are included among the regressors, the past values of the error term are correlated with those lagged variables at time t, implying that they are not strictly exogenous regressors. The inclusion of covariates that are not strictly exogenous causes the d statistic to be biased toward the acceptance of the null hypothesis. The Breusch Godfrey test for higher order autocorrelation is instead applied in this study.

The Breusch-Godfrey test is a more general test for autocorrelation up to the r^{th} order:

$$e_t = \rho_1 e_{t-1} + \rho_2 e_{t-2} + ... + \rho_r e_{t-r} + \varepsilon_t \ , \quad \varepsilon_t \rightarrow N(0, \sigma^2_\varepsilon) \qquad (4.3)$$

According to Lutkepohl and Kratzig (2004) the LM statistic for the null of interest can be obtained easily from the coefficient of determination R^2 of the auxiliary regression model as:

$$LM = TR^2 \qquad (4.4)$$

where T is the sample size. The null hypothesis of no serial correlation is rejected if the probability value (p-value) is smaller than the level of significance which can be at 0.01, 0.05 and at 0.1.The null and alternative hypotheses are:

$H_0 : \rho_1 = 0; \rho_2 = 0;...; \rho_r = 0$; $\quad H_1 : \rho_1 \neq 0; \rho_2 \neq 0;...; \rho_r \neq 0$

The results of the Breusch Godfrey Autocorrelation test conducted in Stata are shown below:

Table 0.13: Results of Breusch Godfrey Test for High Order Autocorrelation

H0: No autocorrelation vs. H1: Autocorrelation		
	M2 as Dependent Variable	M3 as Dependent Variable
Lags(p)	1	1
Chi^2	1.982	1.292
Df	1	1
Prob > chi^2	0.1592	0.2556

The test results fail to reject the null hypothesis of no autocorrelation. It is therefore concluded that regressions are free from high order autocorrelation.

4.5.2. Autoregressive Conditional Heteroscedasticity ARCH Test

This study uses the LM test suggested by Engle (1982) for checking for autoregressive conditional heteroscedasticity (ARCH) in the errors. The p^{th}-order ARCH model can be written as:

$$\pm_t^2 = E(\neg_t^2 | \neg_{t-1} \dots \neg_{t-p}) \quad (4.6)$$

$$= \yen_0 + \yen_1 \neg_{t-1}^2 + \dots \yen_p \neg_{t-p}^2$$

The ARCH LM test was carried out in Stata on the null hypothesis of no autoregressive conditional heteroscedasticity (that is, $H_{0:}\,\yen_1 = \dots = \yen_p = 0$) against an alternative hypothesis $H_{1:}\,\yen_1 \neq \dots \neq \yen_p \neq 0$ and the results for both the M2 and M3 regressions are shown in Table 15 below.

Table 0.14: Results of LM Test for Autoregressive Conditional Heteroscedasticity (ARCH)

H0: no ARCH effects vs. H1: ARCH(p) disturbance		
	M2 as Dependent Variable	M3 as Dependent Variable
Lags(p)	1	1
Chi^2	1.369	2.320
Df	1	1
Prob > chi^2	0.2420	0.1278

For both the M2 and M3 regression models there is insufficient evidence to reject the null hypothesis of no ARCH effects. It is therefore concluded that there is no autoregressive conditional heteroscedasticity in the errors.

4.5.3 Ramsey RESET Test for Functional Form Misspecification

The study applies the Regression Specification Error Test of Ramsey (1969) which uses the powers of the fitted values of D.log_m2 and D.log_m3 to check for misspecification errors in the models. Ramsey's RESET test is designed to detect if there are any neglected nonlinearities in the model. A multiple regression model suffers from functional form misspecification when it does not properly account for the relationship between the dependent and observed explanatory variables. The results of the Ramsey RESET test carried out in Stata are shown below:

Table 0.15: Results of Ramsey RESET Test

H_0: Model has no omitted variables H_1: Model has omitted variables	
M2 as Dependent Variable	M3 as Dependent Variable
1 F(3, 51) = 0.77	F(3, 52) = 0.28
Prob > F = 0.5183	Prob > F = 0.8368

The RESET test results in Table 17 above fail at 5% significance level to reject the null hypothesis of correct specification. This indicates that the functional forms of regressions used in this study are correct.

4.5.4 The Variance Inflation Factor Tests

The Variance Inflation Factor (VIF) quantifies the severity of collinearity in a regression model**.** According to the rule of the thumb:
VIF < 5 is ideal and should be aimed for.
5<VIF< 10 shows high correlation but is tolerable
VIF>10 indicates data is highly correlated (unacceptable)
The VIF for the M2 and M3 regression were 7.71 and 6.26 respectively (see Appendix). They are high but tolerable. The impact of such a regression pathology is that signs of estimated coefficients can be opposite of those expected or loss of statistical significance on affected coefficients. The accuracy of the regressions has to be treated with some caution.

