AN ANALYSIS OF MONEY DEMAND STABILITY IN RWANDA

By

Aüssi SAYINZOGA

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Declaration

The work described in this thesis was carried out by the author in the School of Economics and Finance, University of KwaZulu-Natal, Pietermaritzburg, from February 2003 to January 2005, under the supervision of Dr. Richard Simson.

The study represents original work by the author and has not otherwise been submitted in any form for any other degree or diploma to any University. Where use has been made of the work of others it is duly acknowledged in the text. All deficiencies including typographical errors that remain in the thesis are entirely mine.

Date: January 2005

Student: ____________________

Aüssi SAYINZOGA

Supervisor: ____________________

Dr. Richard SIMSON

Abstract

A stable money demand function and exogeneity of prices is at the core of planning and implementing a monetary policy of monetary targets. This thesis examines both the stability of M2 money demand and price exogeneity in Rwanda for the years 1980 to 2000. We estimate and test the elasticities of the determinants of Rwandan money demand function. We include in this demand function those variables which economic theory indicates must be part of any empirical investigation of money demand. All coefficients had the signs as required by economic theory. We estimate the money demand function for Rwanda using cointegration analysis and an error correction mechanism. The results show real income, prices and M2 to be cointegrated. We employ three tests to show that the estimated demand function for Rwanda is stable. We then test the second requirement for coherence in monetary aggregate targeting that money determines prices. The results show that prices are exogenous to money. But before we can definitely conclude that an inflation targeting regime is feasible from monetary policy perspective, we point out that future research on this important topic must account for exchange rate movements, measure permanent income and specify interest rate changes correctly.

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Abbreviations

COMESA:	Common Market of Eastern and Southern Africa
CPI:	Consumer Price Index
ECM:	Error Correction Mechanism
ESAF:	Enhanced Structural Adjustment Facilities
GDP:	Gross Domestic Product
IMF:	International Monetary Fund
MINECOFIN:	Ministry of Finance and Economic Planning
MIPF:	Money In the Production Function
MIUF:	Money In the Utility Function
NBR:	National Bank of Rwanda
PRGF:	Poverty Reduction and Growth Facilities
PRSP:	Poverty Reduction Strategy Paper
SADEC	Southern African Development Economic Countries
UECM:	Unrestricted Error Correction Mechanism
UK:	United Kingdom
USA:	United States of America

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CHAPTER ONE

INTRODUCTION

1.1 Overview

The key issue of this study is the quest for a stable money demand in Rwanda. An econometric relationship is stable if the parameters in such a relation are not subject to permanent changes over time (Hoffman *et al.*, 1995). A stable money demand is among the indispensable preconditions for the formulation and conduct of monetary policy (Sriram, 1999). In fact, what is being sought in a stable money demand function is a set of necessary conditions for money to exert a predictable influence on the economy so that the central bank's control of the money supply can be a useful instrument of economic policy (Judd and Scadding, 1982). Because of the importance of stability, a steady stream of theoretical and empirical research has been conducted worldwide over the past several decades. Much of the research concerned developed countries, especially in the US and UK. Relatively fewer studies were carried out in the developing countries, but the number of studies has been increasing in recent years. In industrial countries, the quest for a stable money demand function is in most cases supported by extensive data sets and a detailed knowledge of institutional settings. The converse, however, is observed in developing countries where sometimes the relevant data is rare and the knowledge of the performance of the economy is poor.

The stability of money demand has been a longstanding issue (Goldfeld, 1976). However, despite intensive analytical and empirical efforts, there is no general consensus concerning the stability (or instability) of the money demand function (Andersen, 1985). Up to the 1970's the money demand function was considered to be the one of the most stable and reliable in economics. Khan (1974), Laumas and Mehra (1976) and Laumas (1978) all found stable money demand relationships. In contrast to these studies, Friedman and Kuttner (1992) and Miyao (1996) have argued against a stable US money demand. Shifts in the demand for money were also found in other industrial countries in the 1970's, while results are mixed for developing countries (Sriram, 1999). Studies of the M3 money demand in South Africa by Casteleijn (1999), Moll (1999), Moll (2000), and Van den Heever (2001) assert that the relation between money, income and prices has become less stable in recent years. However, Nell (2003) provides empirical evidence of a constant and structurally stable M3 money demand function for South Africa over the period 1968-1997. According to Judd and Scadding (1992) possible causes of money demand instability after the 1970's are changes to the structure of the financial system allowing for greater role for interest rates and economizing on money balances. Many other causes of the increasing instability of money demand have been pointed out such as: (i) the fact that different studies cover different countries at different time periods, and (ii) the various specifications of the money demand function differ from study to study.

In 2000 the South African Reserve Bank adopted an inflation targeting framework and one of the underlying reasons for the change in the monetary policy strategy was based on the view that a stable money demand relation has become increasingly difficult to identify in South Africa (Casteleijn, 1999; Van den Heever, 2001). In recent years many countries such as New

Zealand, Canada, the UK, Sweden, Finland, Spain and Australia have adopted an inflation targeting strategy. A number of circumstances and considerations led to this change. In the 1970's, Western countries experienced a period of stagflation - higher rates of inflation without higher growth - and skepticism about the benefits of expansionary monetary policies began. Keynesian policy prescriptions were called into question. Neoclassical economists managed to formalize reasons for the skepticism about Keynesian policy. One of the early arguments uses the expectations augmented Phillips curve, often associated with Milton Friedman. They argue that there was a short-run tradeoff only between the unemployment rate and the deviation of the inflation rate from its expected level. But there was no long-run tradeoff between unemployment and inflation. Hence, monetary policy had a very limited ability to change the unemployment rate (Handa, 2000: 257). This view was later emphasized by the Modern Classical School - with rational expectations and neutrality of money as its core elements for policy analysis - and advocates that monetary authorities could not induce systematic errors in price expectations and could not bring about the deviation of employment from its equilibrium level. In the 1980's, this theoretical revision about the neutrality of money had the impact of persuading the central banks in western countries to abandon a multiplicity of goals in favor of a sole focus on controlling the rate of inflation. It is worth noting that the goal of price stability is not meant to be an end in itself. It is followed in the belief that price stability fosters growth, so that a low target rate for inflation is meant to provide conditions that produce long-run growth of output and lower long-run unemployment for an economy. As Bernanke *et al.* (1999: 3) asserts, "one element of the new consensus is that low, stable inflation is important for market-driven growth." The target of price stability is also meant to remove or minimize the potential of monetary policy to destabilize economy. It will clearly not remove all the fluctuations from the economy, since fluctuations could still arise from supply shocks. But it is believed that a stable price and financial environment is still the best format for the economy to respond to such shocks.

As part of these developments, in 1998, the Rwandan monetary authority was advised by its economic partners - the IMF and World Bank - to consider a medium term inflation target of three *per cent* a year. The National Bank of Rwanda utilizes the M2 monetary aggregate as an intermediate objective, with the monetary base as its operational instrument. In contrast to a policy of inflation targeting, a monetary policy of monetary aggregate targeting requires first that there is a stable money demand function and, second, that changes in money determine price changes.

In this study, we follow Nell (2003) and investigate whether both requirements are satisfied. We estimate the long-run money demand equation in Rwanda, using the modern approach of cointegration analysis. The study also utilizes the Error Correction Mechanism (ECM) to estimate the short-run money demand in Rwanda. Finally, we utilize relevant tools to test for stability of money demand in Rwanda, and assess the super exogeneity of income and prices before drawing conclusions and policy implications. If income and prices are super exogenous, then money changes do not determine price changes and the second requirement for a workable monetary aggregate targeting policy is not met.

1.2 Key questions and research hypotheses

In order to assess whether such a policy change to inflation targeting is feasible, this thesis attempts to determine whether both requirements (stability and money changes depending on price changes) for remaining with money aggregate targeting are met. In 1990, Rwanda started the implementation of the structural adjustment facilities under the auspices of the IMF and the World Bank. In 1998, Rwanda began a policy of inflation targeting as required by the Bretton-Woods institutions. These events led us to formulate the research questions underlying our research as follows:

(i) Is there a stable money demand function in Rwanda so that monetary aggregate targeting can continue to play a role in the macro economy?

(ii) Does money determine prices?

Based on theses questions, our study will seek to confirm both the following hypotheses:

(i) The demand for money function in Rwanda is stable.

(ii) Causation runs from money to prices.

Both these need to be satisfied if money aggregates are to be targeted by a central bank.

1.3 Objectives and chapter outline

If we can affirm both hypotheses, then we can question the wisdom of the National Bank of Rwanda to adopt the inflation targeting strategy. Thus the main objective of this study is to provide an assessment of the inflation targeting strategy in Rwanda. In order to achieve this objective, we adopt the following structure. Chapter Two devotes itself to the presentation of the theory of the demand for money, and the analysis in the chapter aims to substantiate the specification of the money demand function we use in the empirical chapter of this paper. Chapter Three presents an overview of the evolution of monetary policy in Rwanda and highlights its important features. The main focus in Chapter Four concerns the quest of investigating the stability of money demand in Rwanda and finding out whether prices are dependent on the money supply. We conclude in Chapter Five by summarizing the main empirical results as well as their policy implications. We find some support for inflation targeting.

Before proceeding with the theoretical and policy chapters prior to our empirical investigation in Chapter Four, we are of the view that some insight can be gained from presenting some summary statistics of the data used in this thesis. This has the added benefit of forcing a hard look at the data in order to ensure that no anomalies are present.

Table 1.1 Summary statistics of real GDP, CPI and M2 (all variables in ln)

	ln real GDP	**ln CPI**	**ln M2**
Mean	5.42304	5.20239	10.4543
Median	5.86219	4.84589	10.3628
Variance	0.474801	0.378821	0.36979
Skewness	-0.608636 (Symmetry is rejected) Bimodal	0.600387 (Symmetry is rejected) Bimodal	0.381604 (Symmetry is not rejected) Trimodal

Table 1.1 presents summary statistics and other features of data used in this thesis. All the data is in logarithms. Some interesting features of this data are:

(i) The change in M2 follows closely the sum of the changes in real GDP and the CPI.

(ii) The variance of real GDP is the highest, no doubt reflecting measurement problems. The genocide also plays a role in this variability. The genocide no doubt is the cause of the bimodal shape in the first two variables.

(iii) The real income variable has a long left tail. The price data has a long right tail. The observed symmetry in the money supply data adds weight to the notion that changes in prices and real income match the changes in the money supply.

Table 1.2 Summary statistics for interest rate spread

Interest rate spread		
	Nominal	Real
Mean	6.755	4.5688
Median	6.75	5.54505
Variance	0.764722	14.5748
Skweness	0.94688 (Symmetry is not rejected) Unimodal	-1.65336 (Symmetry is rejected) Trimodal

Table 1.2 presents the same information like Table 1.1 but only for our interest rate variable (a spread between a long-term market rate and a short-term deposit rate) which is not in logarithms. This data comes from fairly symmetrical distribution and unlike our other data is unimodal. Given that after 1995 interest rates were more market oriented it is not surprising that we measure a high variance in the interest rate spread. This variance is more marked when we consider the real (spread less the expected, taken as next year's, inflation rate) interest rate spread. The effect of the genocide in 1994 is to pull the real rate spread below zero making the distribution asymmetrical as prices start to change dramatically. The variance of the inflation rate is high and is hidden in Table 1.1 as the second variable is the logarithm of the CPI and not the inflation rate.

Rwanda has had a long and tumultuous history. The tragedy of the genocide in 1994 is an event possibly beyond our means to understand or contemplate. Some questions as to why and how such an event could occur are important. Very important. However, does that mean all other questions concerning Rwanda are trivial? In a very real sense the answer to this question about questions is yes. Despite this affirmative answer, we proceed with this study of money in Rwanda, recognizing that conclusions here pale in insignificance when considering other far more important issues.

CHAPTER TWO

THEORIES OF MONEY DEMAND

2.1 Introduction and chapter outline

Money is said to be at the heart of economic activities. De Grauwe (1989) argues that the development of modern economies would not have been possible without money. Basically, money serves four major functions: medium of exchange, store of value, unit of account, and source of deferred payments (Sriram, 1999). This chapter is devoted to the presentation of some of the theories on the demand for money, and the analysis aims to provide a theoretical underpinning for the specification of money demand used in the empirical chapter of this thesis. The economy's demand for money is the quantity of money (cash and balances in bank accounts) that people collectively want to hold on average (Kennedy, 2000). Mankiw (1999) postulates that a money demand function is a relationship that shows what determines the quantity of real money balances people wish to hold at any point in time. Money demand theories have evolved over time. There is a broad range of money demand theories emphasizing utility considerations and Keynes' three motives of holding money: transactions, precautionary and speculative. However, this diverse spectrum of money demand theories shares some common and important variables. They generally put forward a relationship between the quantity of money demanded and a set of a few important economic variables linking money to the real sector of the economy (Judd and Scadding, 1982: 993). What distinguishes these theories from each other, however, is that although they consider similar determinants of the demand for money, they frequently differ in the specific role assigned to each variable (Boorman, 1976: 35). The following is how we opted to organize this chapter. Section 2.2 briefly traces the main theoretical contributions of economists on money demand beginning with the classical economists and ending with some more recent developments. Section 2.3 covers the Money in the Utility Function (MIUF) approach, which treats money like any other good. The next section considers the indirect utility approach where real money balances make possible efficient use of the resource *time*. Section 2.5 presents the insertion of Money into the Production Function (MIPF) approach by considering real balances as an input into the firm's production function just like other economic inputs. Money is also presented as an indirect argument of the firm's production function in Section 2.6. Section 2.7 deals with the derivation of the demand for real balances in the Walrasian general equilibrium model. The latter forms the foundation for a micro-economic analysis of markets in the economy and the determination of prices of goods. The Walrasian model also forms the basis of modern classical and neoclassical macroeconomic models, and the standard against which Keynesian macroeconomics sets out its differences (Handa, 2000). Section 2.8 simplifies the real balances demand function derived in the Walrasian perspective (in Section 2.7) for adaptation to macroeconomic analysis. From Section 2.9 through Section 2.11 we present the various money demand models that focus on each of Keynes' three motives for holding money. In addition we outline both Baumol's (1952) and Tobin's (1956) model of money demand. We then synthesize all the theoretical material, in Section 2.12, in order to provide a justification for the money demand function that we estimate in Chapter Four. Section 2.13 summarizes and concludes.

2.2 Theoretical contributions of researchers on money demand

It has been observed that money demand theories evolved over time. This section briefly reviews theoretical studies on the demand for money, tracing the contributions of researchers beginning with the classical economists and ending with some of the more recent works in the area of money demand. Classical economists formulated their theories of money demand by referring to the functions that money serves: (i) a medium of exchange, (ii) a store of value, (iii) a unit of account, and (iv) a means of deferred payment.

Classical economists assume that the market for each good clears, so that the economy is always at full employment except for transitory deviations; and prices are flexible to ensure that equilibrium is attained. In such an economy, money is a medium of exchange, and is given the role of numeraire; that is, a numbering device that is used to express prices and values of various goods, but whose own value remains unaffected by this role (Sriram, 1999). According to the classical theory, money is neutral and does not influence aggregate real income, real interest rates or the determination of relative prices. Walras' analysis of money demand as part of his general theory of economic equilibrium is considered the basis of the modern theory of money demand (Schumpeter, 1954: 1082). Fisher (1911) formulated the famous quantity theory, which led the way to Pigou's (1917) analysis of money holdings.

The quantity theory has a rich and varied tradition. It posits a proportional relationship between the quantity of money and the price level. The quantity theory is the proposition that a change in the money supply in the economy causes a proportionate change in the price level

(Handa, 2000). The quantity theory was developed in the classical framework in two equivalent versions. One version is associated with Fisher and is called the *equation of exchange,* and another version is termed the *cash balances or Cambridge approach* and is associated with Cambridge economists like Pigou. The *equation of exchange* associated with Fisher (1911) is: $M_S V_T \equiv P_T T$ in which the quantity of money in circulation M_S is related to the volume of transactions T and the price level of goods traded P_T through V_T (*the velocity of circulation*) which represents the rate at which money turns over in meeting expenditures. Schumpeter (1954) points out that, treating M_S as exogenous and holding V_T and T constant allows the equilibrium price level to move in direct proportion with the quantity of money. The *cash balances approach,* associated with Pigou (1917) and Marshall (1923), examines the determination of prices from the perspective of demand and supply. In this approach money is held not only as a medium of exchange as in Fisher's case, but also as a store of value. Pigou (1917) provides the familiar quantity formulation as $MV = Py$, which relates the quantity of money M and the *income velocity of circulation* V to the nominal level of income Py. Therefore, given that real income y is at full employment level and assuming V to be stable, an increase in the quantity of money M results in a proportional increase in the price level P. Hence, money is neutral; that is, it only affects nominal variables but not real ones (Sriram, 1999).

Monetarists reinterpret the quantity theory as representing an economy's demand for money, so that they were able to structure an explanation as to how an increase in the money supply caused an increase in economic activity. The result of their analysis is termed the *modern quantity theory of money* in which the original quantity equation is specified as $M = (1/v)PQ$.

The latter is considered a behavioural equation that reflects the economy's demand for money, so that as nominal income, *PQ*, increases, the demand for money increases (Kennedy, 2000).

Neoclassical economists emphasize the store of value function of money and consider the medium of exchange function as the primary role of money. They also postulated various other factors affecting the demand for money. Cannan (1921) advocates a negative relationship between money demand and anticipated inflation, which was later recognized by Marshall (1926), as well as MacCallum and Goodfriend (1987). A shortcoming of neoclassical approach is that there is no explicit role given to the interest rate in determining the demand for money in their writings (Sriram, 1999).

It is Keynes (1930 and 1936) who provides a more rigorous and convincing analysis of the importance of the interest rate variable affecting money demand. Keynes analyses money demand in a different way to that of his predecessors, by focusing on the motives for holding money. He postulates that money demand arises from three motives: transactions, precautionary and speculative. He advocates that the transactions demand for money arises from a need to finance current transactions, and that the transactions' demand for money depends on the level of income. He theorizes that the precautionary motive is due to uncertainty about future payments, that is, sudden expenditures and unforeseen opportunities for advantageous purchases. The speculative motive for holding money which Keynes called *liquidity preference* is considered his main contribution to money demand theory. This motive arises from an individual's desire to secure profit by knowing better than the market what the future will bring forth (Keynes, 1936). With the speculative motive for holding money, Keynes emphasizes the store of value function and focuses on the future yield on bonds.

Therefore, Keynes formally introduces the interest rate in the money demand function which he specify as $m^d = f(y,i)$, in which the demand for real money balances m^d depends positively on real income y and negatively on the interest rate, i. Keynes postulates that when the interest rate is very low, people expect it to rise and prefer to hold whatever money is supplied. Thus, the aggregate demand for money becomes perfectly elastic with respect to the interest rate, leading the economy to get into a situation called the *liquidity trap* (Sriram, 1999).

Based on Keynes writings, post-Keynesian researchers have produced a broad range of theories emphasizing the transactions', the speculative, the precautionary and liquidity motives for holding money. Transactions or inventory models (Baumol, 1952, and Tobin, 1956) stem from the medium of exchange function, whereas the store of value function leads to asset or portfolio models. In the rest of the chapter we present various formal derivations of the money demand function involving theories of money demand from Keynes' three motives for holding cash balances to more recent contributions with a view to justifying the model we use in our empirical chapter.

2.3 Money In the Utility Function (MIUF)

One general approach of the nineteenth century and dominant at present, advocates that the demand for money should be analysed as that of a choice of one good among many other goods. In this case, money demand is analyzed under the consumer demand theory approach[1], in which individuals hold goods because they derive utility from them (Friedman, 1956; Barnett, 1980). We begin by defining what is meant by a good. The analysis of the behaviour of households, defines a good "as something of which an individual desires more rather than less, or less rather than more, *ceteris paribus*" (Handa, 2000: 55). For Rutherford (1995) a good is an output, which bestows utility on the person possessing it. Macroeconomic analysis generally considers four categories of goods: commodities or products, labor or its counterpart leisure, and money and bonds. Compared to commodities, labor and bonds, money has the characteristic of being the most liquid, meaning it is that good which can be easily converted into the others.

Indeed, money cannot be consumed, however an adequate reason for considering money as a good in the utility function is the fact that people desire to hold real balances for exchanges against goods other than money. Hence, the dominant monetary approach at present claims that the utility maximization framework used to determine the demand for commodities in general, should be applied to the determination of the demand for real balances by an individual or a firm (Handa, 2000).

To introduce money into the utility function, Handa (2000) considers money's liquidity services. The greater the quantity of real money balances held by an individual, the greater is that individual's liquidity. Friedman (1956) argues that the demand for money (assets) should be based on axioms of consumer choice. To make the analysis more rigorous we examine the

[1] This approach is often associated with the *Chicago School* which considers the demand for money as a direct extension of the conventional theory of demand for any durable good (see Feige and Pearce, 1977).

underlying assumptions of money in the utility function. Regarding any rational individual, utility theory in microeconomics has the following axioms:

(i) If the individual prefers a bundle of goods A to another bundle B, then he will always choose A over B. This means that rational individual's preferences are consistent.

(ii) If the individual prefers A to B and B to a third bundle of goods C, then he prefers A to C; which means that rational individual's preferences are transitive. To these axioms, monetary theory formulates a third one concerning real balances which Handa states as follows:

(iii) "In the case of financial goods, including money, which are not used directly in consumption or production but are held for exchange for other goods in the present or the future, the individual is concerned with the former's exchange value into commodities - that is, their real purchasing power over commodities and not with their nominal quantity" (Handa, 2000: 57).

The first axiom, which is about individual rationality, and the second concerning the transitivity of preferences ensures that preferences can be ranked and represented by a utility function. Hence, the inclusion of money - and other financial assets – directly in the utility function can be justified on the grounds that the utility function expresses preferences and that since more is preferred to less, they should be included in the utility function just like other goods. Therefore, it ensues from the above-mentioned axioms that the utility function can be stated as:

$$U(.) = U\left(x_1,\ldots,x_K,n,m^h\right) \qquad (1)$$

where x_k is the quantity of the k^{th} commodity (k = 1,..., K), n is the labor supplied in hours and m^h is the average amount of real balances held by the individual for liquidity purposes.

On the one hand, an increase in commodities and real balances raises utility, thus both commodities and real balances yield positive marginal utility. More formally we can say $U_k = \partial U / \partial x_k > 0$ for all k, and $U_m = \partial U / \partial m^h > 0$. On the other hand, an increase in the hours of work decreases leisure time and consequently lowers utility, thus an increase in hours worked has a negative effect on utility, or $U_n = \partial U / \partial n < 0$.

Therefore, an individuals' utility can be expressed as a function of the quantity of commodities, labor supplied, and the average amount of real money balances. An increase of the average amount of real balances and of commodities increases individuals' utility. On the other hand, an increase in labor supplied is regarded as a reduction of time for leisure, and therefore, reduces individuals' utility.

2.4 Money in the indirect utility function

Some economists, however, do not believe that real balances directly yield consumption services (Handa, 2000). As opposed to the money in the utility function approach, they advocate that real balances allow the consumer to save shopping time and therefore to have increased leisure time. Assuming that only consumer goods and leisure directly yield utility, leads to the following utility function:

$$U(.) = U(c, \Theta). \qquad (2)$$

In this utility function c is consumption of goods, and Θ is leisure. Both consumption and leisure yield positive marginal utility, or more formally $U_c, U_\Theta > 0$. Further assume that to buy consumer goods, one needs to secure some shopping time so that leisure is the time remaining in the day after subtracting the hours of work and time spent in shopping. This means that

$$\Theta = h_o - n - n^\sigma \qquad (3)$$

where h_0 is the maximum available time for leisure, work and shopping, n is the time spent working, n^σ is the time spent shopping. In this model, shopping time has negative marginal utility because it reduces time for leisure. It is considered that shopping with enough money in hand will be quite quick and enjoyable while buyers with other means of payments (transfer of bonds, exchange of other commodities) spend more time in shopping and find it tedious as they are required to find special suppliers who accept their medium of payments. Therefore, the shopping time function is assumed to be such that:

$$n^\sigma = n^\sigma(m^h, c) \qquad (4)$$

with $\partial n^\sigma / \partial c > 0$ and $\partial n^\sigma / \partial m^h \leq 0$, and m^h is average real money balances. Equations (2) and (4) above yield the following marginal utility with respect to shopping time:

$$\partial U / \partial n^\sigma = \left(\partial U / \partial \Theta\right)\left(\partial \Theta / \partial n^\sigma\right) < 0$$

which means that an increase in shopping time reduces leisure which in turn lowers utility. On the other hand, additional real balances that are used to purchase commodities decrease shopping time and increase utility; hence $\partial U / \partial m^h = \left(\partial U / \partial n^\sigma\right)\left(\partial n^\sigma / \partial m^h\right) > 0$. In other words, having more real money balances reduces time spent shopping and as there is now more time to allocate to leisure, utility rises. In this monetary economy in which goods can be exchanged for money, people using bonds and goods for exchanges will spend more time shopping. However, beyond some limit, say for $m^h \geq c$, additional real balances are unlikely to decrease the time spent shopping, which means that $\partial n^\sigma / \partial m^h = 0$ once this special limit has been reached. One proportional form of the shopping time function weighted by consumption is:

$$n^\sigma / c = \Phi\left(m^h / c\right) \qquad (5)$$

and substituting this proportional shopping time function (equation 5) into the utility function (equation 2) yields:

$$U(.) = U\left(c, h_0 - n - c\Phi\left(m^h / c\right)\right). \qquad (6)$$

This means utility is directly a function of consumption and leisure but we have now incorporated the determinants of leisure and obtained equation (6). To recognize the new determinants of utility, which impact utility indirectly through leisure, we call the new utility function V. Thus, the indirect utility function is:

$$V(.) = V(c, n, m^h) \qquad (7)$$

With: $\dfrac{\partial V}{\partial m^h} = \dfrac{\partial U}{\partial \Theta}\left[-c\dfrac{\partial \Phi}{\partial m^h}\right]$, since $\partial U / \partial \Theta > 0$ and $\partial \Phi / \partial m^h \leq 0$, therefore $\partial V / \partial m^h \geq 0$.

Intuitively we are saying that as real money balances reduce time shopping and thus add to an individual's enjoyment of leisure, utility rises. It is important to note that the indirect utility function (equation 7) is similar to the direct utility function (equation 1) since both of them depend on commodities, time spent working and real balances. Therefore, either incorporating money in the utility function by considering it as a good or putting money indirectly in the utility function through its shopping time function amounts to the same thing, although the latter analysis is more intuitive and thus easier to accept.

2.5 Money In the Production Function (MIPF)

Money in the Production Function (MIPF) models are concerned with the incorporation of real balances in the firm's production function. In this approach, it is assumed that for a firm to produce a commodity x_k, the firm's production function embodies real balances as an input. "The rationale for putting the firm's real balances as an input in its production function is that holding them allows the firm to produce greater output with given amounts of labor and capital"(Handa, 2000: 63). Thus assume that, a firm, which produces a commodity, x_k has its production function specified as follows:

$$x_k = F(n, \kappa, m^f) \qquad \textbf{(8)}$$

where x_k is the quantity of the k^{th} good ($k=1,...,K$) produced by the k^{th} firm, n is the number of workers, κ is variable stock of physical capital, and m^f are the real balances held by the firm. All the first partial derivatives of x_k with respect to n, κ and m^f are greater than zero. This means that having more inputs (including real money balances) allows the firm to produce more.

