

**THE DEMAND FOR BROAD MONEY (M2) IN BOTSWANA**

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## ABSTRACT

There has been extensive theoretical and empirical research on the subject of demand for money function. This particularly stems from the important role demand for money plays in macroeconomic analysis, especially in the design and implementation of monetary policy. The increase in studies, especially in developing countries, can also be attributed to a number of factors like: the impact of moving towards flexible exchange rate regimes, globalisation of financial markets, ongoing financial liberalisation, innovations in domestic financial products, the advancement in econometrics techniques and other country-specific events.

This study estimates and examines the nature and stability of the demand for broad money (M2) in Botswana. This is particularly important in that the usefulness of a money demand function in the conduct of monetary policy depends crucially on its stability. The stability of the money demand function is crucial in that a stable money demand function would mean that the quantity of money is predictably related to a set of key economic variables linking money and the real economic sector. Therefore, this will help central banks to select appropriate monetary policy actions. Based on the findings, the study also proposes policy interventions.

The vast majority of the literature on demand for money has underscored the fact that variable selection and representation, and the framework chosen are the two major issues relevant to modelling and estimation of the demand for money function. In modelling and estimating the demand for money function in Botswana, this study surveys a stream of theoretical and empirical literature on money demand in developed and developing countries, including countries that have similar financial sector similar to Botswana. Due consideration is also given to the macroeconomic and financial sector development in Botswana to help in the identification of the variables that are included in the demand for money equation. Most importantly, this helped in getting meaningful results that are free from theoretical and estimation problems.

In particular, this study applied the multivariate cointegration approach as proposed by Johansen (1988) and Johansen and Juselius (1990) to estimate the relationship

between broad money (M2), real income, interest rate, South African treasury bill rate, inflation rate and US dollar/pula bilateral exchange rate. The study obtains one unique long run relationship between money and the scale and opportunity cost variables. The coefficients of the long run relationship are then modelled along the general to specific approach as proposed by Campos, Ericsson and Hendry (2005). In this type of approach the general model is reduced by sequential elimination of statistically insignificant variables and checking the validity of the reductions at every stage to ensure congruence of the finally selected parsimonious model.

In accordance with the economic quantity theory of money, the long run income elasticity obtained is 0.8021, which is close to the value one (unitary) suggested by economic theory. The coefficients of real income, exchange and inflation rate have the expected positive signs and were significant in the long run. Therefore, the long run demand for money (M2) in Botswana was found to be positively affected by real income, inflation rate and exchange rate. The lack of statistical significant of the own rate of money (88 day commercial bank deposit rate) and the foreign opportunity cost variable (South African Treasury bill rate) is attributed to multi-collinearity problems between these two interest rates. This could be caused by the fact that short term rates in Botswana are very responsive to movements in the money markets rates in South Africa.

The short run dynamics of the demand for money function shows the slow speed of adjustment to equilibrium of about 2.9 percent in the first quarter and this is reflective of the lack of sufficient availability of banking services and the low returns on financial assets which could allow economic agents to re-establish equilibrium levels of money holdings faster. The final parsimonious model obtained clearly reflects a well specified stable demand for money function. Therefore, based on the findings we can be precise in stating that targeting a monetary aggregate can be a viable policy for the monetary authorities in Botswana.

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## CHAPTER ONE

# INTRODUCTION

### 1.1 BACKGROUND AND CONTEXT OF THE STUDY

The demand for money function represents one of the most valuable aspects of the monetary process in a market economy. The demand for money reflects the degree of willingness to possess money by economic entities/agents (Mankiw, 1997: 476).

The appropriate money demand function indicates (1) whether there are alternative assets available in the economy to hold money; (2) how liquid the money and capital markets are; (3) whether the interest rates are controlled by the authorities or determined by market forces; (4) how fast financial innovation is taking place in the economy; and (5) whether a country can influence the exchange rates (Gurley and Shaw, 1960: 179-190).

The money demand function links money and other real economic variables and it plays an important role in the decision making process of central banks in dealing with monetary and exchange rate policies. It plays a major role in macroeconomic analysis, especially in selecting appropriate monetary policy actions. Central banks in many countries rely mainly on a money demand function as a means to identify medium-term growth targets for the money supply and manipulate interest rates and reserve money to control liquidity in the economy (Treichel, 1997: 4).