4.5.5 .Breusch Pagan Heteroscedacity Test

The Breusch-Pagan (1979) and Cook-Weisberg (1983) test is used in this study to test for heteroscedasticity. One of the assumptions of ordinary least squares estimation is that the variance is constant, a condition called homoscedasticty:
$Var(£_t / X_t) = E(£_t - E(£_t / X_t)) = \pm_2$ (constant). (4.7)

When the conditional variance of Y population varies with X, this situation is known as heteroscedasticity. With heteroscedasticity the coefficients of estimated parameters are still unbiased and consistent but their efficiency is lost. Asteriou and Hall (2007) note that the presence of heteroscedasticity causes the OLS method to underestimate variances and standard errors leading to overestimated and misleading *t*-statistics and *F*-statistics.

The Breusch Pagan test presents evidence against the null hypothesis that the regression has a constant variance against the alternative hypothesis that the variance is not constant. The results of the test conducted in Stata are presented below:

Table 0.16: Results of the Breusch-Pagan Test

H_0: Constant Variance H_1: No Constant Variance	
M2 as Dependent Variable	M3 as Dependent Variable
chi2(1) = 0.32	0.000
Prob > chi2 = 0.5741	0.9810

There is no sufficient evidence to reject the null hypothesis of constant variance. The models are therefore homoscedastic or have constant variances.

4.6 Stability tests

The main objective of Rwanda’s monetary policy is to stabilize prices and achieve a stable financial sector. The monetary authorities pursue these goals through the control of a monetary aggregate. The success of policy crucially depends on the hypothesis of stability of the relationship established between the demand for money and its determinants. Indeed, the impact of the money supply on the real variables is predictable only if the demand for money is stable. On the contrary, if this function is unstable due, for example, to institutional or technological changes, the impact of any intervention may be reduced or even lead to unexpected consequences.

In a linear regression model that contains a random-disturbance term, the vector of the parameters is expected to be constant over time .Therefore, the stability of the parameters of the demand for money function indicates the historic behavior of the equation and ensures that the estimation of the function at different sub-periods of the sample yields the same results, while the precision of the forecasts beyond the sample period reflects its predictive power and its usefulness in forecasting money demand for monetary and economic stabilization policy purposes. On account of the economic reforms carried out in Rwanda since 1996, particularly with respect to the emergency of new financial technologies and the liberalization of the financial sector, it was necessary to check for the structural stability of the demand for money function in the Rwandan economy, which may have been affected by these changes.

The cumulative sum of recursive residuals (CUSUM) and cumulative sum of recursive squared residuals (CUSUMSQ) tests were used to assess the stability of Rwanda’s money demand function. The CUSUM and CUSUMSQ tests are proposed by Brown, Durbin & Evans (1975). They are quite general tests of structural change in that they do not require prior determination of where the structural break takes place. If this is known, the Chow test would be more powerful. According to Baltagi(2008),when this break is not known, the CUSUM and CUSUMSQ are more appropriate .

The CUSUM test is designed to detect a nonzero mean of the recursive residuals due to shifts in the model parameters. The test may not have much power if there are more than one parameter shifts that may have compensated their impacts on the means of the recursive residuals. To check for the effects of suspected simultaneous or synchronous shifts in parameters of the model, the CUSUM-of-squares may be more informative.The CUSUMSQ makes use of the squared recursive residuals and follows the same procedure but is more appropriate in situations where the departure from the constancy of the regression coefficients is haphazard and sudden.

The null hypothesis of structural stability is rejected if the plots cross the critical lines at 5% significance level. The CUSUM and CUSUMQ plots for both the M2 and M3 models produced in Stata are given below in Figure 5.