In fact, it is assumed that, if a firm does not keep real balances, it will experience trouble in paying its employees, suppliers and in selling its output, since it "would have to divert part of its labor and capital to somehow arrange for payments and receipts directly in commodities, with such diversion reducing the amounts of labor and capital allocated to the production of output and thereby reducing the firm's output" (Handa, 2000: 63). Therefore, in a monetary economy in which goods are exchanged against money, real balances are considered as an input in the production function with higher real balances leading to higher output because the firm has no need to divert labor and capital to deal with the payment and receipts process. Instead these inputs can be better used to produce output.

2.6 Money in the indirect production function

Sometimes it is argued that money does not increase a firm's production and should not appear in the production function (Handa, 2000). However, it is possible to formulate a production function in which money appears indirectly in the production function in a similar way that money is incorporated in the utility function.

Assume that the firm's production function depends upon capital and part of the labor directly employed in production. Nevertheless, the firm has to divert part of its workers to take care of transactions involving purchases of raw material and other inputs, hiring labor and selling its production. Taking the extreme case where a firm does not hold any money, it would be forced to exchange its produced goods for needed inputs, labor and pay dividends in kind.

Such a firm could not exist in a modern economy. If the firm had a small amount of money, it would still have to allocate some workers to deal with purchases and sales. By holding adequate real balances, the firm avoids losing production, as workers are not diverted to these other activities.

The above assertion implies that the production function is:

$$x_k = x_k(\kappa, n_1) \qquad \textbf{(9)}$$

where x_k is the output of the k^{th} commodity, κ is the physical capital stock, and n_1 is the labor directly involved in production. All the first partial derivatives of x_k with respect to κ and n_1 are greater than zero, which means more output for more inputs. Having *n,* means that the firm's total employment is composed of the labor directly involved in production n_1 and workers who carry out transactions n_2, so that

$$n = n_1 + n_2 \qquad (10)$$

For a given *n*, an increase in the number of workers performing transactions, n_2, decreases n_1, the labor directly involved in production. This will decrease output. Now consider the situation where x_k represents input on output transactions. Therefore, for a monetary economy, the general form of the *transactions technology function* can be specified as:

$$n_2 = n_2(m^f, x_k) \qquad \textbf{(11)}$$

This function has the feature that n_2 (the workers who carry out transactions) decreases with an increase in real balances held by the firm ($\partial n_2 / \partial m^f \leq 0$), and increases with higher amounts of the commodities, x_k, involved in transactions ($\partial n_2 / \partial x_k > 0$). Therefore, money can be also incorporated in the production function in an indirect way by considering that it helps avoiding diverting workers to deal with transactions instead of working to produce output. Hence, an increase in the number of workers, due to more real balances will indirectly result in an increase in output, *ceteris paribus*, as fewer workers are engaged in unproductive activities

2.7 The derivation of the money demand function in microeconomics

2.7.1 The derivation of an individual's demand for money and other goods

Rational individuals seek to maximize their utility; however, the satisfaction of their needs is constrained by the budget at their disposal. It is possible to derive a household demand for real balances by maximizing the utility function specified in equation (1) in Section 2.2 above, subject to the household budget constraint. Thus one maximizes

$$U(x_1,\ldots,x_k,n,m^h) \tag{12}$$

subject to the following budget constraint:

$$\textstyle\sum_k p_k x_k + (r - r_m)Pm^h = A_o + Wn \quad k = 1,\ldots,\text{K}. \tag{13}$$

In this constraint p_k is the price of the k^{th} commodity, P is the price level, W is the nominal wage rate, and A_o is the nominal value of the initial endowment of commodities and financial assets. Recall that x_k is the quantity of the k^{th} commodity (k = 1,..., K), n is labor supplied in hours, and m^h is the average amount of real balances held by households for their liquidity services. The second term in (13), $(r - r_m)Pm^h$, is the total user cost of holding a nominal amount of money Pm^h. While $(r - r_m)$ is the interest rate forgone per unit of money held with r being the market interest rate on assets other than money and r_m is the interest rate paid on nominal balances.

We can first set the Lagrangian equal to:

$$L = U(x,\ldots,x_k,n,m^h) + \lambda\left[\sum_k p_k x_k + (r - r_m)Pm^h - A_o - Wn\right] \qquad (14)$$

Taking the first derivatives of the Lagrangian above with respect to each of the endogenous variables $x_1,\ldots,\ x_k$, n, m^h, λ and setting them equal to zero yields the first-order maximizing conditions as:

$$\frac{\partial L}{\partial x_k} = U_k - \lambda p_k = 0 \qquad k=1,\ldots,K \qquad (15)$$

$$\frac{\partial L}{\partial n} = U_n - \lambda W = 0 \qquad (16)$$

$$\frac{\partial L}{\partial m^h} = U_m - \lambda(r - r_m)P = 0 \qquad (17)$$

$$\frac{\partial L}{\partial \lambda} = \sum_k p_k x_k + (r - r_m)Pm^h - A_o - W_o = 0\,. \qquad (18)$$

Assuming that the second-order conditions for maximization are satisfied the equations above give a solution for the endogenous variables, based on this maximizing procedure, in general form as:

$$x_k^{dh} = x_k^{dh}(p_1,\ldots,p_k,W,(r - r_m)P,A_o), \qquad k=1,\ldots,K \qquad (19)$$

$$n^s = n^s(p_1,\ldots,p_k,W,(r - r_m)P,A_o), \text{ and} \qquad (20)$$

$$m^{dh} = m^{dh}(p_1,...,p_k,W,(r-r_m)P,A_o) \qquad (21)$$

where the superscripts *d, s* and *h* stand respectively for demand, supply and households. Hence, the demand for real balances in equation (21) is a function of the price of commodities, the nominal wage rate, the user cost of real balances and the nominal initial endowment. x_k^{dh} is the households' demand for commodity *k*, while n^s stands for the supply of labor.

It is worth mentioning that a proportionate increase in the nominal variables $p_1,...,p_k,W,$ and A_o, to $\alpha p_1,...,\alpha p_k,\alpha W,\alpha A_o$ does not change the quantities of real balances and commodities demanded and also does not affect the supply of labor. Formally expressed, the first-order conditions (15), (16), (17), (18) and the solution for the variables x_k^{dh}, n^s and m^{dh} respectively given in (19), (20), (21) obtained by maximizing $U(x_1,...,x_k,n,m^h)$ subject to the budget constraint $\sum_k p_k x_k + (r-r_m)Pm^h = A_o + Wn$, yields the same result as maximizing $U(x_1,...,x_k,n,m^h)$ subject to $\sum_k \alpha p_k x_k + (r-r_m)\alpha Pm = \alpha A_o + \alpha Wn$. This new maximization gives for a positive α:

$$x_k^{dh} = x_k^{dh}(\alpha p_1,...,\alpha p_k,\alpha W,(r-r_m)\alpha P,\alpha A_o) \qquad k=1,...,K \qquad (22)$$

$$n^s = n^s(\alpha p_1,...,\alpha p_k,\alpha W,(r-r_m)\alpha P,\alpha A_o) \qquad (23)$$

$$m^{dh} = m^{dh}(\alpha p_1,...,\alpha p_k,\alpha W,(r-r_m)\alpha P,\alpha A_o). \qquad (24)$$

Therefore, since a proportionate change of the nominal exogenous variables from $(p_1,...,p_k,W,A_o)$ to $(\alpha p_1,...,\alpha p_k,\alpha W,\alpha A_o)$ does not affect quantities demanded x_k^{dh} and m^{dh}, and supplied n^s, the demand and supply functions in equations (19), (20), (21) are said to be homogeneous of degree zero in $p_1,...,p_k,W,A_o$. This feature, homogeneity of degree zero, of the demand for real balances has the corollary that money is neutral provided that all prices (including wages) increase in the same proportion, the real value of the initial endowment does not change, interest is paid on all money balances, and there is no anticipation of further price changes or errors in inflationary expectations (Handa, 2000). However, these are rather stringent conditions and money is not neutral in the short-run (Mankiw, 1999). It is of some interest that in our empirical chapter in Section 4.3 that real money demand is not homogeneous. Further, it can be asserted that the demands for commodities and real balances and the supply of labor depend only upon relative prices – but not absolute prices – and the real value of initial endowments (Handa, 2000). This follows directly from the homogeneity feature of the solutions for endogenous variables. If one was to set α equal to the inverse of the price level *P*, the equations (22), (23), and (24) become, for $\alpha = 1/P$:

$$x_k^{dh} = x_k^{dh}\left({p_1}/{P},...,{p_k}/{P},{W}/{P},(r-r_m),{A_o}/{P} \right) \qquad k=1,...,K \tag{25}$$

$$n^s = n^s\left({p_1}/{P},...,{p_k}/{P},{W}/{P},(r-r_m),{A_o}/{P} \right) \tag{26}$$

$$m^{dh} = m^{dh}\left({p_1}/{P},...,{p_k}/{P},{W}/{P},(r-r_m),{A_o}/{P} \right) \tag{27}$$

As the optimal real demands and the real supply are unchanged (from the homogeneity feature) but the exogenous variables change to reflect relative prices, we can justify the above assertion. In (27), the household's demand for real balances appears to be a function of the opportunity cost of holding money, the real wage rate, the real value of initial endowments, and the relative prices of commodities.

2.7.2 Deriving the firm's demand for money and for other goods

After deriving the household's demand for money, we now turn to the derivation of the firm's demand for money and for other goods. It is assumed that the firm operates in perfect competition and seeks to maximize its profit, which is the difference between its total revenue and total costs. The firm's profit function is specified as:

$$\Pi = p_k F\left(n,\kappa,m^f\right) - Wn - \rho_\kappa \kappa - \rho_m m^f - F_o \qquad (28)$$

The elements of this profit function are:

Π is the firm's profit, $p_k F\left(n,\kappa,m^f\right)$ is the total revenue of the firm, Wn is the wage bill, ρ_κ is the nominal user cost of variable physical capital κ, F_o is the firm's fixed costs, ρ_m is the nominal user cost of real money balances. But we know from equation (13) that the nominal cost of real money balances is $(r - r_m)P$. The nominal user cost of capital is thus $\rho_\kappa = (r - \pi_\kappa)p_\kappa$. In other words the real rate of interest is adjusted for price increases of the capital good. This is what a firm gives up by holding capital. With these definitions of the nominal cost of real balances and capital we can transform equation (28) to:

$$\Pi = p_k F(n,\kappa,m^f) - Wn - (r - \pi_\kappa)p_\kappa \kappa - (r - r_m)Pm^f - F_o. \qquad (29)$$

Now, to get the optimal values of the variables n, κ, and m^f we need to take the first derivatives of the profit function Π with respect to these variables and set them equal to zero. This procedure gives the first-order conditions as:

$$\frac{\partial \Pi}{\partial n} = p_k F_n - W = 0\,, \tag{30}$$

$$\frac{\partial \Pi}{\partial \kappa} = p_k F_\kappa - (r - \pi_\kappa) p_\kappa = 0\,, \tag{31}$$

$$\frac{\partial \Pi}{\partial m^f} = p_k F_m - (r - r_m) P = 0\ . \tag{32}$$

We divide the set by P to get:

$$\left({p_k}/{P} \right) F_n = {W}/{P}, \tag{33}$$

$$\left({p_k}/{P} \right) F_\kappa = (r - \pi_\kappa)\left({p_\kappa}/{P} \right), \tag{34}$$

$$\left({p_k}/{P} \right) F_m = (r - r_m) m^f\,. \tag{35}$$

Equations (33) to (35) can be solved for the firm's demand for labor n^d, its demand for capital k^d, and m^{df} the firm's demand for real balances. This procedure produces:

$$n^d = n^d\left({p_k}/{P}, w, (r - \pi_\kappa)\left({p_\kappa}/{P} \right), (r - r_m) \right), \tag{36}$$

$$\kappa^d = \kappa^d\left({p_\kappa}/{P}, w, (r - \pi_\kappa)\left({p_\kappa}/{P} \right), (r - r_m) \right), \tag{37}$$

$$m^{df} = m^{df}\left({p_k}/{P}, w, (r - \pi_\kappa)\left({p_\kappa}/{P} \right), (r - r_m) \right). \tag{38}$$

Noting that we can use *w,* the real wage, for *W/P.* Then substituting equations (36) to (38) in $x_k = F(n, \kappa, m^f)$ - the firm's production function as specified in equation (8) above - gives the supply function for commodities:

$$x^s = x^s\left({p_1}/{P}, \ldots, {p_k}/{P}, w, (r - \Pi_k)\left({p_\kappa}/{P} \right), (r - r_m) \right) \tag{39}$$

From equations (36) through (39) we learn that firms' demands for real balances, for labor, and for capital as well as the firm's supply for commodities depend only upon relative and not absolute prices. We also learn that, proportionate increases in $p_1,...,p_k,W$ and P do not affect quantities of inputs demanded and outputs supplied by the firm; hence equations (36) through (39) are homogeneous of degree zero in $p_1,...,p_k,W$ and P provided the user costs $(r-\pi_\kappa)$ and $(r-r_m)$ remain constant. We now turn to consider the aggregate demand for money.

2.7.3 Deriving aggregate demand for money

In Section 2.7.1 we show the household's optimal demand for real balances. In order to avoid confusion, we keep the demand for real money balances as m^{dh} but recognize this refers to the aggregate holding of real balances by households. The aggregate households' real money demand function is thus (equation 27):

$$m^{dh}=m^{dh}\left(p_1/P,...,p_k/P,W/P,(r-r_m),A_o/P\right) \tag{40}$$

Similarly, equation (38) is the firm's demand for real balances. Again having the aggregate demand for real balances for the firms to be represented by the same symbol we have:

$$m^{df}=m^{df}\left(p_1/P,...,p_k/P,w,(r-\pi_\kappa)\left(p_\kappa/P\right),(r-r_m)\right) \tag{41}$$

Finally, combining the consumers' aggregate demand for real balances, m^{dh}, in equation (40) and the firms' aggregate demand for real balances m^{df} in equation (41) gives the economy's aggregate demand for real balances m^d which is:

$$m^d = m^d\left(p_1/P, \ldots, p_k/P, W/P, (r - \pi_\kappa)\left(p_\kappa/P\right), (r - r_m), A_o/P\right) \tag{42}$$

It is important to mention that, the microeconomic derivation of the demand for money, which stems from a conventional demand for goods approach, expresses the demand for money in real terms. The determinants of the demand for real money in (42) can be divided in two broad categories: (i) one part that represents income or wealth, and (ii) a second portion standing for the opportunity costs of holding money rather than its alternatives. The analysis of money demand needs to simplify this set of determinants. It bears pointing out that our specification of money demand in Chapter Four has elements of equation (42) in that it includes a variable that captures all prices, another for real GDP, and a variable that attempts to capture the opportunity costs of holding money. Thus our empirical specification is close to the elements of (42) although it does not include endowments.

2.8 The aggregate demand for money: a simplification for macroeconomic models

To simplify the demand for money in macroeconomics we drop some of the independent variables that are present in microeconomic specification of the demand for money function. Recall equation (27), m^{dh}, which is the household's demand for real balances.

$$m^{dh} = m^{dh}\left(p_1/P, \ldots, p_k/P, W/P, (r - r_m), A_o/P\right) \tag{43}$$

Macroeconomic analysis makes the above equation much simpler by ignoring the heterogeneity of commodities and their individual prices, even though they are fundamental to understanding why households and firms will hold money to facilitate transactions among commodities (Handa, 2000). Thus, assuming the relative prices $p_1/P, \ldots, p_k/P$ are constant and excluding them from (43) yields:

$$m^{dh} = m^{dh}\left(W/P, (r - r_m), A_o/P\right). \qquad (44)$$

Moreover, economists rarely want to study the interaction between the demand for money and the supply of labor, but rather focus on national income in the macro economy. Recognizing that not all income is earned in typical labor market, we substitute real wages, W/P, by full real labor income y^L. This means the aggregate household demand for money becomes:

$$m^{dh} = m^{dh}\left(y^L, (r - r_m), A_o/P\right) \qquad (45)$$

We now consider the firm's demand for real balances which in (38) was formulated as:

$$m^{df} = m^{df}\left(p_1/P, \ldots, p_k/P, W/P, (r - \pi_K)\left(p_K/P\right), (r - r_m)\right). \qquad (46)$$

In macroeconomics we simplify the above equation for following reasons: (i) first we eliminate the relative prices of commodities as they are assumed to remain constant; (ii) we then assume equality between the rate of inflation of the prices of capital goods and the inflation rate in the economy. Now we can simplify (46) and substituting W/P with y^L yields:

$$m^{df} = m^{df}\left((r - \pi), (r - r_m), y^L\right) \qquad (47)$$

Finally, adding equations (46) and (47) together yields the macroeconomic specification of the aggregate demand for real balances as follows:

$$m^d = m^d\left((r - \pi), (r - r_m), y^L, \left(A_o/P\right)\right) \qquad (48)$$

This specification means that, the demand for real balances in the economy depends on the user cost of the physical capital $(r-\pi)$, the user cost of holding money $(r-r_m)$, real labor income y^L and the real value of the initial wealth A_o/P.

The Keynesian tradition further simplifies (48) by substituting both the real labor income y^L and the real value of initial wealth A_o/P by the current real income y, which is equal to labor income plus a return on wealth. This changes the economy's demand for real balances to:

$$m^d = m^d\left((r-\pi),(r-r_m),y\right) \qquad (49)$$

Again we note that, the demand for money is in real terms. Also as Judd and Scadding (1982) assert, economic theory generally relates the quantity of money demanded to a small set of key variables linking money to the real sector of the economy. This small set of variables is composed of the real income, on the one hand, and the opportunity cost of holding money on the other hand (Sriram, 1999). The model used for empirical testing in Chapter Four is based on (49) as it asserts nominal balances are a function of prices, y and $(r-r_m)$. We now turn to the presentation of the various money demand models that focus on each of Keynes' three motives for holding money.

2.9 The transactions demand for money

In *The General Theory*, Keynes subdivided the demand for money into three components representing three motives for holding money: transactions, precautionary and the speculative.

However, he did not provide distinctive rigorous analyses for the determination of the demand for money for each of these motives. In the 1950's, Baumol and Tobin managed to formulate a more rigorous theory based on these motives of holding money that other economists subsequently extended.

Keynes in *The General theory* defines the transactions motive as "the need of cash for the current transactions of personal and business exchanges" (Keynes, 1936: 170). However, Keynes (1936) failed to substantiate this claim in a detailed model. He assumes the transactions and the precautionary motives "absorb a quantity of cash which is not very sensitive to changes in the rate of interest as such…apart from its reactions on the level of income" (Keynes, 1936). Thus, he specified the joint demand for money based on transactions and precautionary motives as:

$$M^{tr} = kY \qquad (50)$$

where M^{tr} is the joint transactions and precautionary demand for money, Y is nominal income and k is a constant. Equation (50) implies that increases in Y increase M^{tr}. Moreover, Keynes and many of the traditional classical economists assumed that the elasticity of the demand for transactions balances with respect to nominal income was equal to one. "In particular, the demand for transactions balances was taken to double if either the price level or real income – but not both – doubled. Hardly any analysis was presented in support of such a statement and it remained very much in the realm of an assumption" (Handa, 2000: 86-87). The assumption of unitary elasticity came under attack by Baumol (1952) and Tobin (1956) who later formulated the transactions demand for money balances by applying an inventory approach to the problem.

2.9.1 Baumol's application of the basic inventory analysis to the transactions demand for money

Baumol (1952) and Tobin (1956) formulated a theory of money demand in which money is essentially considered as an inventory held for transactions purposes. Such an inventory (money) is held in order to reduce the transactions costs of going between money and financial assets others than money (Sriram, 1999). Baumol (1952) constructs a model of money demand that shows the optimal holding of real money balances when an individual faces an interest cost by holding money and a transaction cost of converting assets to money. The model makes the following assumptions:

(i) The timing and amount of expenditures and receipts are certain;

(ii) Individuals make all their payments of Y expenditures in money that they already have at their disposal. They spend the money they possess in constant stream for a given period;

(iii) Only two assets are available: bonds, which pay an interest rate of r and money, which does not pay any interest. Bonds include savings deposits and other financial assets. Further, there are transfer costs when converting bonds to money and *vice versa*, but there are no own service costs of using money or bonds;

(iv) Constant withdrawals of cash from bonds are made in lots of W during equally spaced lengths of time over a given period. Each time that the individual "makes a withdrawal, he must incur a brokerage (bonds-money transfer) cost that has two components: a fixed cost of B_o per withdrawal and a variable cost of B_1 per dollar withdrawn. Examples of such brokerage costs are brokers' commission, banking charges and own (or personal) costs in terms of time and convenience for withdrawals from bonds. The overall cost per withdrawal of W is $(B_o + B_1 W)$"(Handa, 2000: 87).

At the beginning of the period an individual has at his disposal an income *Y* held in the form of both bonds *B* and money *M*. He spends his income *Y* over the period in a continuous steady stream. We now describe the workings of the Baumol model in greater detail.

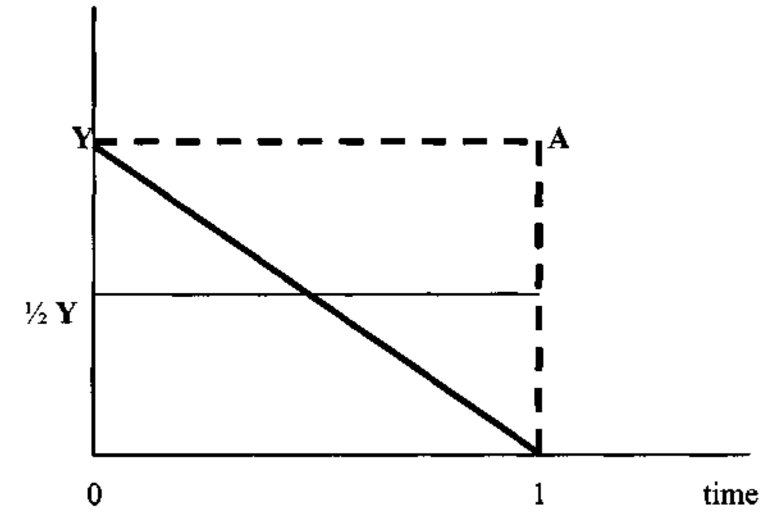

Figure 2.1 Basic inventory analysis of the transactions demand for money (one period)
Source: Handa (2000: 88)

In Figure 2.1, income Y is represented on the vertical axis while periods of time are represented on the horizontal. In this figure the solid line (principal diagonal) from *Y* to 1 (on the horizontal axis) represents the remaining amount of income at the disposal of the individual at various points of time. Thus the triangle YA1 shows the amount of income that has already been spent at various points of time over the whole period. Area 0Y1 is equal to ½ Y*1 over the period, which means that an individual who starts the whole period with an income Y that he spends in constant amounts over the period has an average holding of money equal to Y/2.

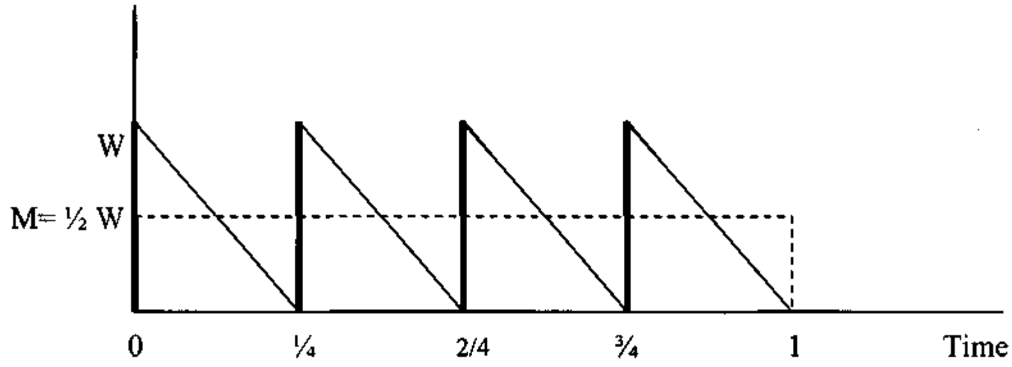

Figure 2.2 Basic inventory analysis of the transactions demand for money (period subdivided)

Source: Handa (2000: 88)

In Figure 2.2 above, we still have one period but it is now subdivided into four weeks. The individual withdraws an amount W at the beginning of the week, spends it in an even stream and has to withdraw W at the beginning of each week. Figure 2.2 shows that the individual's average cash balances over the period are ½ W.

Holding money means two costs for an individual. First, he incurs a brokerage cost of $(B_o + B_1 W)$ per withdrawal of W; therefore, the cost of withdrawing an amount Y from bonds is equal to $\left[(B_o + B_1 W)\left(Y/W\right)\right]$ where Y/W gives the number of withdrawals of lots of W from Y. The second cost is the interest rate forgone due to the holding of ½ W on average over the period instead of holding it in bonds that pay an interest rate of r. This second cost is thus $\frac{1}{2}Wr$. Therefore, the total opportunity cost C is the sum of the two costs, which gives:

developed countries (Handa, 2000). It is of some interest that our estimation of the long-run money demand in Rwanda, detailed in Section 4.2, finds that the interest rate plays no role and the elasticity of money demand with respect to real income is 0.596 which is *close to* the implied theoretical level.

2.9.2 Issues about holding currency or demand deposits

We have not addressed the interesting issue concerning the decision to hold notes and coins rather than demand deposits. In this regard the convenience and safety specific to holding currency rather than demand deposits needs to be taken into consideration.

It has been observed that people prefer demand deposits to cash holdings for safety reasons. In many countries carrying large sums of money is very risky as one may be robbed. This means demand deposits are preferred to currency. However, in those countries with little theft, individuals avoid demand deposits and pay for most transactions in cash (Handa, 2000). In general, in most developed economies or urban sectors of developing countries, individuals tend to prefer demand deposits for transactions rather than currency. Conversely, in many less-developed economies and especially in rural areas poorly served by banks, people prefer to hold currency instead of demand deposit since the latter involves brokerage costs as envisaged in the Baumol model.

The advent of technological innovations in the financial sector such as the increasing use of electronic or smart cards and the proliferation of digital cards has reduced but not entirely eliminated currency demand. In other words W in Figure 2.2 has fallen. So, the general conclusions of the Baumol model remain intact as "in the aggregate, the demand for real transactions balances increases less than proportionately with real expenditures, decreases with the yield on alternative assets; and does not change if all prices change proportionately"(Handa, 2000: 97).