The money demand function has an important role in the transmission of monetary policy and this is especially true where the monetary transmission mechanisms are deregulated.<sup>1</sup> The deregulated monetary transmission mechanisms allow authorities to place greater reliance on market forces and this improves the effectiveness of

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<sup>1</sup> Transmission mechanism of monetary policy is a term used to describe the various routes via which changes in Central Bank monetary policy affect output and prices.

monetary policy. When the transmission mechanisms are deregulated, it means that more market based instruments have been introduced and enhanced in the conduct of monetary policy. Therefore, the money demand function importance becomes implicit in that it helps in the identification of these instruments in the economy.

The usefulness of a money demand function in the conduct of monetary policy depends crucially on its stability.<sup>2</sup> A stable money demand function forms the core in the formulation and conduct of monetary policy. It enables a policy driven change in monetary aggregates to have forecastable influence on output, interest rates and prices (Sriram, 1999a: 3). The issue of the stability of the demand for money is also crucial for our understanding of the monetary policy transmission mechanisms (Laumas and Mehra, 1976: 463). It is crucial because a stable demand for money function means that the quantity of money is predictably related to a set of key variables linking money to the real sector of the economy. Therefore, this helps us to select appropriate monetary policy actions. The evaluation of the stability of demand for money function makes it possible for central banks to modify their monetary policy instruments to ensure an effective control of the monetary base (Treichel, 1997: 25).

The absence of a stable money demand function can lead to monetary policies which are inconsistent with developments in the real aggregate economy and wrong interest rates targets. The targeted monetary aggregates might not then be an appropriate reflection of the total liquidity in the economy. Therefore, it is important to have knowledge of the factors that affect the demand for money in order to ascertain that a stable relationship exists between these factors and money stock. Money demand serves as a conduit in the transmission mechanism for monetary policy. Hence, the stability of the money demand function is critical if monetary policy is to have predictable effects on inflation and real output (Treichel, 1997: 6).

In view of the importance of money demand function and its stability, numerous theoretical and empirical studies have been conducted in developed and developing countries to evaluate the determinants and the stability of the money demand function.

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<sup>2</sup> Stability refers to the actual behaviour of the parameter overtime or the uncertainty associated with the changes in the values of the parameter over time. A parameter is stable if it is constant over time or if the changes in the parameter are known with certainty (Aziakpono, 2000: 142, Laumas and Mehra, 1976: 464).

The majority of the studies on money demand functions have been confined to industrial countries. However, studies carried out in developing countries have been increasing in recent years. This increase in studies has been attributed to the concern about the impact of moving towards flexible exchange rate regimes, globalisation of capital markets, ongoing financial liberalisation, financial innovations in domestic markets, emergence of new financial assets and country specific events on money demand like political transformation and lifting of sanctions in South Africa (Sriram, 1999a: 4, Jonsson, 1999: 4, Bossogo-Egoume, 2000: 6). These developments in the financial sector could affect the instability of the money demand function.

In Botswana, before the late 1980s, the financial sector was not well developed and not diversified. It had a limited range of financial instruments and the central bank exercised a considerable degree of direct control over financial operations (Bank of Botswana, 2001: 66). It was only during the late 1980s that a number of financial reforms took place and much financial development also occurred. In 1986, the controls on maximum lending and minimum deposits rates were removed. In 1989 the stock exchange was established and it made available alternative investment instruments. In 1990 there was the liberalisation of commercial bank licensing requirements and the Bank of Botswana certificates were introduced in 1991. Removal of all foreign exchange controls happened in 1999. In 2000 the International Financial Services Centre was introduced (Bank of Botswana, 2001: 75). The introduction of Botswana government bonds for the first time in Botswana in 2003, was a historic moment in the country's financial markets (Bank of Botswana, 2003: 64). Against the background of these financial sector reforms in Botswana it is appropriate to estimate and examine the stability of money demand function in Botswana to assist in the formulation and execution of monetary policy.