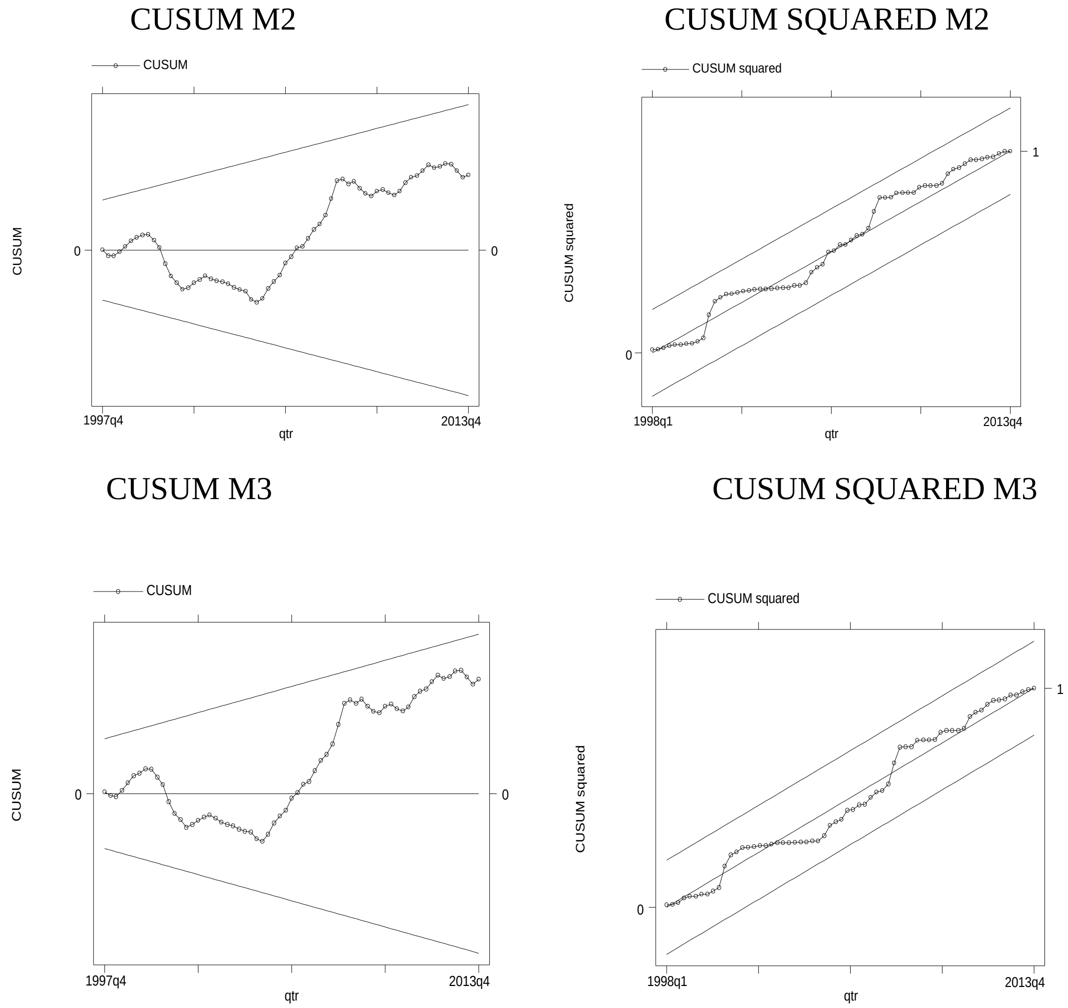


Figure 0.3: CUSUM and CUSUMSQ Plots for M2 and M3 Models

The knotted line should run between the lower and upper bound lines if the model is stable. Both the CUSUM and CUSUM squared plots are showing stability of the money demand function for Rwanda in the period under consideration. The rapid opening up of the financial sector which started in earnest post 1994 and the global financial crisis of 2008 did not affect the stability of Rwanda’s money demand function.

CHAPTER: 5 CONCLUSION AND RECOMMENDATIONS

5.1 Introduction

This chapter summarizes the empirical findings of this study in section 5.1. Policy implications of the study are given in section 5.2 before an evaluation of the study is done in section 5.3. Section 5.4 discusses recommendations for future research.

5.2 Summary of Empirical Findings

The objective of this study was to model the demand for money in Rwanda and its determinants for the sample period 1996-2013 using the Autoregressive Distributed Lag (ARDL) approach of Pesaran and Shin (2001). Evidence from this study shows that the demand for broad money in Rwanda (M2 and M3), and its hypothesized determinants, are cointegrated. The demand for broad money (M2 and M3) is positively influenced by real final consumption expenditure, the exchange rate, the inflation rate and financial innovation. CUSUM and CUSUMSQ tests confirmed the stability of Rwanda's money demand function. Thus, the rapid expansion of Rwanda's financial sector which was built on the bedrock of deregulation and was accompanied by a lot of financial innovations during the period covered by the study, has not affected the stability of the money demand function. The same can be said of major external crises such as the global financial crisis of 2008.

In the long run, the demand for M2 and M3 in Rwanda is significantly positively affected by real final consumption expenditure, the inflation rate, financial innovation and exchange rate (at all known levels of significance). Real gross capital formation does not significantly influence the demand for M2. Real final consumption expenditure, on the other hand, has a positive influence on both monetary aggregates.. However, this study failed to ascertain the influence of real exports expenditure on money demand due to multicollinearity problems.

This study found out that the long run elasticity of the inflation rate has an unexpected but significant positive sign. This may be attributed to the nature of money demand in Rwanda, where the transactions motive dominates other motives in this relationship. This is evidenced and confirmed by highly elastic coefficients of final consumption expenditure for both M2 and M3.

This study found the exchange rate to positively affect the demand for money in Rwanda in long run and negatively affect it in the short run. The positive influence of the exchange rate on money demand established in this study implies that Rwandan wealth holders evaluate their asset portfolios in terms of their domestic currency. Exchange rate depreciation would increase the value of their foreign assets held and so is viewed as wealth enhancing. To maintain a fixed share of their wealth invested in domestic assets, they will convert part of their foreign assets to domestic assets, including domestic currency. Hence, exchange rate depreciation would increase the demand for domestic currency.