2.10 The speculative demand for money

2.10.1 Keynes' speculative demand for money

The speculative demand for money is introduced in the literature by Keynes who defines the speculative motive of holding money as "the object of securing profit from knowing better than the market what the future will bring forth"(Keynes, 1936: 170). In his *The General Theory*, Keynes asserted that the speculative demand for money resulted from the uncertainty as to the future of the rate of interest. Assuming that there are two assets: (i) either individuals can hold money that does not have any yield, or (ii) they can keep bonds that have a positive yield. Since people have different views on the future interest rate, those who believe that the interest rate will be higher in the future than the one assumed by the market will tend to hold money in order to make profit. In fact, for this group of people who believe that the interest rate will rise and the price of bonds will fall, they prefer to sell their bonds now and hold money in order to avoid capital losses in the future. On the other hand, individuals who think that the interest rate will be the one assumed by the market will tend to hold bonds instead of money, since as they think that the interest rate will fall thus raising bond prices. Therefore, they choose to hold bonds now rather than money (Keynes, 1936). Hence, in Keynes view, the speculative demand for money can be written as: $M^{sp} = L(r)$ where, M^{sp} is the speculative demand for money, r is the market rate of interest and *L(r)* is Keynes' degree of the *liquidity preference*. This explanation applies to a single individual. Now concerning the aggregate demand function, Keynes argues that since investor's expectations as to the future interest rate differ, then at high rates of interest more investors will expect them to fall and few will hold cash. Conversely, at rather low rates of interest, only a few investors will expect them to fall further and most investors will hold cash. This implies that the aggregate demand for money is a continuous downward sloping curve M^{sp} as shown in Figure 2.3 below.

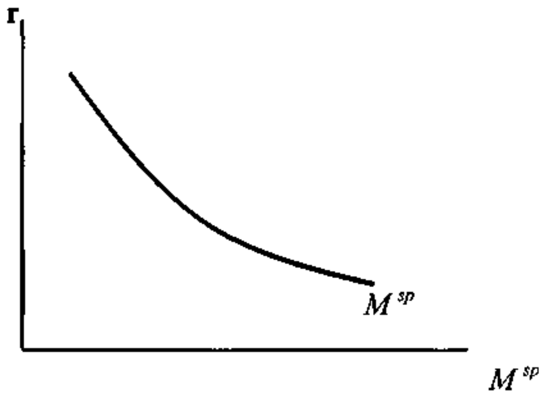

Figure 2.3 Keynes' degree of liquidity preference

Source: Handa (2000: 39)

2.10.2 Formalization of Keynes' speculative demand for money by Tobin

Tobin (1958) postulates that an individual chooses to hold money as part of a portfolio because the rate of return on holding money is more certain than the rate of return on holding earning assets. In other words, holding assets other than money is riskier than holding just money alone. This difference in riskness can be explained by the fact that alternative assets (bonds and equities) are subject to market price volatility, while money is not (Sriram, 1999).

Tobin (1958) formalizes Keynes' approach of the speculative demand for money. He assumed like Keynes that people have only two assets in which to invest: (i) money which does not provide any yield and is risk free and (ii) bonds which have a non-zero yield and the yield has a positive standard deviation indicating these bonds are risky. He further assumes that, the bond is a consol, which is unredeemable. A consol pays a fixed coupon c indefinitely. Thus, in perfect capital markets, the market price p_b of a consol paying a coupon c per period is given by its present discounted value at the market rate of interest, x, on loans as follows (Handa, 2000):

$$
\begin{aligned}
p_b &= \frac{c}{1+x} + \frac{c}{(1+x)^2} + \dots \\
&= c\left(\sum_{t=1}^{\infty} \frac{1}{(1+x)^t}\right) \\
&= c\left(\sum_{t=0}^{\infty} \frac{1}{(1+x)^t} - 1\right) \\
&= c\left(\frac{1}{1-\frac{1}{1+x}} - 1\right) \\
&= c\left(\frac{1}{x}\right) = \frac{c}{x} \qquad \text{(For } c=x \qquad p_b=1)
\end{aligned}
$$

Assuming r to be the current return on consols, or the coupon payment and regarding r^e, as the future expected market rate of return on consols as the expected rate of discount, then P_b

is r/r^e. It is usual to consider the expected capital gain or loss on the consol as g, which can be written as $g = r/_{r^e} - 1$. Then, the sum of the coupon (r) and the capital gain (g) is the expected yield (r + g) given by $r + g = r + \frac{r}{r^e} - 1$. If the yield (r + g) is positive, (r + g) > 0, rational individuals will purchase the consol instead of holding money, which has a yield equal to zero. Conversely, for a negative yield or (r + g) < 0, it is rational to hold money which in this case has a great yield. Between the positive yield (r + g) > 0 and the negative one (r + g) < 0, there is a zero yield (r + g = 0), which is known as the switch point concerning the choice between keeping money or consols. We can derive a *critical return* r^c indicating that interest rate at which an individual will switch from holding consols to money. This critical switching yield is $\frac{r^e}{1+r^e}$ or r^c. Thus if the individual makes the correct guess as to r^e, any r above r^c indicates positive yields can be made on consols. The individual will hold no money.

This situation is illustrated in Figure 2.4 below.

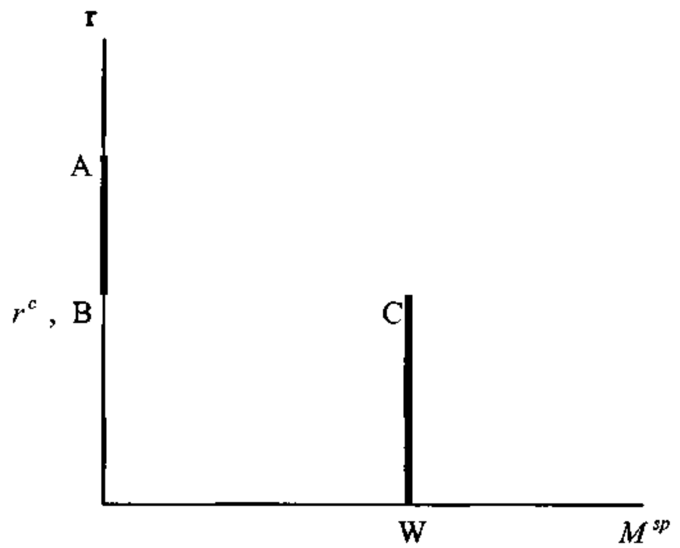

Figure 2.4 Tobin's formalization of Keynes' version of the speculative demand for money
Source: Handa (2000: 39)

For any current interest rate greater than the critical level ($r > r^c$), the whole portfolio *W* of rational individuals will be held in consols, so that money balances will be equal to zero for interest rates along *AB*. On the other hand, for a current interest rate less than the critical level i.e. (r < r^c), rational individuals will hold their entire portfolio *W* as money. This is represented in Figure 2.4 by the portion of the demand for money *CW*. Thus, the individual's demand for money appears to be the discontinuous step function (AB, CW). A smooth downward sloping money demand function is obtained by assuming many investors who do not have the same critical level of the interest rate.

2.11 The precautionary demand for money

Keynes (1936) argues that there is also a precautionary motive for holding money balances that he defined as: "the desire for security as to the future cash equivalent of certain proportion of total resources"(Keynes, 1936: 170). The precautionary motive arose because of the uncertainty of future income and consumption needs and purchases (Whalen, 1966). Therefore, individuals hold money to avoid being obliged to convert their non-money assets into cash when an eventual need for purchases arise. Precautionary money balances are the means of paying for unexpected expenditures during a period (Handa, 2000). The more people expect to make expenditures in the near future, the greater will be the amount of money held. Conversely, as the probability of a need for expenditures in the near future decreases, the amount of cash held decreases.

Recall that in Section 2.10 above, the <u>speculative</u> demand for money is analyzed using the assumption that yields of various assets are uncertain but existing wealth is known; while the <u>transactions</u> demand for money is analyzed (in Section 2.9 above) by assuming the certainty over the amounts and timing of income receipts and expenditures. Models of the <u>precautionary</u> demand for money assume uncertainty of income and expenditures in the future. Unlike the speculative demand for money, which puts a great deal of emphasis on the uncertainty of yields, the precautionary demand for money analysis is simplified by assuming that these yields are certain. "Given this assumption, the analysis of the precautionary demand for money is an extension of the inventory analysis of the transactions demand to the case of the uncertainty of the amount and timing of income receipts and expenditures"(Handa, 2000: 129). A model of precautionary balances is based on the model used to explain transactions balances. The general formula of the inventory analysis of the transactions demand for money is derived in equation (54) above and can be written generally as:

$$m^{trd} = m^{trd}(b, r, y) \qquad (55)$$

Where m^{trd} is the transactions demand for real balances, b is the real brokerage cost, r is the interest rate and y is the real income. Uncertainty as to income is had by y following a normal distribution with mean value μ_y and standard deviation σ_y. Two other elements are required in this model: (i) the degree of risk aversion ρ, and (ii) the available substitutes that allow payments for sudden unexpected expenditures. These substitutes we call Ω. Examples of such substitutes are credit cards or overdrafts. Hence, equation (55) is modified to give the general version of the precautionary demand for money as:

$$m^{prd} = m^{prd}(b, r, \mu_y, \sigma_y, \rho, \Omega) \qquad (56)$$

Where: m^{prd} is the precautionary demand for money, b is the real brokerage cost, r is the interest rate, μ_y is the mean of the distribution of income, σ_y is the standard deviation of income, ρ is the degree of risk aversion, and Ω stands for the substitutes for precautionary money balances. The salient feature of equations (55) and (56) is that the demand for money is a demand for real balances. Also, two categories of determinants can be observed: (i) income which influences demand for money positively, and (ii) a set of opportunity costs whose increase tends to reduce real balances held. A conclusion we reached in Section 2.9 and Section 2.10 as well. Our empirical specification attempts to capture these features by using a relatively broad definition of money.

2.12 Theoretical underpinning of the money demand specification to be used in our empirical chapter

This section brings together all the above and provides the theoretical justification for the model we use in empirical testing in this thesis. Our empirical work is based on Nell (2003) and the following long-run money demand specification:

$$m2_t = \beta_0 + \beta_1 y_t + \beta_2 p_t^c + \beta_3 (RM - RO)_t + u_t \,.$$

In this model, *m2* (see Section 4.2, page 94) is the demand for nominal *M2* money balances (currency plus demand deposits plus quasi money), *y* is real income, p^c the price level, *RM* is the long-term opportunity cost of holding money, *RO* is the long-term own interest rate on money and u_t is the error term. Lower case letters denote variables in natural logarithms and Chapter Four makes specific use of this formulation of money demand. We are able to justify this specification based on concluding in Section 2.7 that the estimated function must include real income, the price level and the opportunity cost of holding money. Section 2.8 justifies this specification in terms of nominal balances. Sections 2.9 onwards do not change the determinants of money demand but do suggest use be made of a broad definition of money. We do this by using M2 rather than M1 in our study of money demand in Rwanda.

Concerning the influence of income on the demand for money, Beguna *et al.* (2002) contends that classical economists theorized that the primary determinant of the demand for nominal balances (M) was an individual's nominal income level (PY) determined by the output level (Y) and the price level (P). This is because classical economists such as Irving Fischer and Alfred Marshall argued that the demand for money arose predominantly from holding money as a medium of exchange for transactions purposes. In their contribution to money demand theory, monetarists reinterpreted the quantity theory as representing an economy's demand for money, so that they were able to structure an explanation for how an increase in the money supply caused an increase in economic activity. This results in what is known as the *modern quantity theory of money* in which the original quantity equation is specified as $M = (1/v)PQ$. The latter was regarded as a behavioral equation that reflects the economy's demand for money, so that as nominal income PQ increases, the demand for money increases (Kennedy, 2000).

As pointed out in Section 2.9 of this chapter, Keynes assumes, like classical economists, that transactions were proportional to income. Therefore, he defined the transactions demand for money to be proportional to income. We have seen in this chapter that Baumol (1952), Tobin (1956) supported by other research did not deny this conclusion in that income still has a positive impact on money demand. Keynes, however, develops a theory of money demand that adds a role for the interest rate. He bases his analysis of money demand on the individuals' decision making process and derived the so-called *liquidity preference function* in which the demand for real balances is negatively related to the interest rate and positively related to real income. Since we know that the question in monetary policy is whether, or to what extent, the quantity of money demand is affected by changes in interest rates (Mishkin, 1998), it is interesting for us to look at the dynamics of interest rates in Rwanda. Beguna *et al.* (2002) asserts that theories of demand for money are developed around a trade-off between the benefits of holding more money against the interest costs of doing so. The cost of holding money could be defined as the difference between the interest rates paid on money and the interest rate paid on the other assets such as savings deposits. The interest rate on money is referred to as the own rate of interest, and the opportunity cost of holding money is equal to the difference between the interest on other assets and the own rate. This is consistent with the interest rate differential that is present in our empirical model (in Section 4.2) and is in accordance with our previous developments in this chapter in equations (42) and (49). In addition, Nell (2003) asserts that the role of interest rate effect in our empirical money demand specification is particularly relevant under a monetary system where the central bank sets the supply price of reserves through its control over the interest rate. If money determines prices and the interest rate is a significant determinant in the money demand function, then the simple transmission mechanism is:

Interest rate $\longrightarrow$ Money $\longrightarrow$ Prices.

Therefore, theory generally relates the quantity of money demanded to a small set of key variables linking money to the real sector of economy (Judd and Scadding, 1982). Money demand theories suggests that the demand for money is a function of a scale variable as measure of economic activity, and a set of opportunity cost variables to indicate the forgone earnings by holding assets which constitute alternatives to money (Sriram, 1999). Also as we work with nominal balances, we must include the price level as a variable. Thus in terms of our first hypothesis (Chapter One, page five) stability means finding relationships between the interest rate and prices that do not vary with time, thus supporting this simple transmission mechanism. In Rwanda we find that prices and income are important determinants of nominal money demand. In terms of our second hypothesis (Chapter One, page five), which attempts to model the link between money and prices, we find that prices determine money. Thus in our transmission mechanism above the first arrow is non-existent (and remains so over time) and the second arrow points in the other direction for Rwanda.

2.13 Summary and conclusion

This chapter traces the theoretical contributions of various economists to money demand, and provides the basis for an economic analysis of the role, and the relevant determinants, of money demand in economy. It presents the models of money in the utility function (MIUF) and money in the production function (MIPF). In fact, money can be incorporated directly into the utility function because the utility function expresses preferences and also because individuals prefer more cash to less. Money deserves to be included in the utility function just like any other good. However, some economists argue that money must not be incorporated in the utility function directly but indirectly because it does not yield consumption services; rather it helps the consumer to save time, therefore increasing leisure. On the other hand, the rationale for including the firm's real balances as an input, like other inputs, in the firm's production function is that in an economy requiring the exchange of goods against money, holding real balances allows the firm to produce more output with given amounts of capital and labor. In other words, the justification for money to be an argument of the firm's production function either directly or indirectly is that its usage increases the proportion of firm's labor force and capital engaged directly in production. Therefore, the firm has no need to divert labor and capital to deal with the payment and receipts process, and as a consequence the firm produces more.

The maximization of the household's utility function and the firm's production function yields the household's and the firm's demand for real balances respectively. The individual's demand for real balances is homogeneous of degree zero in all prices (including wages) and in the nominal value of initial endowments; while the firm's demand for real balances is also homogeneous of degree zero in the firm's output and input prices. This feature of homogeneity of degree zero of the household's and firm's demand for real balances implies that money is neutral provided that all prices (including wages) increase in the same proportion, the real value of initial endowment does not change, interest rate is paid on all money balances, and there is no anticipation of further price changes or errors in inflationary expectations. These are rather stringent conditions and money is not neutral in the short-run (Mankiw, 1999). Our results in Chapter Four suggest that money is not homogeneous. Based on our results we cannot say anything as to the neutrality of money. However we can say that prices change by more than does money. So we can say that money is not superneutral, as an increase in the growth rate of money results in prices rising by higher amount, resulting in lower real money balances.

The combination of households' and firms' demand for real balances yields the aggregate (economy's) demand for real balances in the context of the Warlasian general equilibrium model which provides the foundation for a microeconomic analysis of markets in the economy determine individual prices in the economy. However, in order to ease the analysis, macroeconomics drops some of the independent variables that are present in the demand for money function derived from the perspective of the Warlasian general equilibrium. We test one such simplified version in Chapter Four.

In *The General theory*, Keynes specified that an individual's real balances come from three motives: transactions, speculative, and precautionary. Nevertheless, Keynes failed to substantiate this claim in a detailed model. Baumol (1952) and Tobin (1956) managed to formulate the transactions demand for money balances through an inventory approach. Their finding was that the transactions demand for money depends negatively on the interest rate and its elasticity with respect to the real level of expenditures is less than unity. We find empirical support for this. Keynes introduced the speculative demand for money in the literature and asserted that it resulted from uncertainty as to the future of the interest rate; this led to Keynes' so-called degree of *liquidity preference*. Tobin (1958) formalized Keynes' approach and reached also the conclusion that the individual's demand for money is a function of the rate of interest. Precautionary money balances are a means of paying for unexpected expenditures arising during a period. The more people expect to make expenditures in the near future, the greater will be the amount of money held. Conversely, as the probability of need for expenditures in the near future decreases, the amount of cash held decreases in favor of an increase in other non-money assets. This suggests that any optimal work use as broad money as is possible given any country's structural constraints. The purpose of this chapter is to provide the link between theoretical developments and the money demand function that is going to be used in our empirical chapter. Essentially this chapter suggests our model embody income as a scale variable, includes the price level and some measure of an interest rate differential. We are faithful to this specification in Chapter Four.

CHAPTER THREE

THE EVOLUTION OF MONETARY POLICY IN RWANDA

3.1 Introduction

The purpose of this chapter is to provide an overview of the developments in monetary policy in Rwanda since 1964, but concentrating on more recent changes to the conduct of monetary policy in the late 1980's and the whole of 1990's. We begin by giving a broad overview of developments as regards monetary policy. The chapter then examines, in some detail, monetary policy prior to the reforms made under the structural adjustment programme and points out the various shortcomings of this older monetary arrangement. In Section 3.3, the chapter moves on to examine a second time period in Rwandan monetary history characterized by monetary reforms. Under this new policy commercial banking is liberalized, no longer is government debt monetised, and the central bank makes greater use of indirect instruments of control. Instruments used to control the money supply are examined in some detail and we conclude this chapter by pointing out some of the obstacles that the monetary authorities face when attempting to achieve their targets for inflation. A final section concludes with our original suggestion that a baseline money demand function must be estimated for Rwanda.

3.2 Overview of monetary reforms in Rwanda

The National Bank of Rwanda (NBR) was instituted under the terms of the law in April 1964 as a national, publicly owned, establishment equipped with a civil personality and financial autonomy. The NBR has the following general missions:

(i) To formulate and implement monetary policy to protect the value of the currency and to ensure stability of the Rwandan Franc. For this purpose, it controls the currency and manages operations in the money market, regulates banking structures and monitors the foreign exchange market (NBR, 1999);

(ii) Has the exclusive privilege of providing currency or legal tender in Rwanda;

(iii) Manages the State's portfolio at its disposal and ensures the execution of financial transactions on behalf of the State, that is, the NBR is the financial agent of the State for any credit, banking, and cash transactions.

Since its establishment, the NBR had to ensure that monetary and credit conditions were in accordance with the overall economic policies decided by the Rwandan government at least until 1990, when the implementation of the IMF's Enhanced Structural Adjustment Facilities (ESAF) in Rwanda began. Later, a law was passed in 1997, to give the NBR greater autonomy. Further, a new banking law was adopted and promulgated in June 1999, giving the necessary power to the board of the NBR to determine monetary policy. This law has also strengthened the NBR's role in supervising financial institutions and enforcing rules of sound banking practice that are in conformity with international standards.

The NBR, right from its inception, has been called upon to support the economic policies of the State. This has been difficult as the NBR's goals are to ensure macroeconomic stability through careful monetary management, adopt a suitable exchange rate policy and support efficient banking supervision. These goals may not always be in line with the state's policies. The ESAF, which began in 1990, gave monetary policy another way to influence financial markets. With the disappearance of the credit rationing, rediscounting and setting of interest rates, a new era emerged, as regards monetary management, characterized in particular, by the introduction of the money market as a main source of funds and it became the arena for the determination of interest rates. In other words, interest rates were now determined by the market.

The NBR intervenes in the money market primarily through weekly money market operations using treasury bills. These interventions are intended to inject or to mop up excess liquidity, according to the overall stance of the banking system's excess reserves and taking into account the aims of current monetary policy. This adjustment of the banking system's liquidity, while influencing the monetary creation capacity of commercial banks, makes it possible to influence a short-term interest rate. In addition to this procedure, discount window facilities were also initiated. Available most of the time, the discount window at the NBR intended to offer liquidity as a *last resort* to institutions needing a temporary injection of liquidity. The interest rate at the discount window is determined by the NBR, and is modified when necessary, taking into account the economic situation and in order to ensure the achievement of the final objectives of monetary policy. In addition, the money market is also used as a suitable vehicle for the buying and selling of treasury bills, both on behalf of the State and for the needs of monetary policy. Given that there is greater and greater use of the treasury bill under newer monetary arrangements, the general public has become more familiar with this instrument.

Initiated in 1990, reserve requirements control excess liquidity by limiting the ability of banks to create money through increased loans. This instrument was the subject of multiple amendments that not only changed the rules of complying with regulations concerning reserve requirements, but also changing the penalty rate imposed on those banks that failed to meet their reserve requirements. A flexible exchange rate regime was introduced in Rwanda in March 1995 with the creation of foreign exchange markets, which meant exchange rates were now partially determined by the forces of demand and supply. The NBR does however ensure a smooth path of exchange rates by occasional intervention. To this end, each day, the NBR computes a *reference exchange rate* that banks are required to apply in their operations.

The war and the genocide seriously affected the financial system in Rwanda. Thus the NBR had to move quickly with the necessary counter measures to prevent its adverse effects, while at the same time proceeding with the revision of the regulations and the legal framework governing financial intermediation activities. The new banking regulations recommend in particular, the need for strict banking supervision, making sure commercial banks complied with sensible rules of sound banking practice. The minimum capital required by a commercial bank was raised to 1500 million Rwadan Francs or about 17 million Rand. Soon after the war and genocide, Rwanda engaged in an effort to rebuild the economy and restore macroeconomic stability initially using the IMF's ESAF, and then using the IMF's Poverty Reduction and Growth Facilities (PRGF), which is still the case.

The implementation of the Poverty Reduction Strategy in Rwanda is guided, among other things, by the following key principles:

(i) Policy coherence: any changes must be consistently applied and not be in conflict with national policy;

(ii) Needs and expenditures must be listed in order of priority to ensure that available resources are put to their best use (MINECOFIN, 2001; IMF, 2002; World Bank, 2002).

The Rwandan poverty reduction strategy recognizes that growth is a prerequisite for long-run poverty reduction. The aim is to achieve real economic growth of about seven to eight *per cent* per year over the next 15 to 20 years. Rwanda's medium-term macroeconomic objectives are (i) to maintain the annual average inflation rate at three per cent, (ii) achieve annual real GDP growth of at least six *per cent*, and (iii) keep gross international reserves at least equal to six months of imports. Further, in the context of poverty reduction, the Rwandan ministry of finance is developing a macroeconomic model of the Rwandan economy. In the rest of this section we mention some of the other structural changes that are being made, based on the Poverty Reduction Strategy Paper (PRSP) under the auspices of the IMF, the World Bank and other donors.

Other structural reforms include steps to improve the efficiency and productivity of the private sector, and to strengthen the effectiveness, comprehensiveness and accountability of those in control of public finances and promote greater supervision of the financial sector. In this regard, the domestic fiscal deficit is being kept within limits agreed upon under the PRSP. Substantial progress is also being achieved in the privatization of state owned enterprises. To provide a boost to economic growth, Rwanda promotes economic openness by its membership of the Common Market of the Eastern and Southern Africa (COMESA), the Southern African Development Economic Countries (SADEC), and other regional and international economic organizations.

Agriculture in Rwanda is mainly subsistence, characterized by smallholdings and low soil productivity due to over cultivation and poor use of modern inputs. Agricultural production is largely at the mercy of good weather. The objective of the poverty reduction strategy is to reduce by one half the number of people living below the poverty line. A huge task, that the government hopes to achieve by 2015. For these objectives to be achieved, the poverty reduction strategy has as its focus the diversification and the transformation of the agricultural sector (MINECOFIN, 2001; IMF, 2002; World Bank, 2002). Trade and financial reforms should help in this regard.

The crucial role of the private sector as the engine of economic development of Rwanda has been made clear. Long-term policy objectives require the emergence of a healthy private sector that fosters economic growth. The promotion of the private sector in Rwanda is based on investment promotion, strengthening the financial sector, privatization and improving the legal environment (MINECOFIN, 2001; IMF, 2002; World Bank, 2002).

Rwanda's external debt amounted to US$ 1.4 billion (85 *per cent* of the GDP) at the end of 2003. Given the heavy debt service burden associated with this stock, Rwanda continues to negotiate the canceling and rescheduling of debt including arrears through the Paris Club Creditors and through other agreements. It is important to note that the Rwandan medium-term provide a boost to economic growth, Rwanda promotes economic openness by its membership of the Common Market of the Eastern and Southern Africa (COMESA), the Southern African Development Economic Countries (SADEC), and other regional and international economic organizations.

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Substantial progress has been achieved in making government finances more transparent. The Auditor General conducts audits of the operations of every central government ministry and of other public entities. Financial sector reforms continue with the NBR constantly increasing its efforts to establish compliance with prudential banking regulations on a regular basis, and auditing all commercial banks. Further, key recommendations of an IMF safeguards assessment for the improvements of the NBR's control, accounting, reporting and auditing systems have also been implemented.

Other structural reforms undertaken include steps to improve the efficiency and the productivity of the private sector, and to strengthen, the effectiveness and comprehensiveness of public finances and to make improvements in regulating the financial sector. In this regard, substantial progress has been made with privatization, and important steps have been undertaken in addressing structural problems in the financial sector. Moreover, a new investment code has been established in order to create an attractive environment for capital investment. We now turn to the evolution of monetary policy in Rwanda.

3.3 The monetary policy adopted in Rwanda, before the implementation of the structural adjustment reforms

Soon after its establishment in 1964, the NBR was required to organize all monetary matters in Rwanda. Thus it was required to support the realization of the social and economic objectives planned by the government. Indeed, the National Bank of Rwanda was regarded as being that entity able to guide the social and economic development undertaken in the country. In addition, it was also required to implement monetary policy in order to achieve particular macroeconomic objectives. In this context, and in order to make the banking system comply with the aims of the government, the National Bank of Rwanda decided, as was the case in almost every developing country, to control directly, the banking system.

The central bank then, had to proceed, for this reason, to control the credit given by the banks to their customers. In addition, they had to determine the allocation of credit to the various economic sectors according to a scale of priority based primarily, on the strategic choices required by the government. Moreover, the NBR determined the level of interest rates in the economy. This monetary policy remained unchanged until the end of the 1980's. It is only at the beginning of the next decade, that the monetary policy started to take a new orientation, with the implementation in November 1990, of the first Structural Adjustment Program. For two and a half decades the NBR intervened in the macro economy using monetary policy. The NBR intervened by controlling both the demand and the supply of credit.

3.3.1 Control of the demand for credit by the National Bank of Rwanda

In order to adjust the level of credit awarded by the banking system, and thus control the principal source of liquidity expansion, the NBR carried out, each time that it proved to be necessary, a change to the cost of credit. This action aimed to reduce the quantity of funds demanded.