Some notable work on money demand function in Botswana was done by Kganetsano (2001) and Mosweu (2003). Kganetsano (2001) estimated the demand for money function using the Engle-Granger procedure. However, one major drawback of the Engle-Granger technique and the single equation dynamic model is that they inherently assume the existence of one cointegrating vector even though there may be more than one (Brooks, 2002: 394). If there is more than one cointegration relationship, then adopting a single equation approach is inefficient in that we can

only obtain a linear combination of these vectors. It cannot estimate all the long run relationships validly (Harris, 1995: 6). The Engle-Granger technique also has low power in estimation due to the usual finite sample problem of a lack of power in the unit root and cointegration tests (Brooks, 2002: 395). The other disadvantage of this technique is that there could be a simultaneous equation bias if the causality between variables, say  $y$  and  $x$ , runs in both directions. The researcher is forced to treat  $y$  and  $x$  asymmetrically, even though there may have been no theoretical reason to do so.

The other study is by Mosweu (2003), who estimated the demand for narrow money (M1) using the Johansen (1988, 1991 and 1995) procedure with an annual data sample of twenty seven (27) from 1975 to 2002. Since the Johansen procedure has been found to be sensitive to small samples, his observations may be susceptible to the small sample bias of over rejecting the null hypothesis when it is in fact true. He also used annual data which often loses seasonality. Consequently impulse responses may take longer to converge towards the steady state because the effects that are less than one year cannot be derived (Wang and Dunne: 2000: 6). The use of narrow definition (M1) has also been criticised as it does not capture and reflect the developments in the financial system as do broad money definitions such as M2 (Sriram, 1999b: 7). Broad money (M2) also captures long run economic impacts of the change in monetary policy better than narrow money. Against the backdrop of the weaknesses of these studies, the current study uses a better approach as proposed by Johansen (1988) and Johansen and Juselius (1990).

## **1.2 OBJECTIVES OF THE STUDY**

The main goals of the research are as follows:

1. To estimate the demand for broad money (M2) in Botswana.
2. To examine the stability of the demand for broad money (M2) function in Botswana.
3. To propose policy measures based on the findings of the study.

### **1.3 OUTLINE OF THE STUDY**

This study consists of six chapters. The remaining part of the thesis is organised as follows:

Chapter two provides the theoretical and empirical literature on demand for money. The theoretical literature reviews the relevant theories of demand for money. The empirical literature looks extensively at the studies done in developed and developing countries, especially in Africa. It also reviews some existing work done on Botswana. Chapter three provides an overview of the economy of Botswana and the macroeconomic environment that might influence the choice of variables and model specification. Chapter four discusses the model, the variables and other specification issues of demand for money function. This chapter also includes comprehensive estimation techniques to be applied in the study. Chapter five presents and discusses the empirical results and data characteristics. Chapter six provides a summary of findings and their policy implications as well as recommendations and suggestions for further research.

## CHAPTER 2

# LITERATURE REVIEW

### 2.1 INTRODUCTION

This chapter presents the various theories and empirical studies on money demand. The first part of the chapter deals with the theoretical literature and the second reviews the numerous empirical researches on money demand, both in developed and developing countries, including Botswana.

### 2.2 THEORETICAL LITERATURE REVIEW

There is a diverse spectrum of money demand theories which address a broad range of hypotheses. These theories bring forward the relationship between the quantity of money demanded and a set of economic variables. The monetary relationships found in the demand for money function are a result of a long process of theoretical development. This theoretical development is based on the evolution of the definition and functions of money. Money is defined as the medium of exchange and the standard unit in which prices and debts are expressed (Ritter *et al.*, 1997: 7). It serves basically four functions: medium of exchange, store of value, unit of account and source of deferred payment (Laidler, 1969: 39-62, Wesche, 1996: 2). Demand for money is the demand for real money balances; it is the amount of real cash balances that economic entities are willing to hold at any specific time.