The long run coefficient of financial innovation is positive contrary to priori expectations and this may be due to the fact that most financial innovations may have provided people with easier and quicker access to cash than provide attractive alternative ways of holding wealth.

In the short-run the demand for M2 is affected negatively by the inflation rate, financial innovation and the exchange rate while that of M3 is negatively affected by the inflation rate.

5.3 RECOMMENDATIONS

The findings of this study have important policy implications on the management of monetary policy in Rwanda.

1. The country has managed to maintain low levels of inflation by focusing on the broader monetary aggregate M2 as an intermediate target in its conduct of monetary policy. This research proves that M2 remains an appropriate target and that M3 can also used with almost equal effectiveness. Stability of long-run money demand for broad money is confirmed for both M2 and M3, which is a further indication that both M2 and M3 are appropriate intermediate targets of monetary policy in Rwanda.

2. Monetary policy must be buttressed by complimentary fiscal policies focused on final consumption expenditure by both households and government because the highly elastic log-run coefficients on final consumption expenditure for both M2 and M3 show that it is a major driver of money demand in Rwanda.

3. The positive long-run and negative short-run coefficients of exchange rate indicate the significance of the exchange rate to money demand and therefore to monetary policy in Rwanda. BNR should prioritize exchange rate stability as its volatility will affect the money demand function and with that many other economic variables such as inflation. Furthermore, according to Bahmani-Oskooee (1990), monetary policy would lose its effectiveness if the impact of exchange rate depreciation is negative on money demand. Thus, a positive long run elasticity of the exchange rate acts as an incentive for the conduct of monetary policy by the central bank.

4. While innovations that help consumers to easily access their cash are important, alternative financial instruments must be developed and popularized among Rwandans. The current efforts to develop the stock market must therefore be applauded, although they need to be intensified

5. The study shows both long-run and short-run effects of variables on the demand for money. Therefore, the conduct of monetary policy must clearly distinguish between short-run and long-run objectives.

5.4 Suggestions for Further Research

Another study which incorporates a short term interest rate or long term interest rate or both needs to be carried to investigate the effect of own rate of return on the demand for money in Rwanda.
Further the effects of disaggregated components of GDP on money demand need to be investigated more conclusively probably using a different method or a different data set.

REFERENCES

Akaike, H. (1969). “Fitting autoregressive models for prediction”, *Annals of the Institute of Statistical Mathematics.* Vol. 21:243-247.

Akaike, H. (1970). “Statistical Predictor Identification”, *Annals of the Institute of Statistical Mathematics,* Vol. 22:203-217.

Akerlof, G.A and Milbourne, R. D. (1980). “The Long-run demand for money”, *Economics Journal,* 90 (360), Vol. 53:885-900.

AL-Samara, M. (2010). “An Empirical Analysis of the Money Demand Function in Syria”, *Departmental Paper – Economic Centre of Sorbonne*, University of Paris.

Arango, S, and Nadiri, M. I. (1981). Demand for money in open economy. *Journal of Monetary Economics* Vol 7; 69-83.

Arrau, P., De Gregorio, J., Reinhart, C., Wickham, P., (1995). “The demand for money in developing countries: assessing the role of financial innovation.” *Journal of Development Economics* 46 (2), 317-340

Bahmani-Oskooee, M. and Brooks, T. J. (2003). A new criteria for selecting the optimum lags in Johansen's cointegration technique. *Applied Economics* Volume 35; 875-880.

Bahmani-Oskooee, M. and Chomsisengphet, S. (2002). Stability of M2 money demand function in industrial countries. *Applied Economics* Volume 34; 2075–83.

Friedman, M. (1956). “The Quantity Theory of Money: A Restatement”, in Friedman M (ed) *Studies in the Quantity Theory of Money*, Chicago: University of Chicago Press.

Granger, C.W.J. (1983). “Cointegrated Variables and Error Correction Models, “*Discussion Paper No. 83-13. Department of Economics*. University of California at San Diego

Gujarati, N. D. (2004) *Basic Econometrics, Fourth Edition*. New York, McGraw-Hill.

Hamilton, J. D. (1994). *Time Series Analysis*. Princeton, N.J.: Princeton University Press.

Hauner, D. and Di Bella, G. (2005). How useful is monetary econometrics in low-income-countries? The case of money demand and the multipliers in Rwanda, *IMF Working Paper,* N°05/178, 2005.

International Exchange Libor (2014). Retrieved from www.global-rates.com/interest-rates/libor/libor.aspx

Johansen, S and Juselius, K. (1992). “Testing Structural Hypothesis in a Multivariate Cointegration Analysis of the PPP and UIP for UK”. *Journal of Econometrica 53*:211-244.