3.3.1.1 Modification of banks' conditions

The general conditions applicable by the banks to their customers were defined, in an exhaustive way, by the NBR and their application was imposed on the whole of the banking sector. These conditions were applied with the view to achieve the economic goals of the government and were not always sound from a monetary policy perspective. The modifications in question were applied to the deposit and the lending rates of interest, as well as the commissions charged by the banks for their various services.

3.3.1.2 Adjustment of the rediscount rate

The interest rates applied by the central bank to the commercial banks, as regards rediscount was, on the one hand, an essential element of the structure of interest rates. Changing the interest rate would change the interest cost faced by the customers of commercial banks. In other words, the rediscount rate was a reference rate for the determination of interest rates in the economy. The NBR adjusted the rediscount rate, each time it wanted to increase or decrease the liquidity in the economy. Various rediscount rates were thus applied, and differentiated, according to the nature of the operations initiated by the commercial banks concerned and depending on the sector that required refinancing.

3.3.2 Control of the supply of credit by the National Bank of Rwanda

Credit offered by commercial banks to their customers was conditioned, on the one hand, by the constraints on resources available to commercial banks. On the other hand, credit offered depended upon the possibility that the NBR would rediscount commercial bank securities. While influencing both the demand for, and the supply of credit in order to influence the behavior of the banks, and thus moderate their capacities for monetary creation, the NBR, devoted itself to credit control compatible with macroeconomic objectives. Commercial banks were regulated to prevent their hiding any financial intermediation not in accordance with the targets of credit control.

3.3.2.1 Control of the level of commercial banks' free reserves

By modifying the level of commercial banks' free reserves, the central bank influences their ability to satisfy their customers, and thus controlled their capacity for monetary creation. This action was the most essential part of the monetary policy in Rwanda, during the era of direct monetary policy intervention and was realized in the following manner.

a. Reserve requirement ratios

In an attempt to exert control over the money supply progress, the NBR introduced reserve requirements in August 1990. By compelling commercial banks to keep unused a certain fraction of customers' deposits, the central bank sought to sterilize a part of banks' resources usually used in extending credit. Indeed, keeping the required reserves on deposits at the NBR restricted credit expansion and consequently monetary growth rates. This was not part of any structural adjustment programme, but may have been in anticipation of such changes.

b. The rule of required credit allocation

Within the framework of its selective policy as regards credit, the NBR imposed on banks, in October 1987, the requirement that a part of their resources must be used to provide credit to the following operations:

(i) Government projects within the budget funded by the issue of treasury bills;

(ii) Those that require medium and long-term credit;

(iii) Acquisition of shares in companies operating in the financial sector.

This selective method of credit allocation was also intended to limit the commercial banks ability to extend credit.

3.3.2.2 Credit Extension Ceilings

Depending on the current economic situation and taking into account expected variations in banking reserves, the central bank determined, annually, a total amount they were willing to extend. This total amount was then allocated to each of the respective commercial banks. The individual allocation was determined by the commercial bank's main area of economic interest and their future expected lending and finance activities.

At least three quarters of commercial banks' credit extension to the public was devoted to the financing of activities generating appreciable value added or contributing to those activities that reduced balance of payments' pressures. In the 1980's, commercial banks came under pressure to advance loans to their clients. Not having sufficient funds the commercial banks put pressure on the NBR for additional reserves. As a consequence the NBR had to revise upwards the total amount it was willing to extend to commercial banks.

However, some of the economic activities considered a priority by the government were financed in other ways. Theses activities include those likely: (i) to contribute to the realization of self-sufficiency in food production, (ii) to increase employment, (iii) to support the promotion of exports, (iv) to modernize the primary sector, in particular tea and coffee plantations, and mining production, (v) to support the promotion of international transport, and to stimulate housing construction.

3.3.2.3 Thorough credit control

Motivated by a concern to supervise more closely monetary growth, the central bank made any credit extension by a commercial bank to its customers exceeding a certain amount subject to central bank authorization. Further, this authorization could not be interpreted as a right to increase the NBR's allocation at the discount window. This element of control made it possible to keep money supply growth within the constraints imposed by economic growth and keeping in mind that certain sectors of the economy were to be offered some priority status. In addition, credit control was likely to involve the central bank in the evaluation of the risk incurred by the banks concerned, and thus lead them to change their behavior and take into account the riskiness of their customers before making a loan. However, having said this, some activities, especially in agriculture did receive special support.

3.3.2.4 Judicious control of financial intermediation

Commercial banks had to contribute actively to the development of the economy, according to required standards, and without unfavorable effects on their financial status. Nevertheless, the demand for credit was quite large while financial resources available were relatively limited, and the banking system was hampered by a relative disability to carry out adequate financial analyses indispensable to the well functioning of their activities. It is in this constraining context that the NBR required the banking system, as from October 1987, to follow strict solvency requirements. Banks had to keep capital equal to 7 *per cent* of deposits if these deposits were greater than three billion Rwandan Francs. If deposits were lower, 10 *per cent* of deposits had to be held in capital reserves. One problem that arose is that the NBR did not carry out inspections of commercial banks on a regular basis.

3.3.3 Shortcomings and weaknesses of monetary policy before structural adjustment reforms

As in some other countries, direct monetary policy proved to be inefficient in Rwanda. The use of money as a direct instrument led to the misallocation of available financial resources, and undermined financing conditions in the Rwandan economy. An unintended consequence of the NBR loan authorization process was that the commercial banking system did not do sufficient risk analysis. A reason for this was that the NBR seal of approval was taken by commercial banks to mean that risk considerations were minimal. Some inappropriate financing was made to companies just by virtue of being in economic sectors considered a priority by government. There was also evidence that some companies who did not meet the conditions for loans used undue influence on the authorities in order to obtain finance.

Even if the central bank accepts the interest rate consistent with its money supply and monitors various commercial banks' commissions in order to avoid any kind of abuse, this policy generated perverse effects in Rwandan economy. Resources were allocated to inefficient uses, resulting in reduced savings, investment and growth as a result of excessive liquidity expansion. A major disadvantage of the monetary expansion via credit control was that the interest rate no longer was market determined and did not provide a signal as to the scarcity of capital in the economy.

3.4 The advent of the structural reforms in 1990

Like a number of developing countries, Rwanda shifted from direct to indirect monetary policy in November 1990, as a result of implementing a Structural Adjustment policy imposed by the IMF and the World Bank. Direct control of prices and the money supply (and thus interest rates) were gradually abandoned to allow the determination of prices by market forces. Nevertheless the efforts undertaken with structural reforms in order to reduce the role of the government in the economy were soon suspended following the war that degenerated into genocide in April 1994. The reform process began again, to the extent it could, in 1995. This liberalization process made steady progress and thus monetary policy come to rely more and more on indirect instruments.

3.4.1 The main financial reforms of the 1990's

The financial sector liberalization undertaken in Rwanda during the 1990's had the following fundamental features:

- **Liberalization of banks' activities**

With effect from April 1992, the required preliminary authorization from the NBR before commercial banks could provide credit to their customers was abandoned. Banks' activities that were subjected to rules and regulations imposed by the NBR were removed. This new situation conferred on banks a greater responsibility with regard to financial intermediation particularly in risk analysis.

- **Substitution of *a priori* financial intermediation control by *a posteriori* control**

With the abolition of the procedure of preliminary authorizations, control of the banks by the NBR fell into disuse and was substituted by *a posteriori* supervision carried out under the auspices of the NBR. These controls aimed at limiting banks' activities resulting in the misuse of resources or bank failure, which could compromise the existence of a well functioning banking system and thus affect the whole economy.

- **Market-based financing of the budget deficit**

In the context of economic and financial liberalization based on market forces, financing government activities by the NBR could not continue. In future, the government had to issue treasury bills and other negotiable securities in order to mobilize necessary domestic resources. As a result government would likely be more rigorous in its approval of expenditures.

3.4.2 The indirect character of current monetary policy in Rwanda

In the absence of *a priori* credit control, commercial banks were now able to award loans to their customers without the preliminary authorization of the NBR. Moreover, the rediscount window was no longer as essential as in the past, since inter-bank lending, and the money market could provide the necessary funds provided they were dynamic enough to do so. In this context, monetary policy has to be conducted through indirect tools.

Instead of being constraining, as was the case with direct monetary policy, the current indirect monetary policy achieves its goals by changing incentives. It aims at influencing the financing behavior of the banks keeping in mind the overall economic and financial objectives sought by the NBR.

Nevertheless, the success of this new monetary policy remains reliant on the procedures (and their quality) used in forecasting money demand and commercial banks' liquidity. Other conditions required for the success of monetary policy are: (i) the reliability of economic data, (ii) and the methods of intervention used by the central bank in its management of commercial banks' free reserves in order to change the supply of money.

3.4.2.1 Inflation targeting in Rwanda

In 1998 the central bank was advised by its economic partners - the IMF and World Bank - to consider a medium term inflation target of three *per cent* a year as an ultimate objective. The NBR adjusts the M2 monetary aggregate via changes in the monetary base (currency plus reserves) to achieve its target for inflation. In the next chapter we examine empirically whether this is possible and find some evidence for it being feasible.

a. The ultimate objective of monetary policy

In line with the Poverty Reduction and Growth Facilities (PRGF), the Rwandan monetary authority in collaboration with the IMF and other donors at large, decided on a medium-term inflation targeting of three *per cent* per annum. At the same time, nominal GDP growth rates were shown to be oscillating between five and six *per cent* per annum. Inflation targeting only works in an environment of no adverse supply shocks. These positive growth rates provide some justification for moving to a policy of inflation targeting.

b. The intermediate objective

As the inflation rate cannot be controlled directly, the NBR uses M2 as an intermediate instrument of control; the assumption being that if the intermediate monetary aggregate is controlled, then *ipso facto*, the inflation rate will be controlled. Thus, the realization of monetary stability depends on the NBR being able to change M2. Its choice of M2 is justified, not only by its ability to alter prices but, also, by the constraints that the NBR faces.

In line with its policy of inflation targeting, the NBR attempts to maintain harmony between the supply and the demand for money, so as to keep the economy's liquidity at appropriate levels consistent with a stable inflation rate. To this end, the NBR uses a broad money variable M2 (the current state of the currency held by the public, plus the quasi money), for which reliable data is available each month. Thus it is a variable that the NBR can use, and change, in order to affect the level of prices in the economy.

In compiling this aggregate, the NBR conforms to the rules instituted by the IMF. In Table 3.1 we show the levels of M2 broken down into its constituent parts.

Table 3.1 Nominal M2 and its principal components (in billion Rwandan Francs)

Designation	**Dec/1997**	**Dec/1998**	**Dec/1999**	**Dec/2000**	**Dec/2001**	**Dec/2002**
Currency circulation	22.6	20.9	21.5	22.6	25.8	28.0
Demand deposits	46.2	38.0	44.1	46.2	43.2	49.8
Monetary aggregate M1	68.8	58.9	65.6	68.8	69.0	77.8
Quasi-money	33.1	39.0	38.8	50.6	61.7	69.0
Monetary aggregate M2	**101.9**	**97.9**	**104.4**	**119.4**	**130.7**	**146.8**

Source: National Bank of Rwanda

In Table 3.1 it can be seen that M2 has been increasing over time except for the year 1998. M2 increased by 6.6, 14.4, 9.5 and 12.3 *per cent* in 1999, 2000, 2001 and 2002, respectively. In 1998, M2 shrank 3.9 *per cent;* this decline was caused by a reduction in the autonomous factors, that is, mainly a fall in net foreign assets. Table 3.1 also reveals that, M1 is the principal component of M2; for instance, M1 was 67.5 *per cent* of M2 in 1997, and constituted 76.9 *per cent* of the monetary stock in 2002. On the other hand, it is interesting to note that, currency was 32.8 and 40 *per cent* of money M1 in 1997 and 2002, respectively. There has been substantial growth in the quasi money. Indeed all the growth in M2 is from the last category.

The NBR has in mind a forecast of GDP growth. Based on their models of M2 they know if the required (given GDP) levels of M2 are inconsistent with the targeted rate of inflation.

Having a single number as a target does add a constraint to monetary policy in that levels of M2 consistent with GDP growth may not be consistent with price levels. Thus other countries usually opt for a range of inflation.

c. Operating target

When monetary policy is managed with indirect instruments, the evolution of the monetary stock can only be followed in an indirect way through an operational objective, which is the monetary base. The latter is selected as the central bank is able to control currency and bank reserves (NBR, 2002). The NBR (NBR, 2002: 41) uses the following linear relationship between M2 and *H* (the monetary base): $M2 = bH$[2], where *b* is the monetary base multiplier. The more stable the monetary base multiplier is, the more the central bank is able to control M2 through changes to the monetary base. Even the NBR admits that the required stability of the monetary multiplier is not always assured. However the NBR does monitor changes in M2 on a daily basis and uses base money as an indicator of the future rate of growth of M2, and then the NBR uses its forecast of M2 to determine the nature and the range of its interventions in the money market. The difficulty the NBR faces is that it needs daily information on M2 yet this is only available on a monthly basis. It thus has to forecast M2 and uses the monetary base, which is available on a daily basis, and thus can be used to provide daily forecasts of M2. In Table 3.2 are some of the monetary indicators in Rwanda (for more economic and poverty indicators, see Appendices One and Two), for the years 1997 to 2001.

[2] Handa (2000) suggests that a simple linear relationship between *M* and *B* is given by $M = a_0 + a_1 B$, where *M* is the nominal value of the monetary aggregate, *B* is the nominal value of the monetary base, and a_1 is the marginal monetary base-money multiplier. He further argues that, the central bank can only control *M* through *B* if a_0 and a_1 are stable.

Table 3.2: Evolution of some of Rwandan monetary indicators (In *per cent* unless otherwise specified)

Designation	1997	1998	1999	2000	2001
Inflation rate	11.7	6.2	-2.4	3.9	3.4
Monetary aggregate M2	47.5	-3.9	6.6	14.4	10.1
Monetary base	14.6	-11	13.5	-6	6.0
Monetary base multiplier (not in %)	2.5	2.75	2.58	3.16	3.26
Required reserve ratio	12	10	10	8	8
Real GDP growth	12.8	10	6.2	6	6.2

Source: National Bank of Rwanda

From Table 3.1 above it appears that, except for the year 1997 and 1998 where inflation rates were 11.7 *per cent* and 6.2 *per cent* respectively due to poor rainfalls and the massive return of Rwandan refugees, the inflation rate was kept around the targeted figure of three *per cent* in 2000 (3.9 *per cent*) and in 2001 (3.4 *per cent*). Against the backdrop of these low inflation rates, real GDP growth rates of six *per cent* in 2000 and 6.3 *per cent* in 2001 were obtained.

3.4.2.2 Procedures for controlling the monetary stock

Although the NBR does not directly control the money supply, it does make forecasts of monetary aggregates on an annual basis. It also makes projections of bank liquidity on a weekly basis. These annual and weekly forecasts allow the NBR to provide sufficient currency to meet the needs of the economy in terms of a means of payments. Basically, the annual forecast consists of envisaging, firstly, the sources of excess liquidity from: (i) net foreign assets, (ii) net claims on government, and (iii) the total credit provided by the banking system to the economy. To aid in this forecast use is made of other forecasts such as those for the balance of payments, the government deficit, the real economic growth and the rate of inflation. Armed with these forecasts, the NBR forecasts M2 which should respond to these factors. We find it strange that the NBR does not use an interest rate in the determination of M2. In Chapter Four, we attempt to correct for this shortcoming by estimating an equation that specifically includes an interest rate.

This forecast of the annual monetary stock is then converted into monthly forecasts and updated from time to time. Weekly forecast of banking liquidity are based on the following factors that are likely to determine its evolution: (i) currency in the hands of the public, (ii) the net foreign exchange position at the NBR, and (iii) the government deficit. For a particular week, actual base money is compared with this forecast level and the gap dictates the direction of monetary policy. As long as weekly liquidity forecasts are consistent with monthly forecasts and ultimately annual monetary plans, open market operations can inject or mop up excessive liquidity from the economy. So the NBR adjusts liquidity levels according to the needs of economy but keeping in mind that over the longer-term, base money must be in line with annual forecasts. We now survey the various monetary policy instruments used to achieve monetary policy goals.

3.4.2.3 Instruments of monetary policy in Rwanda

In 1998 Rwanda implemented the so-called Poverty Reduction and Growth Facilities (PRGF). In this programme the NBR committed to a medium-term inflation target of three *per cent* per annum. In line with its current indirect monetary policy, the NBR uses monetary policy instruments to control commercial banks' free reserves to ensure that the supply of base money does not deviate from levels consistent with this inflation targeting. Moreover, the NBR can carry out specific interventions to inject or mop up excessive liquidity, in order to adjust the market interest rate if needs dictate. The indirect monetary instruments currently utilized by the NBR are:

(i) Open-market operations;

(ii) Discount window facilities;

(iii) Reserve ratio requirements.

We now proceed to discuss each of these in detail.

a. Open-market operations, the inter-bank money market and other operations

Instead of operating a direct lending mechanism for commercial banks, the NBR established a money market as part of its plan to achieve better control over the money supply. The NBR realized it would be better able to forecast and thus change monetary aggregates if banks borrowed or lent in a short-term liquidity market. In addition, monetary policy decisions were enhanced by the creation of a monetary policy committee that meets weekly, to assess the stance of monetary policy and conditions in the foreign exchange market. So, this committee has to:

(i) Undertake a retrospective analysis of the current monetary situation and determine how monetary policy has to adapt to any changes in the liquidity of the banking system;

(ii) It also forecasts base money for next week, so as to determine the necessary intervention of the NBR in the money market in order to achieve its macroeconomic goals;

(iii) Suggest any other actions the NBR might undertake to maintain control over the money supply and provide backing to continued bank supervision.

Only approved commercial banks are allowed access to the emerging money market in Rwanda. The committee provides some oversight to ensure a smooth functioning of this market. We now examine some of the mechanisms the NBR has at its disposal to carry out open market operations.

- **Treasury bills**

The NBR is legally empowered to carry out the purchase and sale of treasury bills in order to undertake monetary policy. Treasury bills come in different maturities, namely 4, 13, 26 and even 52 weeks. These treasury bills do have a dual role in Rwandan economy. Not only can the NBR buy and sell these instruments but they are primarily issued by the government to finance its expenditure plans. In the past the government did monetise these debts, which led to inflationary pressures in the economy. The reforms under the structural adjustment programme attempted to stop this practice. If the NBR was no longer to acquire these bills, then they could act as a means to mobilize private savings, provided the government does not change interest rates to such an extent that crowding out occurs, especially in those periods of reduced liquidity. By buying (or selling) these bills the NBR can change liquidity levels in economy and thus influence base money in line with the forecasts of money required to achieve the inflation target. While the NBR and the government must co-ordinate their activities, it must never be the case that the former be forced to acquire government debt. Treasury bills with enhanced features making for ease of negotiation have been introduced with the aim of creating a secondary market in these instruments.

Treasury bills are auctioned every week and the auction is conducted by the NBR on behalf of the government. Each week the government has a certain borrowing requirement and commercial banks can bid for treasury bills issued by the government for this purpose. However, the NBR has in mind the level of the monetary aggregates for each week, so, the auction is conducted taking into account the borrowing requirement and the direction of monetary policy. As Musinguzi and Katarikawe (2001) point out, a central bank cannot control both the price and quantity of treasury bills. Thus, the NBR decides on the volume of treasury bills offered each week and leaves the market to determine their price and thus the interest rate. Non-financial companies and individuals can take part in the money market but their applications are submitted through commercial banks.

- **Other borrowings**

The NBR also sells or buys assets from the commercial banks to provide a reduce liquidity on a weekly basis. Exchanges of liquidity take place on a Monday and Friday with the commercial banks indicating how much they wish to borrow or lend and the interest rate at which these transactions are to take place. The NBR then decides on the net flow of liquidity and announces the weighted average interest rate at which these exchanges took place. So the NBR does have a difficult task. It knows the level of liquidity consistent with its inflation target, yet each week that liquidity level can change as developments in the money market change. In addition, these other borrowings impact on the level of liquidity. So the NBR occasionally has to make specific interventions in the money market so as to mop up excessive liquidity or inject liquidity into the market to ensure consistency with its monetary policy.

- **The inter-bank market**

In 2000, an inter-bank market was established to encourage the exchange of liquidity between banks. The advantage of this is that banks do not seek accommodation at the NBR. This borrowing and lending does take place under strict conditions and collateral is provided. It is often observed that the interest rate in the inter-bank market is lower than other markets. Commercial banks are not limited to inter-bank market and can raise funds by issuing certificates of deposit.

b. The discount window

Banks that fail to satisfy their liquidity needs from the weekly money markets are given room to cover shortages through the discount window facilities at the NBR. Treasury bills or other eligible financial instruments serve as collateral for this borrowing at the NBR. Any amounts borrowed should not exceed 70 *per cent* of the market value of the collateral but this can be extended to 90 *per cent* under certain conditions. The interest rate at the discount window is taken to be the four-week moving average of the inter-bank money market increased by a penal margin under the NBR's discretion. The following figure presents the different interventions made by the NBR in the money market from 1997 to 2001.

Figure 3.2 The evolution of the Rwandan money market (1997-2001) in billion Rwandan Francs

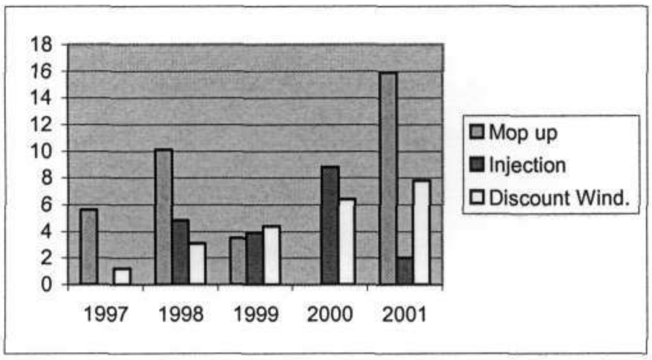

Figure 3.2 shows that over the period 1997-2001, the NBR has intervened on the money market to inject, to mop up excessive liquidity or through discount window facilities in favor of commercial banks with shortages in funds. As the figure shows, in 1997, 1998 and 2001, the levels of liquidity were high which led the NBR to intervene accordingly and mop up 5.6, 10.1 and 15.9 billion Rwandan Francs, respectively. However, as there are different needs for funds in the banking system, banks with deficits have recourse to the discount window. Figure 3.1 reveals that use of the discount window facilities have been increasing over time; starting from 1.2 billion Rwandan Francs in 1997, they reached a level of 7.8 billion in 2001.

c. Reserve requirements as an auxiliary monetary policy instrument

Cash reserve requirements can affect banks' free reserves in the short-run and the supply of broad money in the long-run (Musinguzi and Katarikawe, 2001: 16). Primarily considered a prudential instrument to ensure that commercial banks keep sufficient funds on hand to meet any unexpected withdrawals by customers, cash reserve requirements are also one way the NBR can control base money. In fact, in the event of persistent imbalances in the liquidity in the economy, the central bank can carry out suitable adjustments to the reserve requirements ratio. Any increase indicates a tightening of the banking system's liquidity and, consequently, reduces commercial banks' ability to create money through lending to customers, while a reduction gives the opposite. Nevertheless, recourse to the use of this instrument should hardly be frequent; it should occur only when banking liquidity expands or narrows inordinately. This happens when there is an unusual surge in foreign currency receipts or when all commercial banks face liquidity problems.

Recently, the reserve requirements changed as follows:

(i) With effect from June 2002, the reserve requirements applied to cover foreign currency deposits;

(ii) The reserve ratio on domestic currency and savings deposits has fluctuated in favor of commercial banks' in the last few years. It has varied from a high of 12 *per cent* in 1997 to 8 *per cent* in 2001;

(iii) In September 2001, the maintenance of and compliance with cash reserves was changed from a weekly requirement to a monthly commitment;

(iv) Penalties for not meeting reserve requirements have been reduced.

In an era of developing indirect monetary policy instruments, it is argued that reserve requirements should not be used as a first option in the conduct of monetary policy because of its potential for inefficiency. Nevertheless, in Rwanda, we still see use of the reserve requirements partly because of an inherent weakness in the financial sector and because financial markets are not fully developed (Musinguzi and Katarikawe, 2001: 17)[3].

3.5 Persistent obstacles to the conduct of judicious monetary policy in Rwanda

Monetary policy management in Rwanda faces a number of obstacles. An imperfect knowledge of economy is amplified by the inappropriate behavior of the principal partners (mainly commercial banks) of the NBR. Furthermore, the Rwandan financial sector is still underdeveloped and markets do not have high trading volumes. This section presents some of the obstacles facing monetary policy in Rwanda.

The Rwandan financial sector is probably the least developed in Africa. It comprises the National Bank of Rwanda, six commercial banks (three of them were only established after 1994) and three other non-bank financial institutions, only one development bank, and four insurance companies. The Rwandan financial sector is characterized by a low degree of monetization of the economy, and other structural deficiencies.

[3] Musinguzi, P. and Katarikawe, M. made a silimar assertion in 2001 in their paper "Monetary policy frameworks in Africa: the case of Uganda"; the latter is a neighboring country of Rwanda and both countries are currently implementing the Poverty Reduction and Growth Facilities (PRGF) under the auspices of the IMF.

There appears to be a general consensus that the conduct of monetary policy is facilitated by the existence of well-functioning markets, and that indirect monetary policy instruments contribute to deepening financial markets (Roe and Sowa, 1995; Ncube, 1997). On the one hand, the view is that fully developed markets serve as one of the channels of transmitting monetary policy, and on the other hand, the introduction of indirect monetary policy instruments helps markets to develop. Besides, most indirect monetary policy instruments are market-based, and thus markets need to work efficiently for policy to be effective (Musinguzi and Katarikawe, 2001: 22). As the Rwandan money market has been operational since September 1997, it is in *an embryonic state*. This explains the low volumes and the slow development of a secondary market in Rwanda.

We saw in Section 3.4 that in an effort to encourage banks to lend among themselves rather than resorting to the NBR, an inter-bank money market was initiated in 2000. Unfortunately, banks prefer to lend their surplus funds to the NBR instead of other commercial banks in need of liquidity. Such a situation prevents the inter-bank money market from being very effective. In addition, the majority of commercial banks are reluctant to participate in long-term lending. Furthermore, some of the existing commercial banks prefer to hold most of their free reserves at the NBR, thus adding another constraint to monetary policy.

Future real GDP growth in Rwanda is difficult to forecast. This is attributable to the Rwandan economy being largely informal, and to the fact that the relevant government departments do not have the necessary means to ensure a regular evaluation of overall production. In addition the available macroeconomic data, worked out by the Ministry of Finance and Economic Planning (MINECOFIN) lacks some required and reliable components making monetary forecasts imprecise. Foreign currency inflows in favor of the government are so variable making it difficult to make accurate base money forecasts as part of sound monetary policy management.