The theoretical development on money demand, from the classical to the post-Keynesian economists, used the four major functions of money to formulate their theories of money (Teigen, 1971: 74). The main theories that explain the study of demand for money are: the classical quantity theory of money (which is explained by the Fisher's equation of exchange and the Cambridge approach); the Keynesian theory which explains the three motives for holding money, namely transactions,

precautionary and speculative motives; the post-Keynesian theories of money demand, being the inventory-theoretic approach, precautionary demand for money approach, money as an asset approach (Buffer stock models) and consumer demand theory approach. The sections that follow discuss these theories, starting with the quantity theory of money, then the Keynesian theory and lastly the post-Keynesian theories.

### **2.2.1 Quantity theory of money**

The quantity theory of money owes its origins to the classical theory, which states that all markets for goods continuously clear and relative prices adjust flexibly to ensure that equilibrium is reached. Therefore, the economy is assumed to be always at full employment levels, except for temporary deviations caused by real disturbances, and the role of money is simply to serve as the unit to express prices and values. Money facilitates the exchange of goods and services and its use satisfies double coincidence of wants, that is, it acts as medium of exchange. Money is neutral; it does not influence the determination of relative goods prices, real interest rates and aggregate real income. The role of money as a store of value is regarded as limited under the classical assumption of perfect information and negligible transaction costs. The classical economists, however, recognized that some particular quantity of real money holdings would be needed by the economic entities under certain special circumstances. This therefore led to the formulation of the quantity theory of money.

The quantity theory of money explains the role of money as a medium of exchange. In this classical work, it is stated that money affects nothing but the price level (Ritter *et al.*, 1997: 404). The quantity theory postulates a direct and proportional relationship between the quantity of money and the price level. The theory has two alternative but equivalent expressions. The first version is the “the equation of exchange” associated with Irving Fisher (1911, in Laidler, 1969: 43)<sup>3</sup> and the second is the “Cambridge approach”<sup>4</sup> or cash balance approach. Both versions view money as a means of exchange and propose models of the transactions demand for money.

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<sup>3</sup> Yale University, American economist

<sup>4</sup> For detailed explanation on the origins of this approach see (Sriram, 1999b: 6).

The equation of exchange stresses the concept of transactions velocity of circulation of money. This shows the average number of times a unit of money is used in carrying out transactions in a given period. This well known equation of exchange as formulated by Irving Fisher (1911, in Laidler, 1969: 44) is stated as:

$$M_s V_T = PT \quad (2.1)$$

Where

$M_s$  is the quantity of money in circulation

$V_T$  is the velocity of circulation or rate of turnover

$P$  is the price level and

$T$  is the volume or number of transactions (Laidler, 1969: 44).

The equation of exchange says that total spending ( $MV$ ) equals what is bought ( $PT$ ) (Ritter *et al.*, 1997: 405). It is an equilibrium condition which shows that money is held simply to facilitate transactions and has no intrinsic satisfaction.

In the equation of exchange  $M_s$  is the active variable.  $V_T$  and  $T$  are taken as constants; therefore changes in  $P$  result from changes in  $M_s$ . The money supply causes the price level to change. The variable  $V_T$  takes cognizance of the technological factors and the institutional arrangements of the monetary system and is assumed to be constant in the short run.  $M_s$  and  $T$  are assumed to be determined independently. Therefore, at equilibrium, the equation can be written as:

$$\bar{M}_s \bar{V}_T = P\bar{T} \quad (2.2)$$

Where bars over  $M_s$ ,  $V_T$  and  $T$  show that the variables are independently determined. By treating  $\bar{M}_s$  as exogenous and having  $\bar{V}_T$  and  $\bar{T}$  as constants, the price level will vary in direct proportion to the quantity of money. Fisher's approach simply postulates that the demand for money arises as a result of individual's need to

trade with one another. It leads directly to the macroeconomic theory of the demand for money.

The limitation of the Fisher approach is that velocity is not fixed even in the short run it is unstable. It is, therefore, not independent of changes in money supply. In the real world, changes in money supply are not wholly absorbed by changes in price level (Day, 1958: 252). This approach also fails because empirical evidence does not often support the direct and proportional relationship between money supply and the price level. An example is in the case of economic depression.