Keynes J.M. (1936). *The General Theory of Employment Interest and Money*, London, Longman

Kramer, W and Sonnberger, H. (1986). “The Linear Regression model under test”. *Physica-Verlag*, Heidelberg.

Laidler, D.E.W. and Parkin, J.M. (1970). The demand for money in the United Kingdom 1956-1967: Some preliminary estimates. *Manchester School Journal*, 38:187-208.

Macmillan, of Moggridge D and Jonson E (eds) (1973). *Collected Works of John Maynard Keynes*. Vo1 VII. London: Macmillan.

Mankiw, G.N. (2006) *Principles of Macroeconomics 4th Edition*, New York, McGraw-Hill.

Miskin, F. (2004). *The Economics of Money, Banking and Financial Markets*. New York, Pearson Addison Wesley.

Mutsau, I. (2013). Empirical Analysis of Money Demand in South Africa: An ARDL Approach. *South African Journal of Economics*, Volume 59

Nachega, J.C., (2001). A cointegration analysis of broad money demand in Cameroon, *IMF Working Paper*/2001/ 26.

Nachega, J.C. (2001). Financial liberalization, money demand, and inflation in Uganda, *IMF Working Paper* /2001/118.

Pesaran, M. and H, Shin,Y.(1995). An autoregressive distributed lag modeling approach to cointegration analysis. In: Strom, S., Holly, A., Diamond, P. (Eds.), *Centennial Volume of Rangar Frisch,* Cambridge, Cambridge University Press, Pesaran, M. H, Shin, Y. and Smith, R. J.(2001) Bounds testing approaches to the analysis of level relationships. *Journal of Applied Econometrics* 2001/16; 289-326.

Rutayisire, J.M. (2008). Liberalization, monetary policy and demand for money in Rwanda (1980-2005) Kigali, *National Bank of Rwanda*.

Rusuhuzwa, K. T.(2014).Monetary and financial innovations and stability of money multiplier in Rwanda, Kigali , *National Bank of Rwanda.*

Tan, E.C. (1997). "Money demand amid financial sector development in Malaysia", *Applied Economics*, Vol. 29, No. 9:1201-1215.

Tang, T.C. (2002a). "Demand for M3 and expenditure components in Malaysia: assessment from bounds testing approach", *Applied Economics Letters, Volume 9,* No. 11:721-725.

Tang, T.C. (2004). 'Demand for broad money and expenditure components in Japan: an empirical study', *Japan and the World Economy*, Vol.16, No.4:487-502.

Tang, T.C. (2007). "Money demand function for Southeast Asian countries: An empirical view from expenditure components", *Journal of Economic Studies,* Vol. 36, No 6:476-496.

Tang, C.F. (2010). "The stability of money demand function in Japan: Evidence from rolling cointegration approach", *MPRA Paper* No. 19807.

Tobin, J. (1956).The interest elasticity of transactions demand for cash, *Review of Economics and Statistics,* Vol. 38, 241-247

United Nations (2009) *Handbook of National Accounts* series F, No. 85.

Wickens, W. (2008) *Macroeconomic Theory*. Oxford, Princeton University Press.

Ziramba, E. (2007). Demand for money and expenditure components in South Africa: Assessment from Unrestricted Error-correction Models. *South African Journal of Economics,* Volume 75, Issue 3:412-424

APPENDICES

Appendix 1: Gandolfo Approach

The method proposed by Gandolfo (1981) uses the following formula to generate data for each quarter, given that the annual data are represented by y_t :

1st quarter: $y_t^{(1)} = 0.0546875 y_{t-1} + 0.234375 y_t + 0.0390625 y_{t+1}$
2nd quarter: $y_t^{(2)} = 0,\ 0078125 yt_{-1} + 0.265625 y_t + 0,0234375 y_{t+1}$
3rd quarter: $y_t^{(3)} = 0,\ 0234375 yt_{-1} + 0.265625 y_{t} + 0,\ 0078125 y_{t+1}$
4th quarter: $y_t^{(4)} = 0.0390625 y_{t-1} + 0.234375 y_t + 0.00546875 y_{t+1}$

where y_t is the value for the current period i: y_{t-1} is one period lagged value and y_t+_1 is the value for the next period .

Smith (1998) used Monte Carlo experiment to examine the effects of linearly interpolating technique on Johansen framework and found that Gandolfo's methodology does not introduce any bias into the estimates of the cointegrating vectors even with series covering relatively short periods.