3.6 Conclusion

Soon after its establishment in 1964, the National Bank of Rwanda (NBR) became responsible for organizing and supporting the realization of government social and economic policy. Thus, the conduct of monetary policy was subdued and subordinate to fiscal considerations. In this context the NBR devoted itself to direct monetary control, as was the case in almost all developing countries, thus maintaining the money supply at a level compatible with the government's macroeconomic objectives. Credit controls were achieved by rationing credit to commercial bank customers. Only after 1990 were commercial banks compelled to keep unused a certain fraction of the deposits of their customers, and the central bank sought to sterilize a part of bank resources usually used in making loans. Indeed, the fact of keeping required reserves at the NBR restricted credit expansion and consequently reduced monetary growth rates. Prior to reform, according to how the NBR saw the economic situation evolving, and taking into account the expected variation in banks' reserves, the central bank determined, annually, a total ceiling to the direct lending awarded to the commercial banks. Quotas, then, were established for each one of these institutions, corresponding to each bank's expected shortfall. The NBR had to determine at the end of each year, the limit of its funds that it would devote to commercial banks through rediscounts, during the following year. Furthermore, the central bank had to authorize any loan by a bank to customers exceeding a certain amount.

However, as in some other countries, direct monetary policy proved to be inefficient in Rwanda, and its prevalence led to disastrous consequences as resources were misallocated. Inefficiency in financial intermediation meant lower savings, investment and economic growth.

Like a number of developing countries, Rwanda shifted from direct to indirect monetary policy starting in November 1990, as structural adjustments took effect. Indeed some changes were made in anticipation of these reforms. Direct control of prices and interest rates were gradually abandoned to allow for the determination of prices by market forces. Nevertheless, the efforts undertaken with structural reforms in order to reduce the role of the government in the economy were soon suspended following the war that degenerated into genocide in April 1994. These policies were reactivated in 1995 after the war and genocide, and the liberalization process made steady progress. In this new environment monetary policy come to rely more and more on indirect instruments.

In line with the Poverty Reduction and Growth Facilities (PRGF), which is currently being implemented, the Rwandan monetary authority in collaboration with the IMF and other donors, decided on a medium-term inflation target of three *per cent* a year. As inflation is a variable that the NBR cannot control directly, the central bank uses M2 as an intermediate instrument of control. The assumption being that if M2 is reduced, then inflation will fall. The next chapter examines to what extent this is possible. The monetary stock is changed by adjustments to the monetary base. The latter is selected as it is within the capacity of central bank control. The NBR bases its decision to change the monetary base both on long-term and short-term forecasts. Such forecasts enable the monetary authority to maintain monetary balances at levels compatible with the real needs of the economy. Weekly liquidity forecasts, which are consistent with monthly forecasts and the annual monetary programme, now form the basis for the nature of open market operations carried out by the NBR.

In line with its current indirect monetary policy, the NBR uses effective monetary policy instruments in order to control commercial banks' free reserves to ensure that the supply of base money does not deviate from desired levels. These indirect monetary instruments are: (i) open-market type operations, (ii) the discount window, and (iii) reserve ratio requirements. In August 1997, a money market was established to ensure greater control on base money. A weekly auction of treasury bills establishes a market interest rate known as the Bank rate. Treasury bills were introduced as a reform in order to limit the government monetising its debt that entailed fuelling inflationary pressures. The introduction of treasury bills was also meant to encourage private saving, although crowding out remains a possible problem. In addition, banks in need of liquidity can cover their shortages at the discount window of the NBR. An inter-bank money market has been operative in Rwanda since 2000, and banks can lend to one another, sometimes at rates below the Bank rate.

The effectiveness of the Rwandan indirect monetary policy has been undermined by a number of factors:

(i) Foreign currency flows are difficult to forecast and this affects all other forecasts, including base money that the NBR uses in its decision making. Money demand specifications should include exchange rate considerations. In the next chapter we estimate a money demand function without external links to establish a baseline model. Future research would need to look at the impact of the foreign section on the baseline model.

(ii) It is difficult to forecast real GDP growth given the informal nature of the Rwandan economy. Thus money supply changes are based on incorrect suppositions as to the nature of macroeconomic conditions.

(iii) The Rwandan financial sector is still underdeveloped and financial markets do not have high trading volumes.

(iv) The Rwandan money market, operational since September 1997 is still evolving. Only a few economic agents are involved, which explains the limited volume of money market activities, and this has meant the secondary market has been slow to develop.

(v) Issues of trust between commercial banks hampers the working of the inter-bank money market. The full development of this market might be long in coming.

This thesis attempts to begin dealing with some of these shortcomings by estimating a money demand function for Rwanda. To the best of our knowledge no such function has been published. If income forecasts are incorrect these should show up as odd elasticities in estimated functions. In addition, finding a stable money demand function without foreign or external effects may indicate the need to include these effects in future research. However, against this backdrop of the problems associated with monetary control in Rwanda, we feel that it is high time that an estimate of a base line money demand function be made. We do this in the next chapter and examine its features to ensure compatibility with current monetary policy and suggest possible amendments that can be made in any future research.

CHAPTER FOUR

DATA ANALYSIS, TESTING, EMPIRICAL RESULTS AND DISCUSSION

4.1 Introduction to stability

The main focus of this chapter is a quest for the stability of money demand in Rwanda. The model we formulated in Chapter Two to describe an econometric relationship should be constant over time and should be invariant to alterations in the distribution of the variables that make up the model (Charemza and Deadman, 1992). An econometric relationship is stable if the parameters in such a relation are not subject to permanent changes over time (Hoffman *et al.*, 1995). A stable money demand function is an essential part of planning and implementing the monetary policy (Beguna *et al.*, 2002). What is being sought in a stable money demand function is a set of necessary conditions for money to exert a predictable influence on the economy so that the central bank's control of the money supply can be a useful instrument of economic policy (Judd and Scadding, 1982). So, a stable demand for money describes the effectiveness of the monetary policy; it is an essential link in the transmission mechanism of monetary policy (Laumas, 1978).

Despite intensive analytical and empirical efforts, there is no general consensus concerning the empirical stability (or instability) of the money demand function (Andersen, 1985). Up to the 1970's the money demand function was considered to be the one of the most stable and reliable in economics. Khan (1974), Laumas and Mehra (1976) and Laumas (1978) all found stable money demand relationships. In contrast to these studies, Friedman and Kuttner (1992) and Miyao (1996) have argued against a stable US money demand. Judd and Scadding (1982) argues that prior to 1973, research conducted in the USA using post World war II data shows the existence of a stable money demand (Laidler, 1977 and Lucas, 1988); but post-1973 studies provide evidence that the demand for money had become unstable in the US. Shifts in the demand for money were also experienced in other industrial countries in the 1970's, while results are mixed for developing countries (Sriram, 1999). Studies on M3 money demand in South Africa by Casteleijn (1999), Moll (1999), Moll (2000) and Van den Heever, (2001) assert that the relation between money, income and prices has become less stable in recent years. However, Nell (2003) provides empirical evidence of a constant and structurally stable M3 money demand function for South Africa over the period 1968-1997. One might ask the question "why do empirical results point in such different directions?" (Cyrusson, 2002).

Cyrusson (2002) contends that there are two reasons for the diversity of results concerning stability:

(i) Different studies cover different countries at different time periods;

(ii) There are many different opinions about the specification of the money demand function.

Laumas and Spencer (1980) argue that the specification of the demand for money function is of great significance for the outcome of the empirical tests. One reason for finding instability is that much of the empirical work uses the partial adjustment model as a specification for the money demand function (Beguna *et al.*, 2002). Also, the particular regression technique that these studies use seems to affect the outcome. Papers written during the 1970's and the early 1980's commonly use methods developed by Cochran-Orcutt, and Cooley-Prescott. More recent papers use cointegration and error correction models as a standard tool for the analysis of the demand for money. Handa (2000) maintains there are two reasons for finding that money demand functions were no longer stable: first, there were many innovations concerning monetary variables and second, researchers brought even more sophisticated tools to bear on monetary variables. The attempts to find a stable money demand function have included:

(i) Changes in the definitions of the monetary aggregate used as the dependent variable;

(ii) The use of the current income as opposed to permanent income;

(iii) The use of short-term interest rates, long-run interest rates, the rate of inflation, or a composite index of interest rates for the interest rate variable;

(iv) Changes in the form of the estimating equation from linear to log-linear and semi-log-linear. Some studies even use non-linear functions.

There appears to have been a downward shift in the demand function in the US during the 1970's and an upward shift during the 1980's; while in these decades, as in the 1990's, actual money holdings deviated remarkably from the predictions of most estimated money demand models (Handa, 2000). A stable money demand was found by Hendry and Ericsson (1991a) and Hendry (1995) for the UK, Muscatelli and Spinelli (2000) for Italy, and Baltensperger *et al.* (2001) for Switzerland.

The Rwandan literature in the area of the stability of demand for money is virtually non-existent. It is for this reason that we examine stability using Rwandan data. In 1998, Rwanda adopted an inflation targeting framework as part of its reforms of monetary policy. It is important to note however that, an official monetary framework of inflation targeting does not necessarily rule out the importance of money in the formulation of an efficient monetary policy strategy, as long as there is a stable money demand function and the relevant monetary aggregate contains information about future price changes (Nell, 2003: 156).

In the following sections, we first assess the stability of the money demand function in Rwanda using the M2 definition of money. Then, we determine whether money contains important information about future price changes and we test for weak and super exogeneity of income and prices through the M2 money demand function. The rest of the chapter is organized as follows. Section 4.2 deals with the model specification. Section 4.3 presents the plots of the data and reports the Augmented Dickey-Fuller (ADF) test for the time series under study. In Section 4.4 we estimate the long-run money demand equation in Rwanda, using the modern approach of cointegration analysis. Section 4.5 utilizes the Error Correction Mechanism (ECM) to estimate the short-run money demand in Rwanda. In Section 4.6 we investigate whether there is a stable money demand in Rwanda. The last section summarizes the main empirical results and their policy implications, keeping in mind the two stated research hypotheses of this thesis. We confirm the first and find a stable money demand function in Rwanda. We also reject the second and find no causal link running from money to prices.

4.2 Model specification

In investigating the constancy and structural stability of money demand in Rwanda, we adopt the Nell (2003) specification. Nell (2003) examines the stability of M3 money demand and the monetary growth targets in South Africa by applying Hendry's general-to-specific methodology (Hendry and Ericsson 1991b; Hendry 1995). Nell (2003) also follows Hendry and Ericsson (1991b) to test for weak and super exogeneity of money and prices through the M3 money demand function in order to determine whether money contains important information about future price changes in South Africa. We propose to do the same for Rwanda. Nell's equation to be estimated using Rwandan data is as follows:

$$m3_t = \beta_o + \beta_1 y_t + \beta_2 p_t^c + \beta_3 (RM - RO)_t + u_t \qquad (1)$$

Where *m3* denotes the demand for nominal M3 (for South Africa) money balances (which is currency plus demand deposits plus time deposits); y is real income proxied by real gross domestic product (GDP); p^c is the price level proxied by the consumer price index (CPI); *RM* is the long-term opportunity cost of holding money proxied by the ten-year government bond yield and RO is the long-term own interest rate represented by a fixed deposit rate for twelve months. Lower case letters denote variables in natural logarithms (except for u_t which is the error term). The determinants of the money demand specification in equation (1) are consistent with the theory presented in Chapter Two. Theory relates the quantity of money demanded to a small set of key variables linking money to the real sector of economy (Judd and Scadding, 1982). Money demand theories suggests that the demand for money is a function of a scale variable as a measure of economic activity, and a set of opportunity cost variables to indicate the forgone earnings by holding assets which constitute alternatives to money (Sriram, 1999). The prior expectation of the parameters in our model is that $\beta_1 > 0, \beta_2 > 0, \beta_3 < 0$. As is mentioned earlier, real GDP is likely to affect money demand positively because as the economy produces more, the volume of transactions increases and demand for money balances increases. The price level is also likely to influence money positively. The inflation rate in Rwanda is above zero, when prices go up the demand for money rises because people need more money to purchase the same amounts of goods and services. The interest rate differential is a measure of the opportunity cost of holding money. An increase in the differential raises the cost of holding money and thus decreases the demand for real balances.

In equation (1) above, Nell (2003) proxies real income by real GDP following Mankiw and Summers (1986), who assert that real GDP is the most suitable scale variable for a broad definition of money. Nell (2003) uses the CPI and not the GDP deflator because, according to Muscatelli and Spinelli (2000), the CPI is likely to be a more important determinant of transaction balances. Further, the specification of equation (1) above is consistent with a theory of an interest rate differential (RM-RO), on condition that the coefficients of the two long-term interest rates are of equal magnitudes and opposite signs when they enter the equation independently (Nell, 2003: 157). In fact, the decision making process of M3 holders (in South Africa) is likely to be dictated by movements in long-term rates, because short-term rates are subject to a greater degree of variation (Goodhart and Crockett, 1970). This hypothesis seems to be consistent with the theoretical proposition of an interest rate differential, where M3 holders are not only interested in the long-term opportunity cost of holding money, but also the long-term own rate of return (Nell, 2003: 158). We are to apply this model to M2, which is the broad measure of money in Rwanda and comprises M1 (the sum of currency in the hands of the public and demand deposits in commercial banks) plus Quasi money (various time deposits). Therefore M2 is the relevant counterpart monetary aggregate of the South African M3[4] definition of money (which is currency plus demand deposits plus time deposits). For RM, the opportunity cost, we use the twelve-month lending rate. For the own interest rate we use the twelve-month deposit rate, just like Nell (2003). We cannot use a long-term opportunity cost such as Nell's ten-year bond yield because Rwanda, like most developing countries, lacks the appropriate statistics. Instead of a bond yield we use a twelve-month lending rate. The assumption is that competition at the twelve-month term to maturity ensures similar movements in borrowing and lending rates. A second assumption we make in order to use this proxy is that changes in rates at lower terms to maturity follow changes to rates at higher terms to maturity. In other words we are saying a liquidity effect is operating along the yield curve. We assume an upward sloping yield curve and proxy the long-term opportunity cost of holding money (RM) by the twelve month lending rate, which is higher than the deposit rate (RO) over the period of study. According to the term structure theory[5], the yield curve can possess several different shapes. However, Handa (2000: 598) argues that the yield curve is normally upward sloping from left to right, with the yield rising with the term to maturity.

The empirical analysis in this study makes use of quarterly time series data provided by the department of statistics of the National Bank of Rwanda.

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[4] The formal definitions of money in South Africa are the following: M1=notes and coins+cheque and transmission depositis+demand deposits; M2=M1+short-term and medium-term deposits; and M3=M2+long-term deposits (Nell, 2003: 177).

[5] "The term structure theory deals with the effect that time has on interest rate. It seeks to answer the question of why different maturities should have different yields" (Ephraim Clark, 2002: 476).

The relationship between the short-term and the long-term interest rates is referred to as the term structure of interest rates (yield curve). The yield curve considers the relationship between the maturity and the yield at any given time, assuming all other factors are constant (Van Zyl *et al.*, 2003).

The data in question consists of 84 observations for the Consumer Price Index (CPI) from the first quarter in 1980 to the last quarter in 2000; 84 observations for real GDP (constant 1995 prices) and 84 other observations for M2 (as well as 84 observations for each M2 money component, that is, M1 and Quasi money (see Appendix Three). Lending and deposit rates for this time period are also available from the above-mentioned source. The study is essentially econometric in nature and data testing is carried out using the econometric packages SPSS 11.5 as well as the student version of EViews.

4.3 Data analysis and checking variables for stationarity

One of the important types of data used in empirical analysis is time series data. "A time series is a set of observations on the values that a variable takes at different times (Gujarati, 2003: 25). This type of data poses several challenges to econometricians and to practitioners. Most empirical works based on time series data assume that the underlying time series is stationary. However, most economic time series are generally integrated of order one I(1), that is, they generally become stationary only after taking their first differences. Loosely speaking, a time series is said to be stationary if its mean and variance do not vary systematically over time[6] (Gujarati, 2003). "Non-stationarity of time series has always been regarded as a problem in econometric analysis" (Charemza and Deadman, 1992: 124). Stationary time series are important because if a time series is non-stationary, we can study its behavior only for the time

[6] Such a time series is known as a weakly stationary, or second-order stationary process, or in a wide sense, stochastic process. A time series is strictly stationary if all the moments of its probability distribution and not just the first two (mean and variance) are invariant over time. If, however, the stationary process is normally distributed, the weakly stationary stochastic process is also strictly stationary, for the normal stochastic process is fully specified by its two moments: the mean and the variance (Gujarati, 2003).

period under consideration. Each set of time series data will therefore be for a particular episode. As a consequence, it is not possible to generalize from non-stationary data to other time periods. Therefore, for the purpose of forecasting, such non-stationary time series may be of little practical value (Gujarati, 2003). Moreover, if time series are non-stationary, one is likely to finish up with a model showing promising diagnostic test statistics even in the case where there is no sense in the regression analysis (Charemza and Deadman, 1992). The latter is the essence of what is known as the problem of spurious or nonsensical regression that can arise in studies using non-stationary time series.

4.3.1 Checking variables for stationarity

The previous section mentions the problems posed by regressions involving non-stationary time series. We now turn to find out if the time series in our data set are stationary. Although there are several tests of stationarity, we attempt only those that are prominently discussed in the literature namely, a graphical analysis, the correlogram test as well as the Augmented Dickey-Fuller (ADF) unit root test.

4.3.1.1 Graphical analysis

A visual plot of the data is usually the first step in the analysis of any time series. So, before one pursues formal tests to check variables for stationarity, it is advisable to plot the time series under study, which gives an initial impression about the likely nature of the time series. We now proceed with the plotting of the variables of our model.

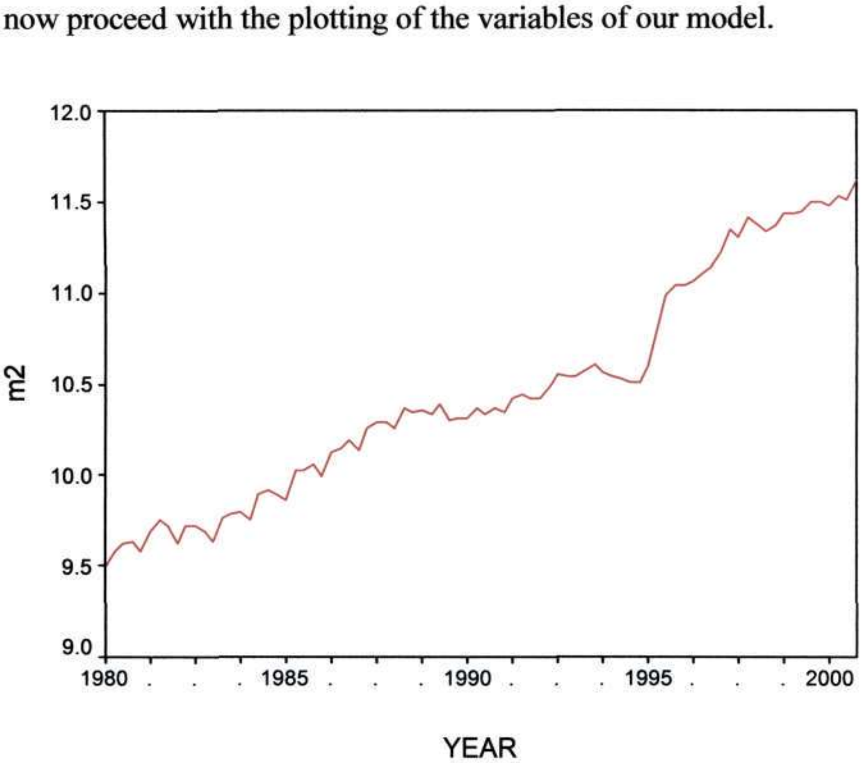

Figure 4.1 The logarithm of broad money M2

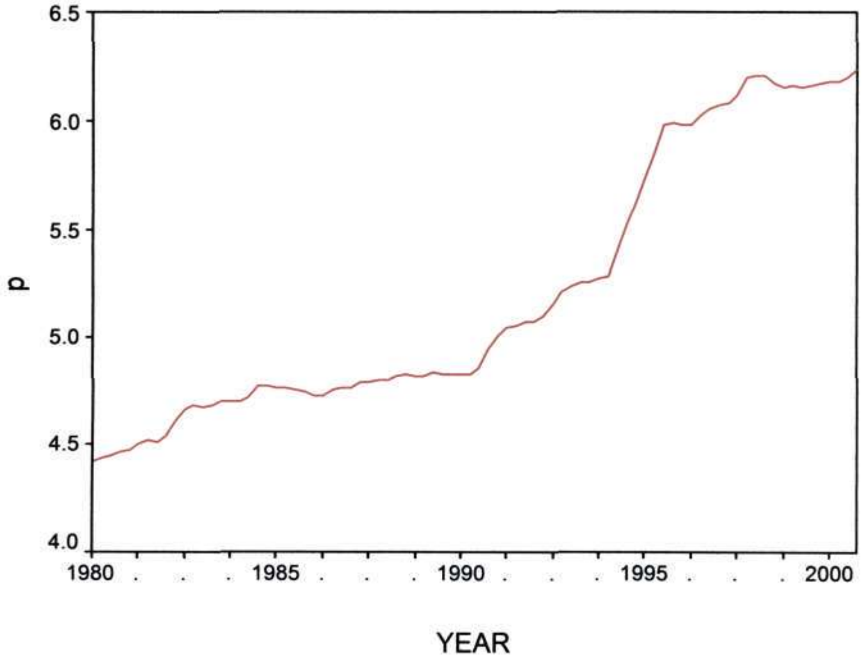

Figure 4.2 The logarithm of the CPI

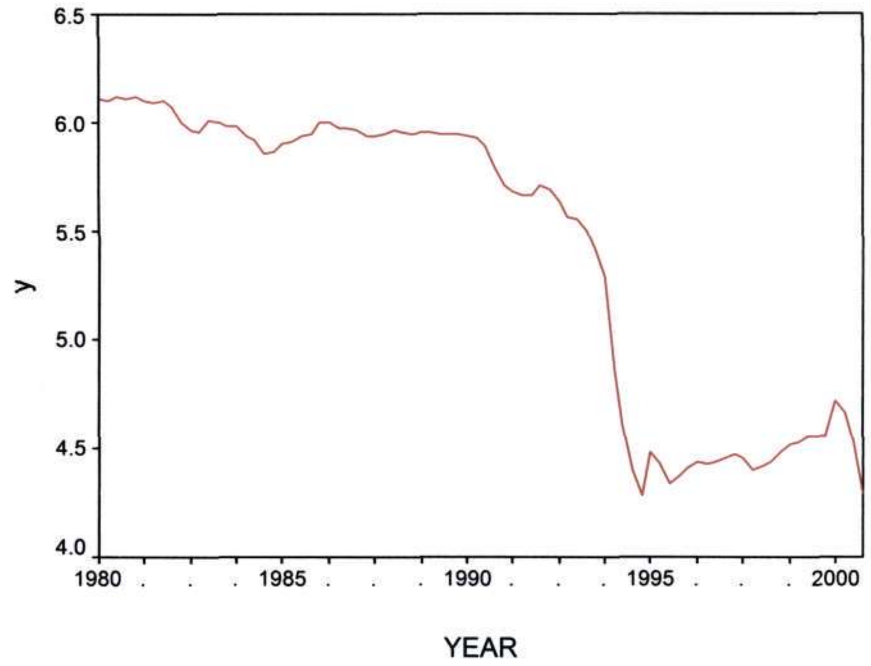

Figure 4.3 The logarithm of real GDP

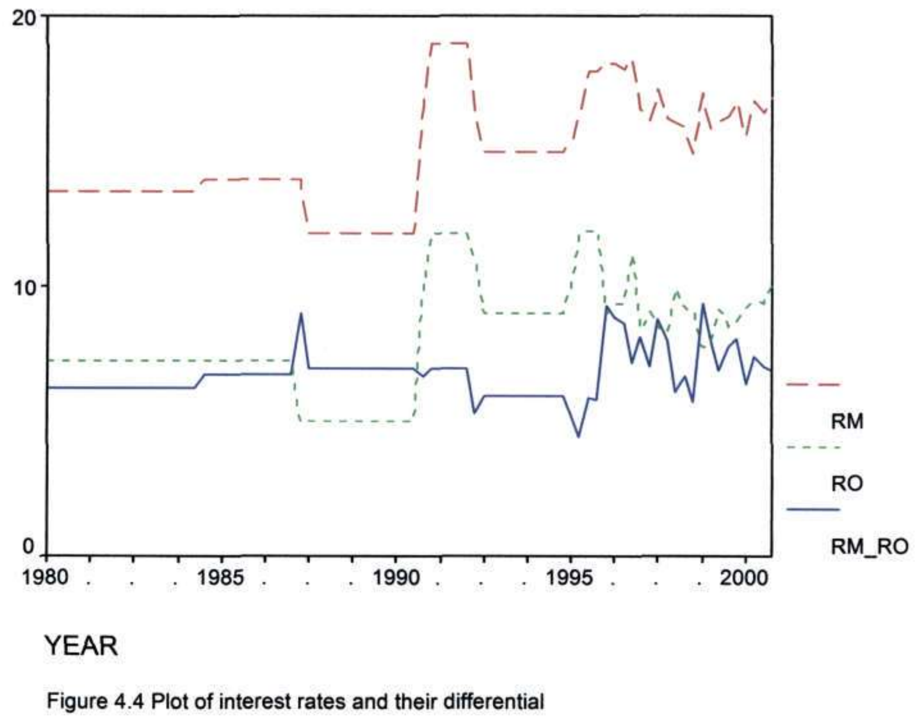

Figure 4.4 Plot of interest rates and their differential

Both *m2* (which is the logarithm of nominal M2 money) in Figure 4.1 and *p* (the logarithm of the CPI) in Figure 4.2 are trending upwards, albeit with fluctuations especially in 1994. Following the war and the Rwandan genocide in 1994, prices (the CPI) have increased in 1995 and became more than double its level in 1993. In Figure 4.3, the logarithm of real GPD trends downwards until 1994 when it starts becoming fairly horizontal. In Chapter Two we noted that real GDP fell by almost a half in 1994. This is evident in Figure 4.3. The interest rate differential in Figure 4.4 does not display any particular trend, as it is fairly variable. Figure 4.4 shows also that the interest rates, RM and RO, share the same trend, which suggests that they might have a long-run relationship. We discuss these long-run relationships in Section 4.4 below. A look at the graphs of the above plotted time series (especially for *m2, p* and *y*) gives the impression that they are not stationary time series because visually at least the mean and variance of the individual series do not seem to be time invariant. Gujarati (2000) points out that these intuitive visual examinations are the starting point of any analysis. We now consider more formal tests of stationarity.

4.3.1.2 Sample correlogram

The Sample Autocorrelation Function (SACF) at lag *k* denoted as $\hat{\rho}_k$, is defined as the ratio of the sample covariance (at lag k) to the sample variance. The sample correlogram is a plot of the sample autocorrelation function (SACF) against *k* (the lag length when computing the SACF). If a particular time series is stationary, the autocorrelation coefficients at various lags hover around zero or decline very quickly. For a non-stationary time series, the autocorrelation coefficient starts at a very high value and declines very slowly towards zero as the lag lengthens (Gujarati, 2003).