An alternative version of the equation of exchange is the Cambridge approach, also known as the “cash balance approach”. This alternative paradigm does not link the amount of money holding to total transactions in the economy, contrary to the Fisher approach. It rather looks at what determines the amount of money an individual would wish to hold given the fact that the desire to undertake transactions makes money holding desirable. The approach relates the quantity of money to nominal income and emphasizes the importance and role of money demand in determining the effects of money supply on the price level (Laidler, 1969: 47-50).

The Cambridge approach is different to Fisher’s equation of exchange in three ways. First, it introduces choice making behaviour of individuals rather than market equilibrium. Fisher’s approach looks at what determines the amount of money an economy needs to carry out given volume of transactions, whereas the Cambridge approach looks at what determines the amount of money an individual agent will wish to hold given the desire to conduct transactions. Secondly, in the Cambridge approach, money is held as part of total assets for the services that it provides. It is a store of value; its demand is a function of wealth. In the Fisher approach, it is only viewed as a medium of exchange. Lastly, Cambridge economists point out the role of wealth<sup>5</sup> and opportunity cost<sup>6</sup> in determining the demand for money (Laidler, 1969: 50).

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<sup>5</sup> An individual cannot hold all the money he might want, if only because his stock of cash balances cannot exceed his total wealth (balance sheet). This is a constraint upon his money holding (Laidler, 1969: 48)

<sup>6</sup> Represented by interest rate.

The formalised Cambridge approach model is as follows:

$$M_d = kPY \quad (2.3)$$

Where

$M_d$  is the demand for money in nominal terms

$PY$  is the nominal level of income

$k$  is the fraction of spending that people have and own in the form of money balances.

When all other things are equal,  $M_d$  is proportional to the nominal level of income ( $PY$ ) for each individual. The variable  $k$  might depend on other variables depending on individual choice or taste such as interest rate (opportunity cost) and wealth. If there is money market equilibrium, that is  $\bar{M}_s V = PY$  we can obtain

$M_s * \left(\frac{1}{k}\right) = \bar{M}_s V = PY$ . Since in equilibrium  $M = M_s = M_d$  we then can have  $MV = PY$ , that is, an equivalent expression to quantity theory formulation.

The variable  $V$  in this expression represents the income velocity of circulation and is determined by the institutional and technological factors, unlike in Fisher's approach.<sup>7</sup> Increases in quantity of money result in a proportional increase in  $P$  at full employment level, assuming real income  $Y$  and  $V$  are fixed. This notable emphasis of the demand for real money balances in determining the equilibrium price level with a given quantity of money by the Cambridge approach influenced the Keynesian and post-Keynesian theories that were formulated after the classical quantity theory.

The important properties of this theory are that it accepts that money is a medium of exchange and can be held for transaction purposes, it recognizes the store of value functions and successfully draws attention to the possible effects of interest rates and expectation on demand for money (Laidler, 1969: 39-62). The theory also redirected

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<sup>7</sup> Where it represents transactions velocity.

the thinking of earlier theory from the aggregate economic factors to the individual's choice making behaviour. The theory, however, fails to explicitly treat interest rates as the determining factor for demand for money rather, interest rates are implied in the optimizing behavior of individuals.

Apart from the equation of exchange and the Cambridge approach to the discussion of factors affecting demand for money, the neoclassical economists suggested, a variety of factors that are thought to affect the demand for money. They suggested among others: the uncertainty about the future, anticipated inflation (postulated to be negatively related to money demand), wealth (balance sheet) constraint. Interest rates were only identified as a determinant of opportunity cost of holding money and their role was never explicitly stated until the emergence of the Keynesian liquidity preference theory. The Keynesian theory, as discussed below, emphasized the significance of interest rate sensitivity of demand for money.

### **2.2.2 Keynesian theory of money demand**

Keynes (1930 and 1936, in Teigen, 1971: 79) modified earlier theory by analyzing money in terms of 'money held', and not 'money in motion' and focused on the reasons that lead people to hold money. In his arguments Keynes stated that individuals hold money for three motives: transactions, precautionary, and speculative.