Appendix 2: Results of the Bounds Test for M3

```
Sample: 1997q4 - 2013q4
Number of obs  = 65
Log likelihood = 129.12127
R-squared      = .57732946
Adj R-squared  = .50816519
Root MSE       = .03608447
```

Pesaran/Shin/Smith (2001) ARDL Bounds Test

```
H0: no levels relationship            F =  10.032
                                      t = -4.406
```

Critical Values (0.1-0.01), **F-statistic**, Case 3

	[I_0] L_1	[I_1] L_1	[I_0] L_05	[I_1] L_05	[I_0] L_025	[I_1] L_025	[I_0] L_01	[I_1] L_01
k_5	2.26	3.35	2.62	3.79	2.96	4.18	3.41	4.68

accept if F < critical value for I(0) regressors
reject if F > critical value for I(1) regressors

Critical Values (0.1-0.01), **t-statistic**, Case 3

	[I_0] L_1	[I_1] L_1	[I_0] L_05	[I_1] L_05	[I_0] L_025	[I_1] L_025	[I_0] L_01	[I_1] L_01
k_5	-2.57	-3.86	-2.86	-4.19	-3.13	-4.46	-3.43	-4.79

accept if t > critical value for I(0) regressors
reject if t < critical value for I(1) regressors

k: # of non-deterministic regressors in long-run relationship
Critical values from Pesaran/Shin/Smith (2001)

Appendix 3: M2 Simple ARDL Model (Before Dropping RGCF)

```
..................................................
BIC optimized over 257250 lag combinations

ARDL regression
Model: level

Sample: 1997q3 - 2013q4
Number of obs  = 66
Log likelihood = 124.85231
R-squared      = .99439884
Adj R-squared  = .99313065
Root MSE       = .04072314
```

log_m2	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
log_m2						
L1.	.7889595	.0797778	9.89	0.000	.6289456	.9489734
log_rgcf	.0467384	.0569589	0.82	0.416	-.0675067	.1609834
log_rfce	.1574795	.0644105	2.44	0.018	.0282883	.2866707
libor	.0066801	.0044669	1.50	0.141	-.0022794	.0156396
cpi						
--.	-.0050491	.0049896	-1.01	0.316	-.015057	.0049587
L1.	-.0019233	.0079104	-0.24	0.809	-.0177896	.013943
L2.	-.0022264	.0077617	-0.29	0.775	-.0177945	.0133416
L3.	.0113978	.004472	2.55	0.014	.002428	.0203676
finin						
--.	.0062648	.0012467	5.03	0.000	.0037644	.0087653
L1.	-.0033526	.0014047	-2.39	0.021	-.0061701	-.0005352
L2.	.0023293	.0012208	1.91	0.062	-.0001192	.0047779
log_ex	.2079319	.0841469	2.47	0.017	.0391546	.3767091
_cons	-1.758074	.488728	-3.60	0.001	-2.738338	-.7778093

.

Appendix 4: ARDL Error Correction Model for M2 (Before Dropping RGCF)

```
ARDL regression
Model: ec

Sample: 1998q1 - 2013q4
Number of obs  = 64
Log likelihood = 123.89417
R-squared      = .66216325
Adj R-squared  = .5743257
Root MSE       = .03950394
```

D.log_m2	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
ADJ						
log_m2						
L1.	-.2138391	.0786773	-2.72	0.009	-.3718671	-.0558111
LR						
log_rgcf	-.0430958	.3038644	-0.14	0.888	-.6534255	.5672338
log_rfce	1.084336	.6128682	1.77	0.083	-.1466458	2.315318
libor	.0241816	.0223498	1.08	0.284	-.0207092	.0690725
cpi	.0182959	.0102501	1.78	0.080	-.0022921	.0388838
finin	.026083	.006926	3.77	0.000	.0121718	.0399943
log_ex	.744163	.2740359	2.72	0.009	.1937457	1.29458
SR						
cpi						
D1.	-.0018947	.0048202	-0.39	0.696	-.0115763	.0077868
LD.	-.0099558	.0048888	-2.04	0.047	-.0197753	-.0001364
L2D.	-.0104389	.0044264	-2.36	0.022	-.0193295	-.0015483
finin						
D1.	.0002906	.0018865	0.15	0.878	-.0034986	.0040798
LD.	-.0027167	.0012388	-2.19	0.033	-.0052048	-.0002286
log_ex						
D1.	-.7496778	.3823902	-1.96	0.056	-1.517731	.0183756
_cons	-1.798956	.495866	-3.63	0.001	-2.794932	-.8029795

Model Diagnostics

ARCHLM chi^2 =3.411 Prob>chi^2 = 0.04

Breuch-Pagan Test for Heteroscedasticity chi^2 =0.01 Prob>chi^2 = 0.9079

Mean VIF 15.15

R^2 = 0.6622

Appendix 5: Simple ARDL Regression Model for M3 (before dropping RGCF)

```
..................................................
BIC optimized over 62500 lag combinations

ARDL regression
Model: ec

Sample: 1997q1 - 2013q4
Number of obs  = 68
Log likelihood = 125.39098
R-squared      = .46917705
Adj R-squared  = .38680797
Root MSE       = .04144487
```