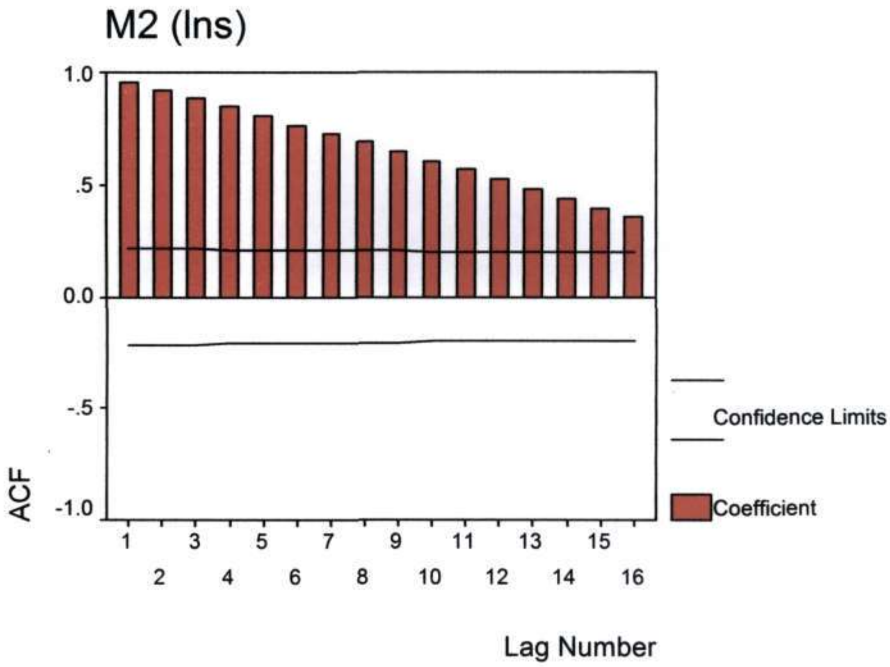

Figure 4.5 Correlogram of m2

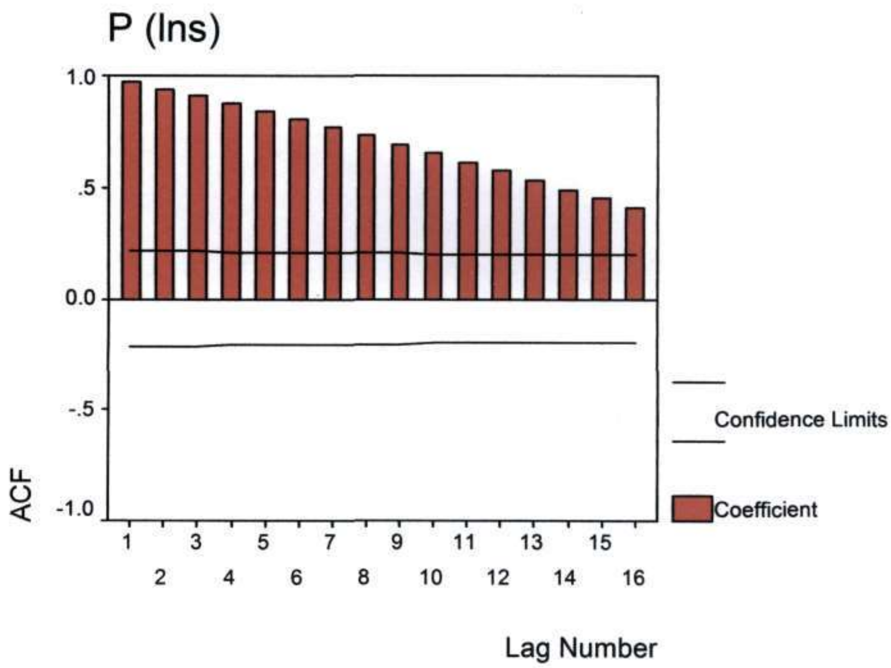

Figure 4.6 Correlogram of p

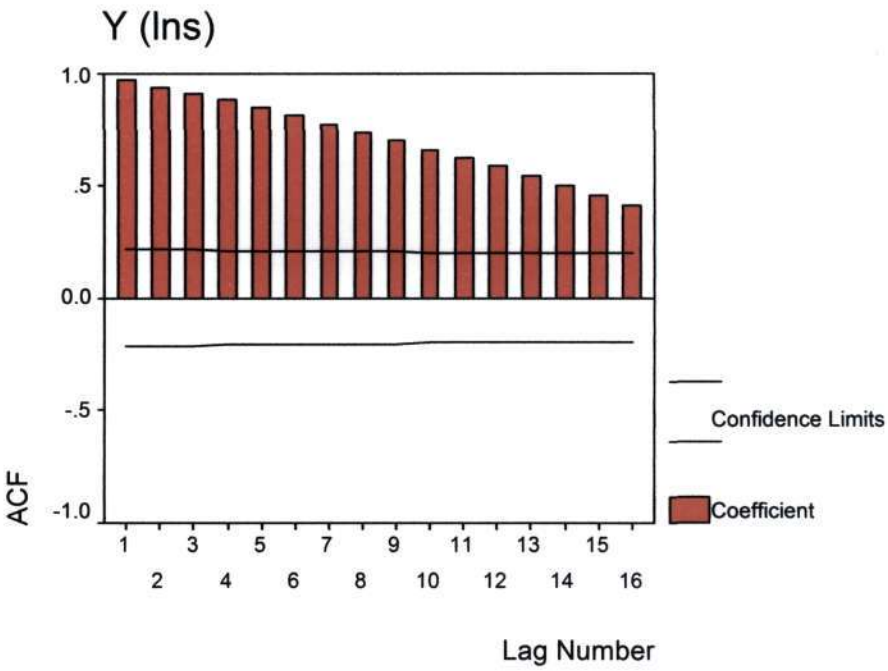

Figure 4.7 Correlogram of y

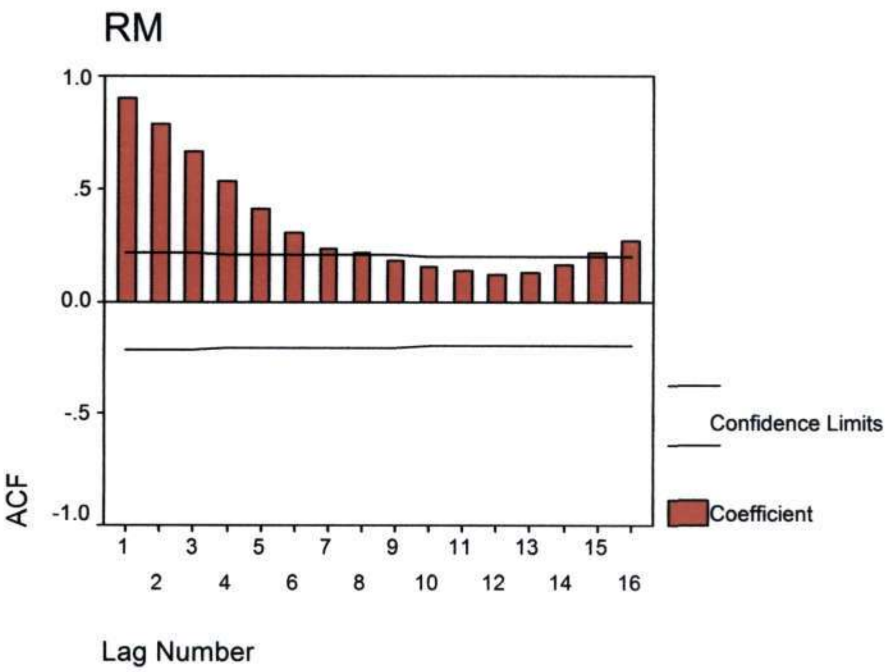

Figure 4.8 Correlogram of RM

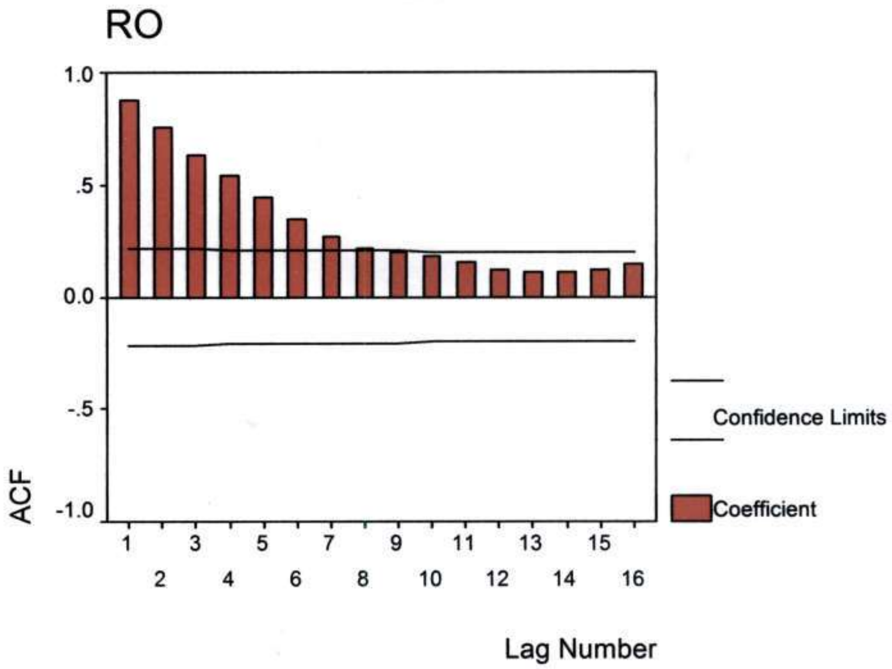

Figure 4.9 Correlogram of RO

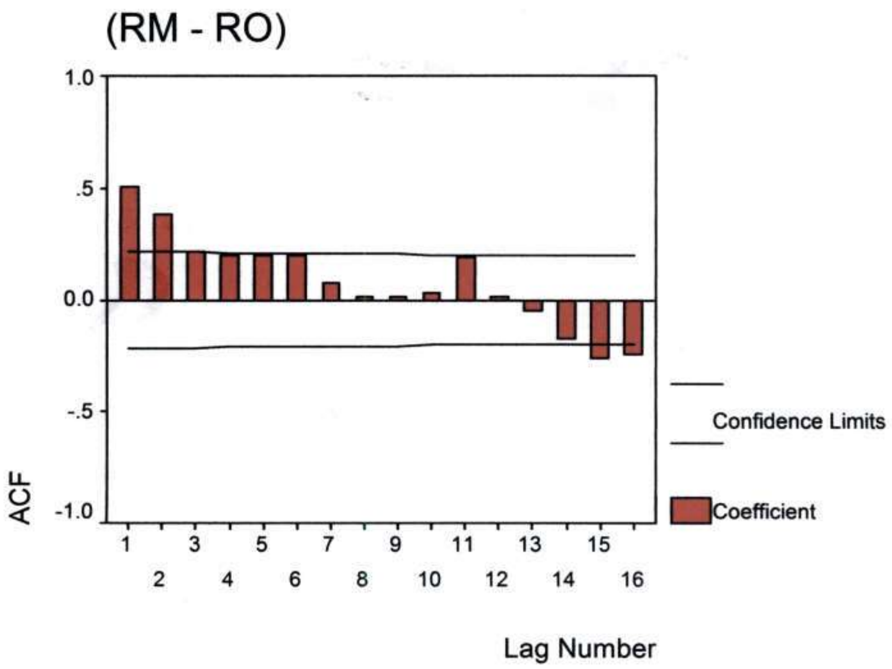

Figure 4.10 Correlogram of RM-RO

As it appears from the correlograms of *m2*, *y*, *p*, *RM* and *RO*, their autocorrelation coefficients start at very high values (close to one) and taper off slowly toward zero as the lag lengthens leading as to the conclusion that all these time series are non-stationary. The pattern shown by the correlogram of *(RM-RO)* is different from the other variables. The autocorrelation function starts at a very low value of 0.5 (unlike for the other correlograms where it was close to one) and declines quickly to hover around zero. Thus, we can conclude that *RM-RO* is a stationary time series.

4.3.1.3 The Augmented Dickey-Fuller (ADF) unit root test

Before any sensible regression analysis can be performed, it is essential to identify the order of integration of each variable – provided that the variables under consideration can be made stationary through differencing (Charemza and Deadman, 1992). In general, a time series in said to be integrated of order *d*, denoted I(d), if it has to be differenced *d* times to become stationary. Thus, stationary time series do not require any differencing, they are said to be integrated of order zero, I(0). Unit root tests are designed to test the order of integration of a variable (Darnell, 1994). An appropriate method of testing the order of integration has been proposed by Dickey and Fuller (1979). The Dickey-Fuller (DF) test is based on the regression of the following equation[7]:

$$\Delta Y_t = (\rho - 1)Y_{t-1} + \varepsilon_t = \delta Y_{t-1} + u_t \quad (2)$$

[7] The DF test is estimated in three variants (random walk, random walk with drift, and random walk with drift around a deterministic trend) namely: $\Delta Y_t = \delta Y_{t-1} + u_t$, or $\Delta Y_t = \beta_1 + \delta Y_{t-1} + u_t$, or $\Delta Y_t = \beta_1 + \beta_2 t + \delta Y_{t-1} + u_t$.

Where $-1 \le \rho \le 1$, and u_t is assumed to represent a series of white noise error term. The Dickey-Fuller test consists of testing the null hypothesis that $\delta = 0$ in equation (2). If $\delta = 0$, then $\rho = 1$, that is we have a unit root, meaning the time series under consideration is non-stationary. But if $\delta < 0$, this implies that $\rho < 1$, we conclude that there is no unit root, and the time series in question is stationary. Dickey and Fuller have shown that under the null hypothesis that $\delta = 0$ (or $\rho = 1$), the estimated t value of the coefficient of Y_{t-1} in equation (2) follows the τ (tau) statistic. A weakness of the original Dickey-Fuller test is that it assumes that the error terms u_t in equation (2) are uncorrelated. But in case the u_t are autocorrelated (that is, u_t is not white noise) then the ordinary least squares (OLS) estimates of equation (2) are not efficient. A solution advocated by Dickey and Fuller (1981) and known as the Augmented Dickey-Fuller (ADF) test is to use the lagged values of the dependent variable ΔY_t as additional explanatory variables to approximate the autocorrelation. The ADF equivalent of (2) is the following[8]:

$$\Delta Y_t = \delta Y_{t-1} + \alpha_i \sum_{i=1}^{k} \Delta Y_{t-i} + \varepsilon_t \quad (3)$$

where ε_t is a pure white noise error term. The practical rule for establishing the value of k (the number of lags for ΔY_{t-i}) is that it should be relatively small in order to save degrees of freedom, but large enough so that the error term in (3) is serially uncorrelated (Charemza and Deadman, 1992). The ADF test follows the τ (tau) statistic and we still test whether $\delta = 0$. If the estimated τ value is less than the critical value of τ, in absolute terms, then we accept the

[8] The ADF test is also estimated in three different form namely: $\Delta Y_t = \delta Y_{t-1} + \alpha_i \sum_{i=1}^{k} \Delta Y_{t-i} + \varepsilon_t$ or $\Delta Y_t = \beta_1 + \delta Y_{t-1} + \alpha_i \sum_{i=1}^{k} \Delta Y_{t-i} + \varepsilon_t$, or $\Delta Y_t = \beta_1 + \beta_2 t + \delta Y_{t-1} + \alpha_i \sum_{i=1}^{k} \Delta Y_{t-i} + \varepsilon_t$.

null hypothesis that $\delta = 0$ (that is, $\rho = 1$), and there is a unit root, in which case the time series is non-stationary. On the other hand, if the estimated τ value is greater that the critical value of τ, in absolute terms, we reject the null hypothesis that $\delta = 0$, in which case $\rho < 1$, and this implies that there is no unit root, which leads to the conclusion that the time series under consideration is stationary. The ADF test is widely regarded as being the most efficient test from among the simple tests for integration and is at present the most widely used in practice. Thus, we apply the ADF test to formally test the order of integration of the variables in our model. Table 4.1 below reports the ADF test results. The second column lists the estimated ADF τ values for the variables in level form (and in logarithms for variables in lower case), while the last column gives τ values for variables in their first differences.

Table 4.1 ADF test results

Variable	**ADF test (τ)**	**Δ Variables**	**ADF test (τ)**
m2	-1.921	Δm2	-6.907^{***}
y	-0.198	Δy	-4.077^{***}
p	-0.04	Δp	-4.31^{***}
RM	-2.149	ΔRM	-5.763^{***}
RO	-2.236	ΔRO	-5.99^{***}
(RM - RO)	-3.719^{***}		
(m2 - p)	-1.674	Δ(m2 - p)	-6.06^{***}

Notes: (1) The 99 *per cent* critical value of Dickey-Fuller (with constant) is -3.51 and the 95 *per cent* value is -2.89 (our sample is made of 84 observations).

(2) The 99 *per cent* critical value of Dickey-Fuller (with constant and trend) is -4.04 and the 95 *per cent* value is -3.45.

(3) The ADF tests are of order one and contain intercepts and no trends (except for *m2* whose ADF contains an intercept and trend).

(4) *** denotes significance at the one *per cent* level.

(5) Recall that "the ADF test adjusts the DF test to take care of possible serial correlation in the error terms of the regressand"(Gujarati, 2003).

The second column, ADF test (τ), in Table 4.1 shows that except for the variable (*RM-RO*), the computed τ statistics, in absolute value, are less than the 99 *per cent* critical value of Dickey-Fuller which is -3.51 and even less than the 95 *per cent* critical τ which is equal to -2.89. This implies that we accept the null hypothesis that $\delta = 0$ (that is, $\rho = 1$), and there is a unit root; the time series in question are not stationary. Therefore, on the basis of graphical analysis, the correlogram, and the ADF test, the conclusion is that for the quarterly periods of 1980 to 2000, *m2*, *y*, *p*, *RM*, and *RO* are non-stationary.

Unit root tests are often used as preliminary cointegration tests. If two series are individually I(1) but the difference between them is I(0), the two series cointegrate with a unit coefficient. However, if the difference between the two I(1) series is also I(1), the two series could still be cointegrated, but with a non-unit coefficient (Nell, 2003). Thus, the last two rows in Table 4.1 present preliminary cointegration tests. In the penultimate row of Table 4.1, the interest rate differential (*RM-RO*) is I(0) leading to the conclusion that the two interest rate series (*RM* and *RO*) cointegrate with a unit coefficient. The last row in Table 4.1 indicates that *m2* deflated by consumer prices (*m2* – *p*) is I(1) suggesting that the M2 money demand function may not be homogeneous of degree one in the level of prices. The relation between M2 and prices might be very close to proportionate, but Hendry (1995) warns against imposing restrictions that may affect short-run dynamics. Many studies include the inflation rate as an additional variable. This can cause difficulties if the two series are not stationary. Real money and inflation could move together only because of price movements (Nell, 2003). We do not adopt this approach.

The fourth column (the last one) in Table 4.1 shows that all the considered variables become stationary in their first differences. This is conformed by a plot of the first difference of the variables mentioned above (see Figure 4.11 below).

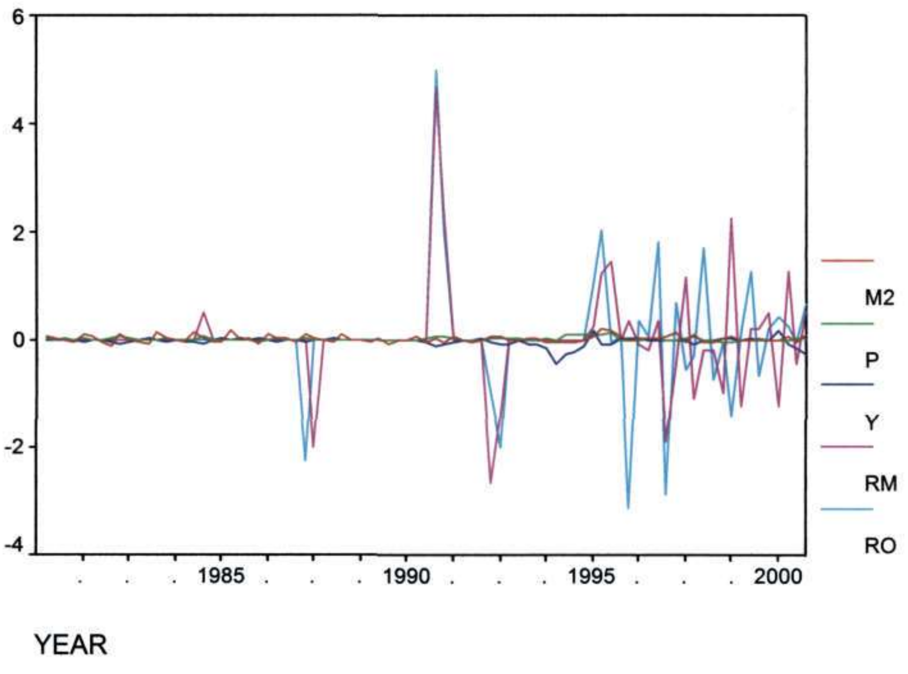

Figure 4.11 Fisrt difference of m2, y, p, RM and RO

In comparison with the plots of the original variables (see Figure 4.1 to Figure 4.4), the plots of the transformed time series does not display any trend and seem to be constant in their mean, variance and covariance. Therefore, since the represented time series originally are not stationary, but becomes stationary in their first differences, they are integrated of order one I(1).

4.3.1.4 The income velocity of money

Before we proceed, we briefly present the velocity of money in Rwanda. The earliest empirical works on money demand primarily involved producing an analysis of velocity, characterizing its behavior over time and identifying the institutional factors responsible for long-run movements in velocity. Velocity is defined as the ratio of income to the money supply (PQ/M) and is interpreted as the number of times the money stock turns over per year in supporting financially the production of output (Kennedy, 2001). Figure 4.12 presents the plots of the logarithm of the income velocities of M2 money and its sub-components over the period 1980q1-2000q4.

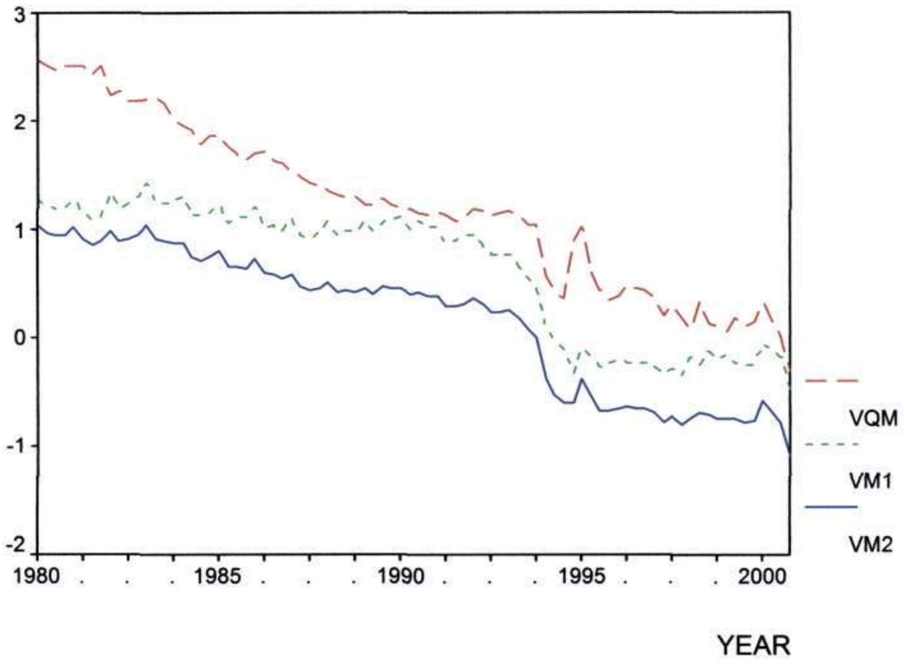

Figure 4.12 The income velocity of M2 money and its sub-compontents(lns)

The graph shows that VM1 the logarithm of the income velocity of M1 (currency plus demand deposit), VQM the logarithm of the income velocity of quasi money (various term deposits), and VM2 the logarithm of the income velocity of M2 (M1 plus quasi money) seem all to be trending downward despite the broken trends in 1994 during the Rwandan war and genocide. This decreasing velocity might be caused by the growing demand for money. The plots suggest that the trend in M2 is influenced by the behavior of its sub-components VQM and VM1. Another feature that is worth mentioning is that, even if VM2 is trending downward, the plot shows that it has remained stable around its trend (albeit with the broken trend in 1994) despite the financial reforms implemented during the 1990's in Rwanda.

4.4 Cointegration and long-run money demand estimates

We caution in Section 4.3 above that a regression of a non-stationary time series on another non-stationary time series might produce a spurious regression. However, if the residuals from the latter regression are subjected to a test of stationarity (say the unit root test) and found to be stationary, this regression will be meaningful (not spurious). In this case, the variables in question are said to be cointegrated. Economically speaking, two variables (or more) are said to be cointegrated if there is a long-run or equilibrium relationship between them (Charemza and Deadman, 1992; Gujarati, 2003). Therefore, as Granger (1986: 226) puts it, a test for cointegration can be thought of as a pre-test to avoid spurious regressions situations. Table 4.1 indicates that except for the interest rate differential (*RM-RO*), the variables in our model (*m2, y, p, RM*, and *RO*) are individually I(1). So, in order to avoid the problem of spurious regression, we ought to subject the residuals of our model to unit root test to find out whether our selected variables cointegrate and determine whether there is a long-run relationship between them.

Our long-run model consists in regressing *m2* on *y* and *p*. The interest rate differential (*RM-RO*) will not be included in our long-run specification. Following Nell (2003), since the ADF unit root test (in Table 4.1) shows that *RM* and *RO* cointegrate with a unit coefficient (because (*RM-RO*) is I(0)), in other words, there are two cointegrating vectors in the money demand function when the interest rates enter independently. The net long-run interest rate effect is therefore zero, because a positive shock to *RM* will be equally offset by an increase in *RO*, that is, in the long-run, *RM=RO*. If the interest rate effect is immediately entered as a differential

(*RM-RO*) the long-run impact is zero. The cointegrating regression results for our model are given below, with *t*-statistics in parentheses.

$m2 = -1.064 + 0.596y + 1.592p$ (4)

(-1.269) (7.927) (18.916)

$R^2 = 0.958$ adjusted $R^2 = 0.957$ d = 0.308 F = 926.7

According to the extremely high *F*-test, the model is significant. The computed *t*-statistics (for *y* and *p*) are highly statistically significant, the adjusted R^2 is high, but the Durbin-Watson *d* value is extremely low indicating that the model is plagued by the problem of autocorrelation. We know from Gujarati (2003: 792) that, sometimes autocorrelation results because the underlying time series is non-stationary. However, according to Granger and Newbold (1974), an $R^2 > d$ is a good rule of thumb to suspect that the estimated regression is spurious. Moreover, since *m2*, *y*, and *p* are individually non-stationary, there is a possibility that our regression of *m2* on *y* and *p* in equation (4) is spurious. Therefore, to find whether the regression (4) is not spurious, we performed a unit root test on the residuals estimated from (4) to check whether *m2*, *y* and *p* cointegrate, in other words, we performed the Engle-Granger test as follows.

$\Delta \hat{u}_t = -0.151 u_{t-1}$

t = (-2.515)

adjusted $R^2 = 0.060$ d = 1.809

The Engle-Granger 5 *per cent* critical τ value is −1.95. Since the computed τ value (-2.515) is greater, in absolute value, than the critical Engle-Granger, we reject the null hypothesis $(\delta = 0)$ that we have a unit root. The residuals from our regression are I(0) or stationary.