The transactions motive is similar to Fisher's and the Cambridge approaches. It agrees that money is there for the services it provides and to the extent that  $M_d = f(Y)$  is a certain proportion of income. There is a stable relationship between the level of income and money demanded for transaction purposes. Individuals at any particular time hold sufficient funds to bridge the gap between non-receipts and payments. Individuals are uncertain about the payments they may want or make and they will hold money to guard against the unexpected (Teigen, 1971: 79). This precautionary motive, to guard against unplanned expenses, also creates the demand for money. This is because money serves as a medium of exchange in this motive and the amount of money demanded will obviously depend on the level of income. Therefore, the

precautionary demand for money provides an emergency plan for unforeseen expenses.

Keynes also postulated that individuals will hold money in order to speculate or for the purpose of investment. This speculative motive shows Keynes's significant contribution to the theory of money demand. Keynes, however, focused on one variable, the future level of the interest rate, especially the future yield on bonds (Teigen, 1971: 78). According to Keynes, bonds were the alternative assets to holding money. Money provides zero interest, whereas bonds provide interest income and capital gain. The analysis of speculative motive depends on expectation in the movements of future interest rates. When interest rates rise, the price of a bond falls. Therefore, if individuals expect interest rates to rise, they expect the price of the bond to fall and hence suffer a negative capital gain. Money and bonds are considered perfect substitutes, according to this theory. Individuals can hold their wealth either in money or in bonds. The price individuals are willing to pay to acquire bonds depends on the rate of interest that will be earned. The introduction of interest rate in the money demand by Keynes led to the function being represented as follows:

$$M_d = f(y, i) \tag{2.4}$$

Where

$M_d$  is the demand for real money balances

$y$  is real income

$i$  is the interest rate.

The above equation shows that demand for money is a function of interest rates and income. According to Keynes, low interest rates will lead to high money demand because people will prefer to hold money and expect interest rates to increase, hence if there is a decrease in the price of bonds and no one would want to hold bonds (Ritter *et al.*, 1997: 441). The theory simply states that there is a negative relationship between money demand and interest rates. Interest rates determine the allocation between money and bonds. When interest rates are very low, individuals in the economy will expect interest rates to go up in the future, and hence, prefer to hold

money in whatever quantities supplied. The link between interest rate ( $i$ ) and income ( $y$ ) is obtained through the negative relationship between bond prices and interest rates. However, when the economy is in the liquidity trap, that is, the flat portion of money demand function, the interest elasticity of money demand can be infinite (Sriram, 1999a: 9).

According to the Keynesian theory, how much money to keep for transaction, precautionary and speculative motives is determined by the level of income and most importantly the interest rate? His main empirical legacy in this area was the introduction of interest rates into the demand for money, primarily via the speculative motive. Keynes's conclusion that the demand for money is related not only to income but to the interest rates is a major departure from Fisher's quantity theory of money, in which interest rates have no effect on the demand for money, but it is less of a departure from the Cambridge approach, which did not rule out the possible effects of interest rates (Mishkin, 1997: 537). However, the classical Cambridge economists did not explore the explicit effects of interest rates on the demand for money. The contribution by Keynes about the effects of level of income and interest rate on money demand led to the formulation of other theories which emphasized the three motives of holding money, namely: transactions, speculation and precaution. These theories are discussed in the section that follows.

### **2.2.3 The Post-Keynesian theories of money demand**

The post-Keynesian theories are a result of mainly two characteristics of money, the medium of exchange and store of value functions. The role of money as a medium of exchange leads to transactions models of which inventory models assume a known level of transactions and certainty and the precautionary demand models that treat net inflows as uncertain. The store of value role leads to portfolio models where money is regarded as being part of the portfolio of assets held by an individual. Therefore, these two functions of money lead to postulation of theories that are based on motives for holding money.

There are, however, other post-Keynesian theories that completely ignore the three motives and analyze the demand for money in a consumer demand theory approach. They assume though that people do hold money. The most common characteristics of the post-Keynesian theories of money demand is that they attempt to reformulate the simple Keynesian demand for money function in such a way as to make empirical testing more meaningful. The following sub-sections discuss the main features of these post-Keynesian approaches, namely: the inventory-theoretic, precautionary demand for money, money as an asset (buffer stock) and the consumer demand theory.