D.log_m3	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
ADJ						
log_m3						
L1.	-.2072436	.0572493	-3.62	0.001	-.3218406	-.0926467
LR						
log_rgcf	.2377426	.2609715	0.91	0.366	-.2846487	.7601338
log_rfce	.3314724	.326086	1.02	0.314	-.3212596	.9842045
libor	.0119215	.0218469	0.55	0.587	-.0318098	.0556528
cpi	.0061607	.0082411	0.75	0.458	-.0103357	.0226572
finin	.0231897	.0061988	3.74	0.000	.0107814	.0355979
log_ex	.867944	.2361506	3.68	0.001	.3952371	1.340651
SR						
cpi						
D1.	-.0053418	.0041233	-1.30	0.200	-.0135954	.0029118
LD.	-.0126104	.0043612	-2.89	0.005	-.0213402	-.0038806
_cons	-.8555165	.4589874	-1.86	0.067	-1.77428	.0632465

Model Diagnostics

ARCHLM	chi^2 =0.507	Prob>chi^2 = 0.4765
Breuch-Pagan Test for Heteroscedasticity	chi^2 =3·21	Prob>chi^2 = 0.07
Mean VIF	17.30	

R^2 = 04691

Appendix 6: Simple ARDL Regression Model for M2 (after dropping RGCF)

```
BIC optimized over 49000 lag combinations

ARDL regression
Model: level

Sample: 1998q1 - 2013q4
Number of obs  = 64
Log likelihood = 123.88081
R-squared      = .9944934
Adj R-squared  = .99319773
Root MSE       = .0391229
```

log_m2	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
log_m2						
L1.	.7823816	.0734876	10.65	0.000	.6348491	.9299141
log_rfce	.2238064	.0434093	5.16	0.000	.1366585	.3109542
libor	.0049865	.0041654	1.20	0.237	-.0033758	.0133488
cpi						
--.	.0016384	.0049043	0.33	0.740	-.0082073	.0114841
L1.	-.0076959	.0076809	-1.00	0.321	-.0231159	.0077241
L2.	-.000774	.0074765	-0.10	0.918	-.0157836	.0142357
L3.	.0105189	.0043493	2.42	0.019	.0017873	.0192505
finin						
--.	.0059451	.0011153	5.33	0.000	.0037061	.0081842
L1.	-.0029805	.001345	-2.22	0.031	-.0056807	-.0002803
L2.	.0027029	.0012231	2.21	0.032	.0002473	.0051585
log_ex						
--.	-.563701	.3495679	-1.61	0.113	-1.265488	.1380858
L1.	.7223432	.3291225	2.19	0.033	.0616022	1.383084
_cons	-1.752132	.3717369	-4.71	0.000	-2.498425	-1.005839

Appendix 7: Simple ARDL Regression Model for M3 (after dropping RGCF)

```
BIC optimized over 67200 lag combinations

ARDL regression
Model: level

Sample: 1997q4 - 2013q4
Number of obs  = 65
Log likelihood = 129.12127
R-squared      = .99480928
Adj R-squared  = .99395988
Root MSE       = .03608447
```

log_m3	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
log_m3						
L1.	.774369	.0512052	15.12	0.000	.6717515	.8769866
log_rfce	.1360974	.0330916	4.11	0.000	.0697802	.2024145
libor	.005496	.0036619	1.50	0.139	-.0018426	.0128346
cpi						
--.	-.0021365	.0040009	-0.53	0.595	-.0101545	.0058815
L1.	-.0038306	.0067328	-0.57	0.572	-.0173234	.0096623
L2.	-.0002744	.0067374	-0.04	0.968	-.0137764	.0132276
L3.	.0094021	.0039072	2.41	0.019	.0015719	.0172323
finin	.004996	.0010155	4.92	0.000	.0029608	.0070312
log_ex	.2411861	.0639355	3.77	0.000	.1130565	.3693157
_cons	-1.490131	.3307803	-4.50	0.000	-2.153029	-.8272321

Appendix 8: ARDL Error Correction Model for M2

```
BIC optimized over 472392 lag combinations

ARDL regression
Model: ec

Sample: 1998q1 - 2013q4
Number of obs  = 64
Log likelihood = 123.88081
R-squared      = .66202216
Adj R-squared  = .58249796
Root MSE       = .0391229
```