Hence, *m2*, *y* and *p* are cointegrated, and equation (4) represents the long-run money demand in Rwanda. Compared to Nell's results we note that prices adjust less than the change in the money supply.

Nell (2003) contends that the cointegration test in equation (4) has to be taken as an initial estimation because it prevents difficulties associated with other cointegration procedures. Moreover, Inder (1993) demonstrates that excluding dynamics in finite samples may affect the performance of the estimator and as an alternative suggests the Unrestricted Error Correction Model (UECM), which should reduce bias and also includes dynamics in the estimation of the long-run model. We specified our UECM of order two as follows:

$$\Delta m2 = \delta_0 + \sum_{i=1}^{2} \delta_{1i} \Delta m2_{t-i} + \sum_{i=0}^{2} \delta_{2i} \Delta y_{t-i} + \sum_{i=0}^{2} \delta_{3i} \Delta p_{t-i} + \sum_{i=0}^{2} \delta_{4i} \Delta (RM - RO)_{t-i} + \delta_5 D_1$$
$$+ \delta_6 D_2 + \delta_7 t + \alpha_1 m2_{t-1} + \alpha_2 y_{t-1} + \alpha_3 p_{t-1} + \alpha_4 (RM - RO)_{t-1} + \varepsilon_t \qquad (5)$$

In equation (5), the variables have the same definition as before except for the dummy variable D_1 that takes the value of one in 1994q1-1995q4 and zero otherwise, and D_2 which takes the value of one in 1990q1-2000q4 and zero otherwise, whereas t is a time trend. Nell (2003) insists on the inclusion of dummy variables, and even outlier dummies, since one cannot easily detect outliers on visual displays of the economic data. The omission of relevant dummies may lead to predictive failure, because the Error Correction Model still converges to the *old* equilibrium (Clement and Hendry, 1997). Our dummy variable D_1 captures the dramatic price increase in 1994-1995 following the Rwandan war and genocide, and we expect its coefficient to have a negative sign. D_2 captures the structural adjustment reforms that were implemented in Rwanda since 1990. Variables in level form such as $(m2_{t-1})$ represent the long-run part of the model, while those in differences such as (Δy_{t-1}) stand for the short-run. For our parsimonious specification, we have decided to eliminate all other insignificant parameters from the model except for the coefficient of the change in the short-run interest rate differential $\Delta(RM - RO)$. The results of the regression for equation (5) are presented below, with t-statistics in parentheses.

$$\Delta m2 = \underset{(1.49)}{0.994} + \underset{(3.11)}{0.297}\,\Delta y_{t-1} + \underset{(3.71)}{0.86}\,\Delta p + \underset{(0.16)}{0.001}\,\Delta(RM - RO) - \underset{(-2.31)}{0.063}\,D_2 + \underset{(2.93)}{0.005}\,t$$

$$-\underset{(-3.79)}{0.319}\,m2_{t-1} + \underset{(2.12)}{0.121}\,y_{t-1} + \underset{(2.81)}{0.289}\,p_{t-1} \qquad \textbf{(6)}$$

The insignificance of (α_4) the coefficient of $(RM - RO)_{t-1}$ in equation (6) suggests that *(RM-RO)* has no long-run effect. This is in line with Nell's (2003) assertion that when the unit root test shows that the *RM* and *RO* cointegrate with a unit coefficient, the long-run impact of the interest rate differential *(RM-RO)* is zero. The salient feature of equation (6) is the statistical insignificance of the coefficients for all lagged changes in (*RM-RO*). Despite having this, we kept $\Delta(RM - RO)$ in our model because the theory suggests that the demand for money is a function of a scale variable and a set of opportunity cost variables to indicate the forgone earnings by not holding assets, which are alternatives to, money. The opportunity cost of holding money involves two ingredients: the own rate of money and the rate of return on assets alternatives to money (Sriram, 1999). In equation (6), the cointegration test is based on the coefficient of $m2_{t-1}$ (the error correction coefficient)[9]. The computed τ value of the latter

[9] Tests of cointegration based not directly on the residuals but on the regression coefficients themselves, might have higher power (Banerjee *et al.*, 1993)

is equal to –3.79 which in absolute value is greater than the 5 *per cent* Dickey-Fuller critical τ of –3.45, leading to the rejection of the null hypothesis of no cointegration. The existence of cointegration is also supported by the plot of the residuals from equation (6) in Figure 4.13 below, as well as a unit root test conducted on the same residuals.

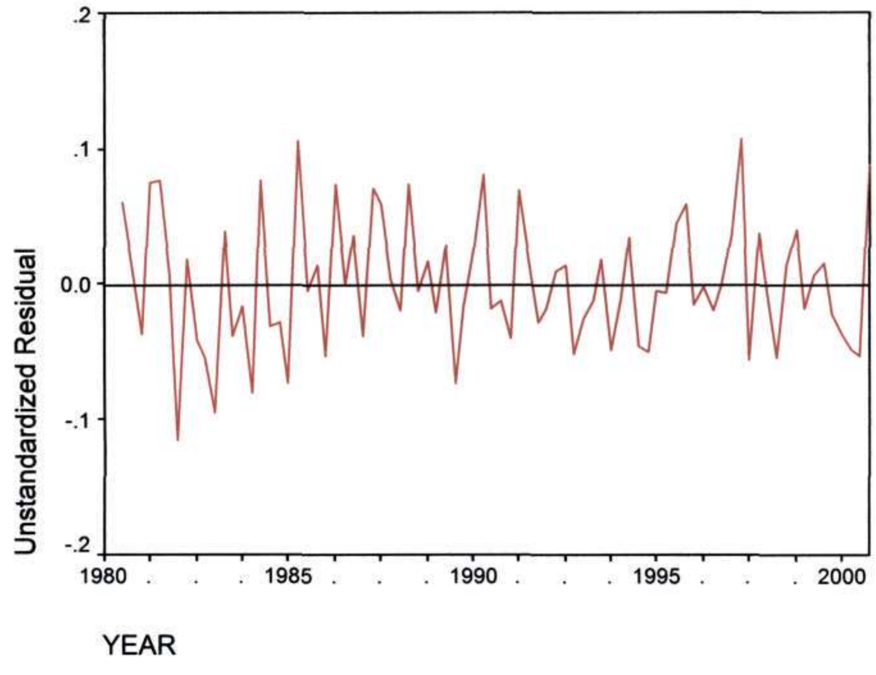

Figure 4.13 Residuals from the UECM in equation (6)

It is apparent from Figure 4.13 above, which is a plot of the residuals from the regression of equation (6), and their frequent crossing of zero, that our UECM is a cointegrating regression. Therefore, *m2, y*, and *p* have a long-run relation between them. We derived the long-run solution of equation (6) by taking the ratio of the coefficients of the level variables (y_{t-1} and p_{t-1}) to the error correction coefficient of 0.319. This gives us the following equation:

$$m2 = 0.38y + 0.91p \qquad (7)$$

There are however differences between the magnitude of the coefficients in equation (4) when compared to equation (7). We now note that in this second estimation, which includes the short-run dynamics, that prices adjust by more than the money supply. As noted in Chapter Two, money is not superneutral.

4.5 Short-run dynamic Error Correction Model

Error Correction Models (ECM) have proved to be one of the most successful tools in applied money demand research (Sriram, 1999). The ECM contains information on both the short and the long-run properties of the model with disequilibrium as a process of adjustment to the long-run model. When cointegration holds, and if there is any shock that causes disequilibrium, there exists a well defined short-term dynamic adjustment process, the error correction mechanism, that will push back the system toward the long-run equilibrium. In fact, cointegration implies the existence of a dynamic error correction form relating to the variables in question (Engle and Granger, 1987). As ECM's have demonstrated their ability to incorporate the difficult empirical issues of equilibrium in modeling and estimating money demand, and given their widespread implication, they have attracted significant research interest among economists from around the world. Arize and Schwiff (1993) summarize the desirable properties of the ECM as follows:

(i) The ECM avoids the possibility of spurious correlation among strongly trended variables;

(ii) The long-run relationships that may be lost by expressing the data in differences to achieve stationarity are captured by including the lagged levels of variables on the right-hand side;

(iii) The specification attempts to distinguish between short-run and long-run effects;

(iv) The ECM provides a more general lag structure, which does not impose many restrictions on the model (Hendry, 1979).

Equation (6) above represents the ECM for our data. However, in order to obtain an equation that shows the equilibrium adjustment, the long-run portion of equation (6) is changed to the equilibrium error, or $m2 + 1.064 - 0.596y - 1.592p$ following Nell (2003). Then, this error term can be used to tie the short-run behavior of money demand to its long-run value. The results for this ECM are presented below, with t-statistics in parentheses:

$$\Delta m2 = 0.01 + 0.316\Delta y_{t-1} + 0.936\Delta p - 0.0003\Delta(RM - RO) - 0.12ecm_{t-1}$$

(1.53) (3.5) (5.05) (0.05) (-2.41) **(8)**

As these results show, the coefficient of the equilibrium error term (ecm_{t-1}) is negative, and statistically significantly different from zero implying that 0.12 of the discrepancy between money demand, income, and price in the previous quarter is eliminated in the following quarter. Therefore, the speed of adjustment for money demand in Rwanda is equal to 0.12, which is considered to be low, indicating the slow adjustment of the amount of money demanded toward its long-run equilibrium value. Only 12 *per cent* of the deviation is corrected, suggesting that the Rwandan money market needs about two years to re-adjust to equilibrium. It is of some interest that the correlogram for the interest rate differential (Figure 4.10) also goes to zero after two years. Note that the interest rate differential in (8) above, which we kept in the model on theoretical grounds has once again yielded an insignificant coefficient. Equation (8) has the coefficients for Δy_{t-1} and Δp showing larger magnitudes than in (6) but for most purposes they are the same. Moreover, standard errors were found to be slightly lower in equation (8) because:

(i) There is an increase of degrees of freedom in (8) that was gained because the long-run part of equation (6) was transformed to yield the equilibrium error and also the insignificant variables were dropped;

(ii) Equation (8) captures both short and long-run effects.

Figure 4.14 below records the actual and fitted values of equation (8) as well as the plot of the residuals.

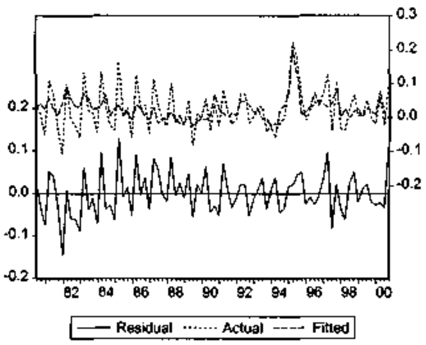

Figure 4.14 Actual, fitted values, and residuals of equation (8)

An examination of this figure confirms that equation (8) fits the actual data very well, and the residuals from the regression in equation (8) appear to be stationary. Indeed the model fits the data for years of the war and genocide rather well.

4.6 Testing for stability of the money demand function

The question of whether the demand function for money is stable is one of the most important recurring issues in the theory and application of macroeconomic policy (Judd and Scadding, 1982). A stable money demand function is at the core of the conduct of monetary policy as it enables a policy-driven change in monetary aggregates to have a predictable influence on output, interest rates, and ultimately prices (Sriram, 1999). Recall that an econometric relationship is stable if the parameters in such a relation are not subject to permanent changes over time (Laumas and Mehra, 1976). What is being sought in a stable demand function is a set of necessary conditions for money to exert a predictable influence on the economy so that the central bank's control of the money supply can be a useful instrument of economic policy (Judd and Scadding, 1982). Section 4.1 above gives an account of the various issues concerning the study of money demand functions in different countries. In this section, the key issue is to test whether there exists a stable money demand in Rwanda for the period 1980-2000 using quarterly data. Gujarati (2003) contends that when we use a regression model involving time series data, it may be that there is a structural change in the relationship between the regressand and the regressors. By structural change, we mean that the values of the parameters of the model do not remain the same through the entire time period. Our sample period includes a certain number of events that potentially could cause structural changes, namely, the financial reforms dictated by the Bretton-Woods institutions since 1990, and the genocide of 1994, which then resulted in high rates of inflation. There are several methods to test for structural stability. We have opted for three relevant tools suggested by Charemza and Deadman (1992) for such an inquiry, namely, the plots of the recursive least squares coefficients, the one-step residuals, and the scaled recursive Chow test statistics. We now discuss each of these tests in greater detail.

4.6.1 Recursive Least Squares (RLS) Coefficients

In this test, the interest is on the behavior of the parameters of the model over time. The test consists of starting from a small sub sample of $t = 1, 2, 3, \ldots, n$, where $n \geq k$, and using this sub-sample we estimate the k parameters of the model by OLS. Then one extends the sample period by one observation to $t = 1, 2, 3, \ldots, n+1$, and re-estimates the model . We then continue this procedure until the estimation period is the complete sample $t = 1, 2, 3, \ldots, T$. In other words, the vector of the estimated coefficients is computed sequentially for $t = n$, then $t = n+1$, up to $t = T$, by rolling forward the data admitted to the sample one period at a time. Hence, these least squares estimates are termed the recursive least squares coefficients (Charemza and Deadman, 1992). Then, in order to obtain the time path of the coefficients in the model, the values of each recursively estimated coefficient is plotted against time. Plots of the recursive least squares coefficients' of our ECM are presented in Figure 4.15 below.

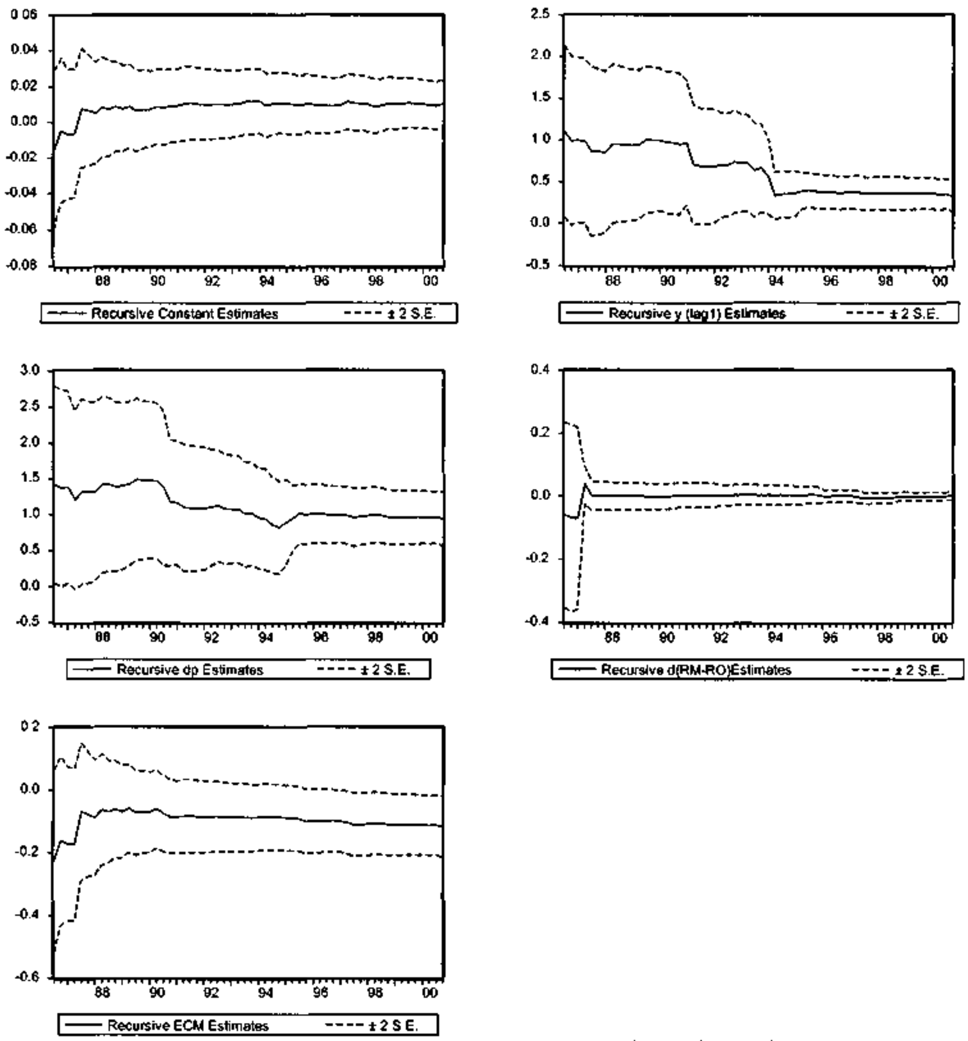

Figure 4.15 Recursive least squares coefficients of the ECM (equation (8))

It appears from the time paths of the recursively estimated coefficients presented in these figures, that all the parameters of our error correction model remained stable over our period of study. Charemza and Deadman (1992) argue that the instability that is observed at beginning of the plots of the parameter estimates simply reflects the small number of the observations used to estimate them at the start of the recursions. Note that the last panel in Figure 4.15 plots the recursively estimated error correction coefficient, which appears to be constant and very close to the value of –0.12 computed in equation (8). This is fairly strong evidence that money demand in Rwanda is stable.

4.6.2 One-Step Recursive Residuals

A plot of the one-step residuals provides another guide to parameter constancy in a model. In fact, when we are computing the recursive least squares coefficients, at each recursion an OLS residual for the last period in the sample can be obtained. Then, from the set of such last period residuals available at time t, their standard error $\hat{\sigma}_t$ is computed and helps to determine error bands of $\pm 2\hat{\sigma}_t$ around zero. At any break point a residual is likely to appear abnormal, compared with the other residuals, when it lies outside the error bands of $\pm 2\hat{\sigma}_t$ (Charemza and Deadman, 1992). Figure 4.16 below presents the one-step residuals of our ECM.

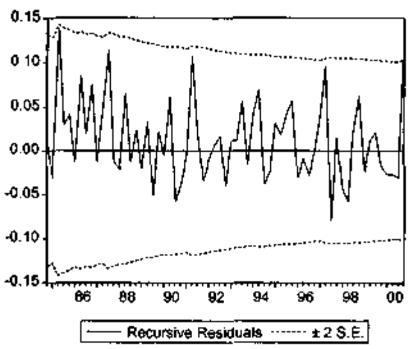

Figure 4.16 One-step recursive residuals of our ECM

It is seen from Figure 4.16 above, that all the one-step recursive residuals lie within the error bands of $\pm 2\hat{\sigma}_t$, also suggesting that our model has not undergone any structural changes over the period sample, although the early nineties and the single year 1997 show near instability. Again it is 1995 that is remarkable for its stability.

4.6.3 Scaled Recursive Chow Test

Unlike the Chow test, which assumes the point of structural breaks to be known, the scaled recursive Chow test helps to detect unknown possible structural breaks. Following Charemza and Deadman (1992), if the residual sum of squares for the model fitted by OLS up to and including period t-1 is RSS, and if the corresponding residual sum of squares for the model fitted up to and including period t is RSS^*, then the Chow test statistic is computed as:

$$Chow_t = \frac{(RSS^* - RSS)}{RSS/(t-k)}$$

Under the null hypothesis that there has been no structural break in the model between periods t-1 and t, the above statistic has an F distribution with 1 and t-k degrees of freedom. The F statistic computed for each recursion is then divided by its 5 *per cent* critical value from the tables of F, which yields a scaled recursive Chow test for each recursion as follows:

$$\frac{Chow_t}{F_{0.05}(1, t-k)}$$

Under the null hypothesis of no structural break, the plot of the scaled recursive Chow test statistic should be less than unity. Therefore, values of the scaled recursive Chow test that are greater than one imply that the null of no structural change between periods t-1 and t has to be rejected at the 5 *per cent* level of significance. In other words, there has been a structural break. We first obtain the recursive Chow statistics then divide them by their 5 *per cent* critical F value from tables which yields the scaled recursive Chow statistics. The following plot shows the scaled recursive Chow test against time.

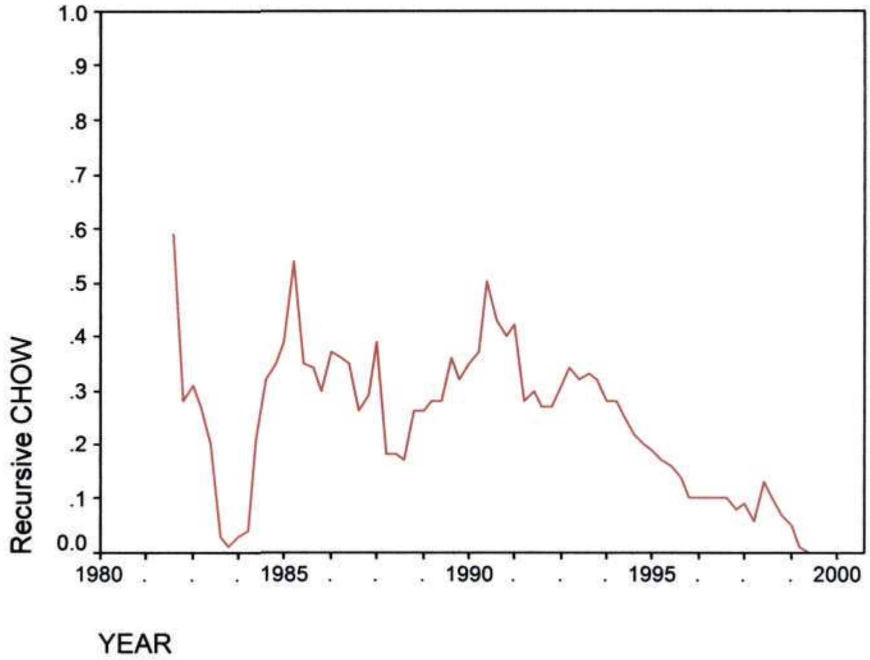

Figure 4.17 Scaled recursive CHOW test

In can be seen from Figure 4.17 that there is no value of the scaled recursive Chow that is greater that unity, all the values lie under unity implying that the null hypothesis of no structural change has to be accepted at the 5 *per cent* level of significance. Therefore, on the basis of all the tests performed, namely, the recursive least squares coefficients, the one-step recursive residuals, and the scaled recursive Chow test, all these visual displays strongly suggest that equation (8) is stable over time. Following Nell (2003), the constancy of equation (8) not only implies that the short-run part of the money demand function is structurally stable, but also the long-run part, since the long-run relation is captured by the error correction coefficient in equation (8).

4.6.4 Tests for exogeneity

We now test for super exogeneity of y and p. Hendry (1995) argues that a variable is said to be super exogenous for the parameters of interest if it is weakly exogenous for the parameters of interest, and if it is also invariant to changes in the parameters of the marginal model. The lack of structural invariance is usually a sad message to a policy analyst (Charemza and Deadman, 1992: 270). In other words, if a model intended for policy use is structurally invariant, the estimated parameters of the model in question can safely be used in a policy simulation experiment. If however the model is found to be not structural invariant, no knowledge can be retrieved from the considered sample relevant to the parameters of interest. Therefore, in our case, if equation (8) is to be used for policy purposes we must ensure that for a given change in the money supply, the coefficients of the exogenous variables are invariant with respect to the policy change. This section uses an indirect test – weak exogeneity – to determine that the coefficients do not change as policy decisions change.

We followed Charemza and Deadman (1992) in our attempt to test for weak exogeneity. Testing for weak exogeneity is, in many cases, equivalent to testing for zero covariance of the error terms in what is considered to be the conditional and the marginal process. Charemza and Deadman (1992: 265) suggest that technically, testing for zero variance can be performed by the use of the Lagrange Multiplier test. We simply estimate the equation we think represents the marginal process by OLS, compute the residuals and test these residuals as a missing variable in what we think is the conditional process. Since there is only one variable (the computed residuals) added to the regression, the traditional Student-t significance test is equivalent to the Lagrange Multiplier test. This way of testing for weak exogeneity was originally suggested by Engle (1984: 815-816). Applying the technique explained above yields the following results (t-Statistics in parentheses).

$$\Delta m2 = 0.14 + 0.295\Delta y_{t-1} + 0.731\Delta p - 0.001\Delta(RM - RO) - 0.12ecm_{t-1} + 0.33resM\arg p$$

(1.73) (3.14) (2.48) (-0.18) (-2.48) (0.36)

F = 7.93 d = 2.26 adj $R^2 = 0.3$ **(9)**

$$\Delta m2 = 0.01 + 0.31\Delta y_{t-1} + 0.92\Delta p - 0.000006\Delta(RM - RO) - 0.12ecm_{t-1} + 0.04resM\arg y$$

(1.5) (3.4) (4.7) (-0.009) (-2.38) (0.49)

F = 7.745 d = 2.298 adj $R^2 = 0.3$ (10)

In equation (9) the variable *resMargp* stands for the residuals of the marginal process[10] of Δp, while *resMargy* in equation (10) refers to the marginal process of Δy. In other words we are checking that the parameters do not change, when we include expectational effects. It appears from the results in equations (9) and (10), based on the t-statistics reported below *resMargp* in equation (9) and below *resMargy* in equation (10), that the residuals from the marginal processes enter the conditional process (equation (8)) insignificantly. Hence, prices and income are weakly exogenous.

[10] Following Nell (2003), the marginal processes of Δp and Δy were proxied by regressing each on an intercept and two lags of themselves.

The concept of structural invariance focuses on the problem of possible variability in the parameters of a model generated by changes in variables. If there is no such variability in the model, it is said that the model is structural invariant. Testing for structural invariance and super exogeneity is not an easy task. Some guidance however is available. We follow Charemza and Deadman (1992) who suggest that, if there is a structural break in the conditional model, it should correspond to a structural break in the marginal model. In this case, the straightforward procedure is to test for structural breaks in both conditional and marginal processes by examining the one-step residuals (like in our figure 4.13) and to compare the eventual occurrences of structural breaks. If there are some structural breaks, it means that the parameters of the processes are not constant within the sample. If the structural breaks for the conditional and the marginal processes coincide in time, that is they appear for the same time period, it is likely that the structural break in the conditional model has been caused by variability in the parameters of the marginal model. If this is the case, the hypothesis of structural invariance (or, if weak exogeneity holds, the hypothesis of super exogeneity) can be rejected. In addition we do this knowing prices and income are weakly exogenous.

Recall that the one-step residuals (in Figure 4.16) of what we consider as our conditional model (equation (8)) demonstrated that there is no structural break. To allow for comparison, we present below the one-step residuals of the marginal processes of Δp and Δy.