### **2.2.3.1 Inventory–theoretic approach**

The inventory-theoretic approach associated with Baumol (1952, in Mankiw, 1997: 486) and Tobin (1956, in Mankiw, 1997: 486) analyses the costs and benefits of holding money. Money is viewed as an inventory held to make transactions. The inventory-theoretic models assume that there exist two stores of value: money and interest bearing alternative assets. It is also assumed that there is a cost in switching between money and the alternative asset. The benefit of holding money is convenience: for example, avoiding going to the bank every time a person wishes to buy something. The cost of this convenience is the forgone interest they would have received had they left the money on less liquid financial assets that paid interest. The assumption under this approach is that money is used to make every payment and all the relevant information is known with certainty.

The individual has to balance his allocation of money in interest earning assets and holding money which does not earn interest. However, if an individual allocates part of his money to interest earning asset, there are brokerage costs that might be incurred when these interest earning assets have to be sold to finance transactions. Therefore, a higher average holding of money minimizes these brokerage costs, but this means greater forgone earnings on interest.<sup>8</sup> The balance between the increase in transaction

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<sup>8</sup> It can be reasoned that as brokerage fees increase, the demand for money balances increases as well. When brokerage fees increase, the benefits from holding money balances increase because by holding these balances, an individual will not have to sell bonds as often, thereby avoiding these higher brokerage costs.

costs incurred in selling an interest earning asset and interest income forgone as a result of holding higher cash balances leads to the formula:

$$M^* = \sqrt{(a_0 y) / 2r} \quad (2.5)$$

Where

$M^*$  is real money balances

$a_0$  is transaction costs

$y$  is real income

$r$  is the rate of interest (Sriram, 1999b:10).

The above “square-root formula” states that optimal demand for real money balances ( $M^*$ ) is directly proportional to transaction costs ( $a_0$ ) and real income ( $y$ ).  $M^*$ , the demand for real money balances, is however inversely proportional to the interest rate ( $r$ ). The individual agent minimizes the sum of brokerage costs and interest forgone. The importance of this approach is that it introduces the optimization behaviour of individuals in demand for money, the trade-off between money and alternative interest earning assets. The basic analysis of this approach is that there is an opportunity cost of holding money, that is, the forgone interest that can be earned on other assets. There is also a benefit to holding money, the avoidance of transaction costs.

The weaknesses of this approach are that: (1) although it assumed that money is used for transactions (payments), it failed to provide a convincing microeconomic foundation as to why people use money and (2) the assumption that receipts and payments are known with certainty might not be true in the real world. These weaknesses lead us to the precautionary demand for money approach, which introduces some uncertainty in the analysis of demand for money (Sriram, 1999b: 11-12).

### **2.2.3.2 Precautionary demand for money approach**

The precautionary demand for money framework postulates that people are uncertain about the payments they might want, or have to make, hence there is demand for money balances for these unknown expenditures (Sriram, 1999b: 12). People do hold money for this precautionary motive. The more money the person holds, the less likely that the person incurs the costs of illiquidity. There is, however a trade-off between money and interest. That is, the more money the person holds, the more interest is forgone. The precautionary demand for money approach argues that people optimize the amount of money held for precautionary purposes by thoughtfully weighing the interest costs versus the advantage of not being caught insolvent. Therefore, the precautionary demand for money is negatively related to interest rates. The precautionary money demand models introduced an element of uncertainty, unlike the inventory models which assumed that receipts and payments are known with certainty. The other implication of precautionary models is that an increase in the overall volume of transactions would lead to a less than proportional increase in money holding (Sriram, 1999b: 12).

### **2.2.3.3 Buffer-stock models/Portfolio models**

The buffer-stock models recognize the role of money as a store of value. They consider demand for money in the framework of a portfolio choice problem. The buffer stock models state that the individual wealth-holder allocates his portfolio between money treated as a risk free asset and assets with an uncertain rate of return. The buffer stock models place a major emphasis on risk and expected returns of the other assets. Money is viewed as providing liquidity for transactions and rendering safety. These models show the relationship between interest rates and the demand for real money. The importance of wealth and liquidity are noted as other key variables in determining the demand for money.