D.log_m2	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
ADJ						
log_m2						
L1.	-.2176184	.0734876	-2.96	0.005	-.3651509	-.0700859
LR						
log_rfce	1.028435	.4400737	2.34	0.023	.1449504	1.91192
libor	.022914	.019815	1.16	0.253	-.0168662	.0626943
cpi	.0169442	.0033849	5.01	0.000	.0101487	.0237397
finin	.0260433	.0067329	3.87	0.000	.0125264	.0395602
log_ex	.7289924	.2466899	2.96	0.005	.2337417	1.224243
SR						
cpi						
D1.	-.002049	.0046551	-0.44	0.662	-.0113945	.0072966
LD.	-.0097449	.0046208	-2.11	0.040	-.0190216	-.0004682
L2D.	-.0105189	.0043493	-2.42	0.019	-.0192505	-.0017873
finin						
D1.	.0002776	.0018662	0.15	0.882	-.0034689	.0040241
LD.	-.0027029	.0012231	-2.21	0.032	-.0051585	-.0002473
log_ex						
D1.	-.7223432	.3291225	-2.19	0.033	-1.383084	-.0616022
_cons	-1.752132	.3717369	-4.71	0.000	-2.498425	-1.005839

Appendix 9: ARDL Error Correction Model for M3

```
..................................................
BIC optimized over 67200 lag combinations

ARDL regression
Model: ec

Sample: 1997q4 - 2013q4
Number of obs  = 65
Log likelihood = 129.12127
R-squared      = .57732946
Adj R-squared  = .50816519
Root MSE       = .03608447
```

D.log_m3	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
ADJ						
log_m3						
L1.	-.225631	.0512052	-4.41	0.000	-.3282485	-.1230134
LR						
log_rfce	.6031856	.2154588	2.80	0.007	.1713965	1.034975
libor	.0243585	.0164964	1.48	0.145	-.008701	.057418
cpi	.0140078	.0019617	7.14	0.000	.0100764	.0179392
finin	.0221422	.0051364	4.31	0.000	.0118486	.0324359
log_ex	1.06894	.1721993	6.21	0.000	.7238452	1.414036
SR						
cpi						
D1.	-.0052971	.0038846	-1.36	0.178	-.0130821	.0024879
LD.	-.0091277	.0041957	-2.18	0.034	-.0175361	-.0007193
L2D.	-.0094021	.0039072	-2.41	0.019	-.0172323	-.0015719
_cons	-1.490131	.3307803	-4.50	0.000	-2.153029	-.8272321

Appendix 10: ARDL Error Correction Model for M2 (AIC Model)

```
AIC optimized over 49000 lag combinations

ARDL regression
Model: ec

Sample: 1998q1 - 2013q4
Number of obs  = 64
Log likelihood = 126.95464
R-squared      = .69297687
Adj R-squared  = .59703214
Root MSE       = .03843589
```

D.log_m2	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
ADJ						
log_m2						
L1.	-.3202214	.1026065	-3.12	0.003	-.5265256	-.1139172
LR						
log_rfce	.8047302	.2724855	2.95	0.005	.2568614	1.352599
libor	.0173467	.0132581	1.31	0.197	-.0093104	.0440039
cpi	.0156826	.0022464	6.98	0.000	.011166	.0201992
finin	.0247047	.0051524	4.79	0.000	.0143452	.0350643
log_ex	.747806	.1641705	4.56	0.000	.417719	1.077893
SR						
log_m2						
LD.	.0971873	.1342592	0.72	0.473	-.172759	.3671335
L2D.	.2589395	.1209157	2.14	0.037	.0158222	.5020569
cpi						
D1.	-.002222	.0046531	-0.48	0.635	-.0115776	.0071337
LD.	-.0085436	.0046521	-1.84	0.072	-.0178973	.0008101
L2D.	-.0089897	.0043823	-2.05	0.046	-.017801	-.0001785
finin						
D1.	-.0022746	.0027153	-0.84	0.406	-.007734	.0031848
LD.	-.0044025	.0021999	-2.00	0.051	-.0088257	.0000208
L2D.	-.0025062	.0017338	-1.45	0.155	-.0059923	.0009799
log_ex						
D1.	-.6096104	.3483823	-1.75	0.087	-1.31008	.0908592
_cons	-2.089986	.4584892	-4.56	0.000	-3.01184	-1.168132

—more—

Appendix 11: Variance Inflation Factor Test for M2

```
. estat vif
```

Variable	VIF	1/VIF
log_m2		
L1.	33.78	0.029602
cpi	17.08	0.058535
log_ex	10.72	0.093269
log_rfce		
--.	7.45	0.134305
D1.	6.79	0.147369
finin	3.63	0.275737
libor	3.06	0.326609
log_rfce		
LD.	3.02	0.331475
cpi		
L2D.	1.94	0.516416
LD.	1.79	0.557760
L3D.	1.71	0.584988
D1.	1.51	0.662908
Mean VIF	7.71	

Appendix 12: Variance Inflation Factor Test for M3

```
. estat vif
```

Variable	VIF	1/VIF
log_m3		
L1.	27.95	0.035774
cpi	12.67	0.078927
log_ex	9.50	0.105272
libor	2.68	0.372519
finin	2.15	0.465220
cpi		
LD.	1.89	0.530422
L2D.	1.69	0.590882
D1.	1.59	0.629605
log_rfce	1.33	0.753653
Mean VIF	6.83	