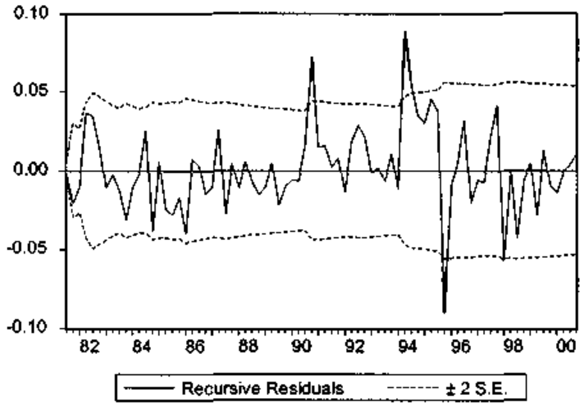

Figure 4.18 One-step recursive residuals for Δp

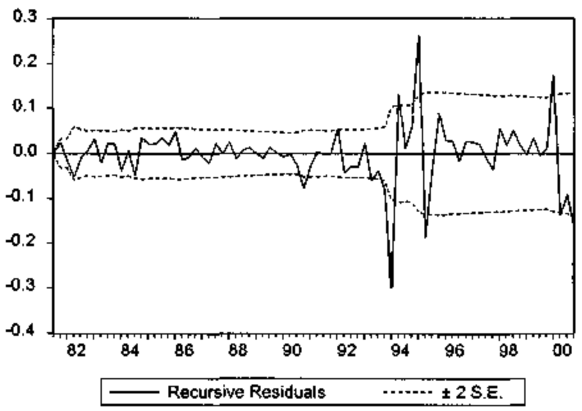

Figure 4.19 One-step recursive residuals for Δy

Figure 4.18 and 4.19 display the one-step recursive residuals for the marginal processes of Δp and Δy, respectively. Figure 4.18 shows that the marginal process of Δp displays non-constancies in 1990, 1994 and 1995; while Figure 4.19 shows that the marginal process of Δy suggests that there were non-constancies in 1990, 1994, 1995 and 2000. Based on Figure 4.18, we proxied the non-constancies in the marginal process of Δp by a dummy variable (D_3) that takes the value of one in 1990, 1994, and 1995 and zero otherwise, and perform the regression of the marginal process. We then proxied the non-constancies in the marginal process of Δy by a dummy (D_4) that takes the value of one in 1990, 1994, 1995 and 2000 and zero otherwise, and carried out the marginal regression of the marginal process of Δy. We finally perform the conditional regression of equation (8) adding to it the two dummies D_3 and D_4. The results of these three regressions are reported below, with *t*-statistics in parentheses:

$$\Delta p = 0.008 + 0.58\Delta p_{t-1} - 0.17\Delta p_{t-2} + 0.04D_3$$

(2.46) (5.2) (-1.7) (3.86)

adj R^2= 0.5 d = 2.08 (11)

$$\Delta y = -0.007 + 0.5\Delta y_{t-1} - 0.1\Delta y_{t-2} - 0.5D_4$$

(-0.8) (4.26) (-0.9) (-2.36)

adj R^2=0.3 d = 1.95 (12)

$$\Delta m2 = 0.01 + 0.34\Delta y_{t-1} + 0.8\Delta p + 0.003\Delta(RM - RO) - 0.12ecm_{t-1} + 0.007D_3 + 0.02D_4$$

(1.4) (3.65) (3.82) (0.47) (-2.33) (0.3) (0.72)

adj R^2= 0.3 d = 2.33 (13)

The salient feature of the above results is that, the dummies D_3 and D_4, respectively are statistically significant in the marginal process of Δp (in equation (11)) and the marginal process of Δy (in equation (12)). However, on the basis of the *t*-statistics, both dummies D_3 and D_4 are statistically insignificant in the conditional process in equation (13). Therefore, these observations lead us to conclude that the parameters in the conditional $\Delta m2$ equation (8) are structurally invariant to the non-constancies observed in the marginal processes and thus are super exogenous. It is worth mentioning that this finding is consistent with Hendry and Ericsson's (1991) result for the UK, MacDonald and Taylor's (1992) finding for the US, and Nell's (2003) result for South Africa. Therefore, the money stock in Rwanda is endogenous and inconsistent with the hypothesis of exogenous money determining prices through the money demand function.

4.7 Conclusion and summary of the main empirical results and their policy implications

We now conclude this chapter by concisely summarizing our main empirical results as well as their policy implications. In this study our first hypothesis (Chapter One, page five) is that, despite the implementation of the IMF and World Bank's suggested reforms, the money demand function in Rwanda is stable. The analysis in this chapter provides empirical evidence of a constant and structurally stable M2 money demand in Rwanda. On the basis of all the tests performed, namely, the recursive least squares coefficients, the one-step recursive residuals, and the scaled recursive Chow test; all these visual displays strongly suggest that M2 money demand in Rwanda is stable. In fact, the recursive least squares' estimates of our error correction model remained stable over our period of study; all the one-step recursive residuals lie within two estimated standard deviations from their mean (the error bands of $\pm 2\hat{\sigma}_t$), also suggesting that our model has not undergone any structural changes over the sample period; and all the values of the scaled recursive Chow test lie under unity implying that the null hypothesis of no structural change is accepted at the 5 *per cent* level of significance. The non-constancies observed in the marginal processes were modeled with dummies and enter statistically insignificantly the conditional process, leading us to conclude that the parameters in the conditional model are structurally invariant with respect to these non-constancies.

Prices and income were found to be super exogenous. Recall that a variable is said to be super exogenous for the parameters of interest if it is weakly exogenous for the parameters of interest, and also invariant to changes in the parameters of the marginal model (Hendry, 1995). Super exogeneity is the crucial concept for policy purposes and links to the Lucas critique. Lucas (1976) questions the appropriateness of using econometric models for policy simulation experiments by arguing that the structure of model can be altered by the impact of expectations concerning the policy. In our investigation of super exogeneity we found that prices and income were weakly exogenous and the parameters of our conditional model were invariant to changes in the parameters of the marginal process leading to the conclusion that prices and income are super exogenous. Therefore, despite empirical evidence of a constant and structurally stable M2 money demand function, our results suggest that M2 money provides little information about future price changes in Rwanda and may not be a reliable indicator for changes in monetary policy. This means that our second hypothesis in this thesis (Chapter One, page five) that changes in M2 determines changes in prices is rejected. Therefore, the money stock is endogenous and prices influence money through the stable money demand function (Nell, 2003). Since prices are super exogenous to money, the conditional money demand equation cannot be *inverted* to determine prices (Hendry, 1995). Money does not determine prices. This result confirms the wisdom of the central bank to opt for a policy of inflation targeting, as prices determine money.

Other results that are worth noting are that, $m2$ deflated by consumer prices ($m2 - p$) is I(1), suggesting that M2 money demand function may not be homogeneous of degree one in the level of prices. In other words price changes are greater than money demand changes, indicating that money is not superneutral. The coefficient (equal to 0.12) of the equilibrium error term in our error correction model is statistically significantly different from zero implying that 0.12 of the discrepancy between money demand, income, and price in the previous quarter is eliminated in the following quarter. Therefore, the speed of adjustment for money demand in Rwanda is equal to 0.12, which is considered to be low, indicating the slow adjustment of the amount of money demanded toward its long-run equilibrium value, suggesting that the Rwandan money market adjusts back to equilibrium, after a shock, in about two years for our sample.

CHAPTER FIVE

CONCLUSIONS AND POLICY IMPLICATIONS

5.1 Introduction

This thesis concerns itself with the stability of money demand in Rwanda. In Chapter One we point out that the thesis sets out to examine money demand theory, provides a brief history of monetary developments in Rwanda and for the first time estimates a money demand function for Rwanda. Chapters Two to Four did exactly this. However, to provide some context to the thesis we wanted to draw out the monetary policy implications based on the research, given that the Rwandan central bank had recently changed to a policy of inflation targeting.

5.2 Research hypotheses

In Chapter One we state that the thesis hopes to provide an answer to what we feel are the <u>two</u> most fundamental research questions in Rwanda as regards monetary policy considerations. These research questions are:

(i) Is there a stable money demand function in Rwanda, so that a monetary aggregate targeting can continue to play a role in macro economy?

(ii) Does money determine prices?

These two questions yield the following hypotheses:

(i) The demand for money function in Rwanda is stable.

(ii) Causality runs from money to prices.

For monetary aggregate targeting to be a coherent policy, we must confirm both these hypotheses.

5.3 Conclusion and future research

After giving a theoretical overview of monetary theory in Chapter Two in order to provide support for our estimated equation we covered some of the more recent developments in monetary policy in Rwanda in Chapter Three. Chapter Four is where we examine the validity of both our research hypotheses. This original empirical chapter shows that the answer to our first question is yes and there is a structurally stable M2 money demand relationship in Rwanda. All three of our tests confirm stability. Chapter Four also shows that prices are exogenous and that the answer to our second research hypothesis is no and if prices are not determined by money, then the inflation rate can be targeted. The finding that our second hypothesis is not validated suggests that inflation targeting <u>may</u> be best strategy for the central bank of Rwanda to follow. But having said that we must point out the limitations of our study. Our specification of money demand does not incorporate exchange rate considerations, and nor does it have a satisfactory variable for interest rate changes. In addition income should be measured as permanent income. There is no guarantee that real GDP measures permanent income. So before we can conclude with certainty that inflation targeting in Rwanda is based on our finding that prices are exogenous, any <u>future</u> research must correct for these shortcomings.

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APPENDICES

APPENDIX ONE: Selected Rwanda's Economic and Financial Indicators 1995-2004

(Soucre: Rwandan Ministry of Finance and Economic Planning)

Table 3. Rwanda: Selected Economic and Financial Indicators, 1995-2004

	1995	1996	1997	1998	1999	2000	2001 Est.	2002 Est.	2003 Rev Prog.	2004 Rev. Prog.	2005
					(Annual percentage changes, unless otherwise indicated)						
Output and prices											
Real GDP growth	35.2	12.7	13.8	8.9	7.6	6.0	6.7	9.4	6.0	6.2	6.2
GDP deflator	51.3	10.9	15.6	2.2	-3.5	3.3	0.2	0.0	3.2	3.7	3.5
Consumer prices (period average)	48.2	13.4	11.7	6.8	-2.4	3.9	3.4	2.0	4.5	3.0	3.0
Consumer prices (end of period)	38.4	8.7	16.6	-6.0	2.1	5.8	-0.2	6.2	3.0	3.0	3.0
External sector											
Export, f.o.b (in U.S. dollars)	56.8	22.9	50.0	-31.0	-3.3	44.7	4.0	-28%	7%	11%	8%
Imports, f.o.b (in U.S. dollars)	-47.2	9.9	30.1	-7.8	-2.7	-3.6	6.4	-2%	6%	6%	2%
Government finance											
Revenue	283.4	70.5	47.3	13.7	-3.6	7.9	25.5	17.4%	16.7%	11.5%	10.0%
Total expenditure and net lending	161.3	37.1	15.1	7.1	7.7	4.2	20.0	21%	14.6%	-3.7%	7.8%
Current expenditure	89.7	32.7	14.6	17.6	14.2	3.8	20.4	15.1%	23.1%	-10.6%	3.7%
Money and credit 1/											
Domestic credit 2/ 3/	15.3	-2.6	42.1	9.9	12.9	0.8	1.1	-4.0%	-19.1%		
Money and quasi money (M2)	73.7	8.2	47.5	-3.9	6.6	14.4	10.0	12.4%	9.0%		
Reserve money	43.1	21.5	14.6	-11.0	13.5	-6.4	9.1	12.3%	11.7%		
Velocity (ratio of GDP to M2, end of period)	5.3	6.1	5.5	6.3	6.2	5.9	5.7	5.7	5.7		
Interest rate (one-year savings deposits, in percent, end of period)	12.0	11.0	11.4	10.0	10.1	11.6	10.2	9.2			
					(In percent of GDP, unless otherwise indicated)						
Government finance											
Total revenue	6.8	9.3	10.4	10.6	9.9	9.7	11.4	12.3%	13.1%	13.2%	13.2%
Total expenditure and net lending	20.5	22.5	19.6	18.9	19.6	18.7	21.0	23.2%	24.3%	21.3%	20.9%
Capital expenditure	8.1	9.3	8.2	6.8	6.3	6.0	6.6	2.3%	4.6%	2.1%	1.4%
Current expenditure	12.4	13.2	11.5	12.1	13.3	12.6	14.2	15.0%	16.9%	13.7%	12.9%
Primary fiscal balance 4/	-3.3	-1.8	0.3	0.0	-2.2	-0.6	-0.1	-1.7%	-3.8%	0.5%	1.2%
Augmented current balance 5/	-4.5	-2.9	-0.3	-1.3	-3.8	-2.6	-2.7	-4.2%	-3.9%	-1.0%	-0.4%
Overall balance (payment order)											
Including grants	-2.4	-5.8	-2.5	-3.0	-3.8	0.1	-1.1	-2.4%	1.3%	0.7%	1.2%
Excluding grants	-13.7	-13.2	-9.2	-8.3	-9.7	-8.9	-9.5	-11.0%	-10.7%	-8.0%	-7.6%
External sector											
External current account balance											
Including official transfers	-3.0	-6.7	-9.5	-9.6	-7.4	-5.0	-5.9%	-7.3%	-10.4%	-11.0%	-10.1%
Excluding official transfers	-19.0	-19.3	-17.4	-17.0	-16.7	-16.3	-15.9%	-17.1%	-18.5%	-16.4%	-14.8%
External debt (end of period) 6/	82.2	80.4	61.6	58.3	65.3	72.1	77.3	82%	85%	77%	71%
Gross reserves (in months of imports of G&S))				4.4	4.7	5.2	6.0	6.7	8.3	8.0	7.9
Memorandum items:											
Nominal GDP (in billions of Rwanda francs) 1/	339.1	424.1	558.3	621.3	644.9	705.7	754.3	825.2	902.8	994.8	1 093.4
Nominal exchange rate (period average; per U.S. dollar)	262.2	306.5	302.4	312.3	333.9	389.7	443.0	475.4	521.0	521.0	532.6

Sources: Rwandese authorities; and staff estimates and projections.

1/ All numbers are based on current exchange rates

2/ As a percent of the beginning-of-period stock of broad money.

3/ The 2001 rates of growth assume that the excess external budgetary support at end-2000 would be used in its entirety to finance additional social expenditure during 2001.

4/ Revenue excluding grants; minus current expenditure except interest due and except exceptional social expenditure.

5/ Revenue excluding grants; minus current expenditure (excluding external interest), domestically-financed capital expenditure and net lending.

6/ After rescheduling. On a disbursed basis, including arrears, rescheduling and new debt.

7/ On a post HIPC basis and based on assumptions about expected new borrowing. HIPC assistance is assumed to be delivered unconditionally as of 1999. The exports denominator is calculated using a three-year bad

8/ Financing gap after taking into account identified financing expected during the course of the year.

CPI	72.95763	82.7587	92.43243	98.75694	96.24562	100	103.3655	105.432825	110.177302	113.482621	116.8871

APPENDIX TWO: Poverty monitoring indicators in Rwanda

Item	2001 baseline	2002	2003	Source
Health/Nutrition				
Infant Mortality Rate/1000	**107**	107	95	DHS
➢ Vaccination/100	**77**	85	90	SIS
➢ Malnutrition<5ans	**29**	25	-	SIS
Maternal Mortality Ratio/100,000	1071	1071	950	DHS
➢ Births attended by qualified personnel				
➢ Rate of contraceptive use	31%	33%	35%	SIS
➢ Rate of antenatal care	7%	8%	9%	
	30%	35%	45%	
HIV/AIDS Incidence rate				DHS & SIS
➢ Use of condom	11.2	13.5	10.5	SIS
➢ Rate of STD's cases	-	5%	-	SIS
	16,2%	17%	16%	SIS
Malaria				SIS
➢ Use of mosquito nets				SIS
➢ Malaria new cases/100.000	10%	13%	16%	SIS/PNIL
	13,175	14,175	-	SIS/PNILP
Rate of use of health services				
➢ Distance to health centre				
➢ Population /doctor	4,000m	4,000m	4,000m	SIS
➢ Population/Nurse	55,000	50,000	45,000	DHS
➢ Access to mutuelles	5,500	5,000	4,500	DHS
	15%	20%	25%	DHS
Quality of health services				
➢ Annual rate of consultation/population				
➢ nurses/health centre			-	DHS
	0.24	0.28	0.30	DHS
	2	2	3	SIS
Education				
Literacy rate	52.36%	-	-	EICV
Female	47.79%	-	-	
Men	58.06%	-	-	
Level of instruction of the population				
Primary schools				
Gross Enrolment rate	99.9%	103.7%	108.9%	MINEDUC
Girls	98.2%	102.3%	108.0%	
Boys	101.9%	105.8%	109.9%	
Net Enrolment rate	73.3%	74.9%	82%	MINEDUC
Girls	74.9%	74.9%	82.3%	
Boys	72.9	74.0%	80.9%	
Drop-out rate	14,2%	16.6%	-	MINEDUC
Repetition rate	31.8%	17.2%	-	
Promotion rate	54,0%	66,2%	-	
Transition rate from primary to secondary				
	37,0%	-	-	
Ratio Pupils/qualified teacher				
Ratio Pupils/teacher	82	72.6	70.3	MINEDUC

C

Item	2001 baseline	2002	2003	Source
Secondary schools	51	58,9	59,9	
Gross Enrolment rate				
Female	141,163	157,210	-	MINEDUC
Male	50,22%	49,48%	-	
	49,78%	50,52%	-	
Ratio students/ qualified teacher	52.1	47.8	-	
Ratio students/ teacher	24,8	22,8	-	
Income/Consumption Poverty				
Poverty incidence rate	64.1%	-	-	EICV
Unemployment rate	-	-	-	
Agricultural and productivity				
Maize				
• Production (tons)	92,129	91,673	81,195	MINAGRI
• Acreage (ha)	89,053	11,864	13,864	
• Productivity per ha	1.03	7.72	5.86	CPI
• Average market price	77	55	-	
Rice				
• Production (tons)	17,697	22,032	26,943	MINAGRI
• Acreage (ha)	4,275	5,455	5,955	
• Productivity per ha	4.14	4.04	4.52	
• Average market price	276	236	-	CPI
•				
Soya				
• Production (tons)	6,584	17,278	19,487	MINAGRI
• Acreage (ha)	29,543	31,416	32,416	
• Productivity per ha	0.22	0.55	0.60	
• Average market price	133	-	-	
Beans	289,983	246,827	249,117	MINAGRI
• Production (tons)	333,205	381,598	-	
• Acreage (ha)	0.87	0.65	-	
• Productivity per ha	93	80	-	CPI
• Average market price				
Irish potatoes	988,982	1,038,858	1,121,466	MINAGRI
• Production (tons)	108,983	119,017	-	
• Acreage (ha)	9.07	8.73	-	
• Productivity per ha	41	37	-	CPI
• Average market price				
Coffee				
• Production (tons)	18,267.7	19,4670	-	MINAGRI
• Acreage (ha)	-	-	-	
• Productivity per ha	-	-	-	
• Average market price	209	-	-	
Tea				
• Production (tons)	17,817,480	14,947,973	-	MINAGRI
• Acreage (ha)	-	-	-	
• Productivity per ha	-	-	-	
• Average market price	732	-	-	
Imported fertiliser volume(tons)	13,000	-	-	MINAGRI
Meat (tons)	35,748	39,126	-	
• Average market price per kilo	596	-	-	
Milk (tons)	63,484	97,981	-	
• Average market price per litter	228	-	-	
Eggs(tons)	7,308	7,612	-	
• Average market price per unit	37	-		
Insemination artificial (cattle)	9,325	5,721	-	
Food aid needs forecast (1,000 t cereal-equivalent)	36	197	-	

Item	2001 baseline	2002	2003	Source
Cattle	814,124	960,450	-	
Small livestock	1,3080,3873	1,428,168	-	
Poultry and rabbits	1,550,934	2,921,078	-	
Housing and settlements				
Population with Access to Safe Water	41.2	-		RDI
Population with Access to hygienic facilities	87.2	-		RDI
Employment/Wages				
Wage Rate of Casual Labor (On-Farm)	-	-	-	
Active population	62.5	-	-	
Public Expenditure Data (Health and Education)				RDI & MINECOFIN
Health % of Total Gov Expenditure	0..5	-	-	
% ∑ budget	3.6	-	-	
Education % of GDP	3.5	-	-	
% ∑ budget	17.4	-	-	

Source: Rwandan Ministry of Finance and Economic Planning

APPENDIX THREE: Data

Year	quarter	M1	Quasi-Money	M2	GDP const.95	CPI	RM	RO
1980	I	10373.00	2891.00	13264.00	37212.60	83.00	13.50	7.25
	II	11336.10	3079.80	14415.90	37960.10	84.78	13.50	7.25
	III	11778.10	3268.80	15046.90	38601.30	85.02	13.50	7.25
	IV	12009.30	3199.80	15209.10	39194.60	86.96	13.50	7.25
1981	I	11211.40	3243.10	14454.50	39680.30	87.62	13.50	7.25
	II	12841.40	3265.30	16106.70	40116.60	90.30	13.50	7.25
	III	13656.10	3568.50	17224.60	40444.50	91.76	13.50	7.25
	IV	13393.70	3335.10	16728.80	40726.10	91.20	13.50	7.25
1982	I	10681.30	4341.70	15023.00	40428.10	93.25	13.50	7.25
	II	12394.80	4218.20	16613.00	40742.30	100.55	13.50	7.25
	III	11893.90	4676.50	16570.40	41131.80	106.13	13.50	7.25
	IV	11442.20	4712.20	16154.40	41664.00	107.67	13.50	7.25
1983	I	10412.50	4834.60	15247.10	43251.20	106.56	13.50	7.25
	II	12671.30	4765.30	17436.60	43608.20	107.62	13.50	7.25
	III	12764.70	5020.20	17784.90	43654.20	110.30	13.50	7.25
	IV	12294.40	5759.20	18053.60	43452.40	110.05	13.50	7.25
1984	I	11293.10	5979.00	17272.10	41605.80	109.62	13.50	7.25
	II	13541.60	6176.10	19717.70	41376.00	111.51	13.50	7.25
	III	13340.10	6996.70	20336.80	41358.60	118.11	14.00	7.25
	IV	13332.30	6548.80	19881.10	41625.60	117.98	14.00	7.25
1985	I	12559.60	6578.00	19137.60	42693.80	117.48	14.00	7.25
	II	15044.00	7560.60	22604.60	43226.20	116.98	14.00	7.25
	III	14493.50	8121.30	22614.80	43740.00	115.87	14.00	7.25
	IV	14576.70	8730.90	23307.60	44304.30	115.47	14.00	7.25
1986	I	13565.10	8391.10	21956.20	45241.20	112.59	14.00	7.25
	II	16715.70	8200.90	24916.60	45678.90	113.49	14.00	7.25
	III	16404.60	9078.40	25483.00	45942.30	116.63	14.00	7.25
	IV	17205.60	9273.60	26479.20	46101.00	117.41	14.00	7.25
1987	I	15138.40	10138.30	25276.70	45418.10	116.82	14.00	7.25
	II	17846.20	10459.90	28306.10	45562.80	120.78	14.00	5.00
	III	18363.30	11028.50	29391.80	45794.10	120.67	12.00	5.00
	IV	17668.60	11548.50	29217.10	46187.60	121.37	12.00	5.00
1988	I	16298.30	12223.00	28521.30	47294.90	121.75	12.00	5.00
	II	18670.20	12950.20	31620.40	47686.80	123.81	12.00	5.00
	III	17802.00	13347.80	31149.80	47918.10	124.96	12.00	5.00
	IV	18210.40	13158.80	31369.20	48062.00	124.27	12.00	5.00
1989	I	16460.90	14185.50	30646.40	47887.70	123.77	12.00	5.00
	II	17968.40	14295.90	32264.30	47843.60	125.70	12.00	5.00
	III	16473.50	13264.00	29737.50	47699.70	125.08	12.00	5.00
	IV	15930.30	14133.70	30064.00	47531.20	124.36	12.00	5.00
1990	I	15591.60	14367.70	29959.30	47145.30	124.72	12.00	5.00
	II	17191.40	14507.00	31698.40	46898.60	125.41	12.00	5.00

	III	15838.90	14694.00	30532.90	46598.70	128.75	12.00	5.00
	IV	16723.70	15020.00	31743.70	46320.50	141.00	16.67	10.00
1991	I	16447.50	14516.60	30964.10	45323.10	149.96	19.00	12.00
	II	19014.10	14603.20	33617.30	45282.10	154.90	19.00	12.00
	III	18665.50	15473.10	34138.60	45450.60	157.13	19.00	12.00
	IV	18023.10	15479.70	33502.80	45906.70	159.88	19.00	12.00
1992	I	18644.80	14668.90	33313.70	48258.40	160.29	19.00	12.00
	II	20593.70	15126.30	35720.00	48537.50	164.44	16.33	11.00
	III	22345.10	15892.00	38237.10	48363.30	173.21	15.00	9.00
	IV	22508.90	15161.70	37670.60	47803.80	182.92	15.00	9.00
1993	I	22438.10	15310.90	37749.00	48593.10	187.93	15.00	9.00
	II	24028.80	14941.60	38970.40	46459.00	190.59	15.00	9.00
	III	24916.00	15330.90	40246.90	43163.70	191.60	15.00	9.00
	IV	24919.40	13701.30	38620.70	38757.70	195.62	15.00	9.00
1994	I	23290.04	14604.59	37894.63	25665.70	197.62	15.00	9.00
	II	22852.19	14330.02	37182.21	22001.10	218.63	15.00	9.00
	III	22422.57	14060.62	36483.19	20142.60	248.08	15.00	9.00
	IV	28067.90	8375.40	36443.30	20170.00	277.53	15.00	9.00
1995	I	29965.60	9829.50	39795.10	27108.40	306.98	15.27	10.04
	II	34220.00	15522.80	49742.80	28818.40	345.72	16.49	12.06
	III	39748.30	19518.20	59266.50	30338.40	395.55	17.94	12.04
	IV	40257.10	22387.70	62644.80	31709.30	400.87	17.95	12.12
1996	I	39886.70	22244.40	62131.10	32495.20	396.24	18.30	9.00
	II	42633.90	20932.40	63566.30	33678.70	397.09	18.23	9.36
	III	44305.80	22234.40	66540.20	34821.30	415.69	18.06	9.43
	IV	45831.00	23049.70	68880.70	35975.60	426.68	18.44	11.26
1997	I	48416.70	25720.90	74137.60	37204.70	433.68	16.55	8.39
	II	53079.60	31209.20	84288.80	38280.20	438.29	16.13	9.07
	III	52078.90	29030.60	81109.50	39264.90	454.87	17.31	8.52
	IV	56833.20	33330.30	90163.50	40217.80	492.21	16.22	8.24
1998	I	49267.20	37874.90	87142.10	41078.10	495.79	16.04	9.94
	II	53776.90	30254.50	84031.40	41905.40	496.86	15.87	9.21
	III	48530.40	37478.20	86008.60	42638.70	481.47	14.88	9.16
	IV	52877.50	39107.00	91984.50	43343.00	471.99	17.13	7.76
1999	I	51023.80	41355.50	92379.30	43795.10	474.42	15.88	7.91
	II	56578.70	36901.90	93480.60	44437.00	469.01	16.10	9.19
	III	57741.30	40608.07	98350.00	45044.10	475.05	16.32	8.53
	IV	58524.00	39532.20	98056.20	45687.00	480.71	16.84	8.75
2000	I	57119.80	39235.20	96355.00	54094.90	481.70	15.59	9.20
	II	57878.00	44349.50	102227.50	51593.60	485.65	16.85	9.44
	III	54857.20	45052.90	99910.10	45990.90	494.83	16.43	9.41
	IV	60281.50	51108.40	111389.90	37301.70	511.09	16.99	10.11

Source: National Bank of Rwanda (Department of statistics)