The portfolio demand theories argue that under the assumption of expected utility maximization, the optimal portfolio can be shown to depend on wealth and on the properties of the utility function and the distribution function for the return on the risky asset. The degree of risk aversion and the mean and variance of the return on the

risky asset are of particular importance. An individual would hold part of his/her wealth in the form of money in his/her portfolio because the rate of return on holding money is more certain compared to that of holding interest earning assets. It is less risky to just hold money alone compared to holding alternative assets. The difference in the risk may be due to the fact that alternative assets are affected by market price volatility, while money is not. The individuals will only want to face the risk because of the reward offered by the alternative assets, which exceeds those offered by holding money.

Given a menu of assets available in a country, money pays a zero return, and if there is a riskless asset which is paying a positive rate of return (e.g. a savings deposit), then money will not be held (Goldfeld and Sichel, 1990: 310). However, the risk-averse economic entities would want to include some money in an optimally structured portfolio. Risk-aversion behaviour, however, does not alone provide the basis for holding money.

Portfolio theories predict that the demand for money depends on the risk and return offered by money and alternative assets. The portfolio theory of demand for money can, therefore, be formulated as:

$$\left(\frac{M}{P}\right)^d = L(r_s, r_b, \pi^e, W) \quad (2.6)$$

Where

$r_s$  is the expected real return on stock

$r_b$  is the expected real return on bonds

$\pi^e$  is the expected inflation rate

$W$  is real wealth

$M$  is the quantity of money

$P$  is the price level

$M/P$  is the quantity of money measured in units of constant purchasing power

(Mankiw, 1997: 484).

This function simply shows, for example, that an increase in the expected real return on stock ( $r_s$ ) and/or the expected real return on bonds ( $rb$ ) reduces money demand because alternative assets become attractive. An increase in expected inflation rate ( $\pi^e$ ) reduces money demand because money becomes less attractive. An increase in real wealth ( $W$ ) will obviously raise money demand because higher wealth means a larger portfolio. The demand function can, therefore, be simplified as  $L(i, y)$ , where  $y$  is a proxy for real wealth ( $W$ ) and  $i = rb + \pi^e$  i.e. sum of real return on bonds and expected inflation.

Although the buffer-stock models recognise the role of money as a medium of exchange, its ability to act as a store of value makes it possible to facilitate the intertemporal shift of consumption possibilities (Sriram, 1999b: 14). Therefore, these models present money as an asset rather than a means of exchange to facilitate transactions. The major criticism of these models is that they fail to explain the observed tendency for agents to hold money when other assets exist which are devoid of nominal risks but pay positive interest rates (Sriram, 1999b: 14).

#### **2.2.3.4 Consumer theory approach**

The consumer theory approach analyses money using the consumer demand theory, where goods are held because an individual derives utility from them. The theory of consumer demand is the derivation of demand functions by considering a model of utility-maximisation behaviour coupled with underlying economic constraints (Varian, 1992: 94). Consumer behaviour in economic analysis is conveniently summarised by means of a utility function, where the utility function is a way to describe preferences. Therefore, a rational consumer will always choose the most preferred bundle from the set of affordable alternatives. In order for the function to be well-defined, it is assumed that there is a unique bundle that maximises utility. The theory emphasises the importance of income and prices in achieving a certain demand function. The approach basically answers the question: how much money would a given consumer need at the price, say  $P$ , to be as well off as he could be by consuming the bundle of goods, say  $X$  (Barnett *et al.*, 1992: 2093)?

The consumer theory approach also argues that real goods (physical goods) are included in the economic agent's portfolio choice, since they yield a stream of services (Sriram, 1999a: 14). Therefore, the expected rate of return on physical goods can be measured by the expected rate of inflation. This variable then plays an important role in the demand for money theoretical analysis. The consumer demand theory approach has been able to suggest that a good part of the problem of the "missing money"<sup>9</sup> episode may be the way money was measured both in the choice of component groupings and in the method of aggregating over those groupings. That is, the way the demand model's capabilities relate to the general optimizing behaviour of economic agents (Barnett *et al.*, 1992: 2115). When developed through data produced from the Divisia index it can capture those movements in money holding that are due to changes in the relative prices among assets (Barnett *et al.*, 1992: 2115).

The consumer demand theory approach provides a consistent framework for analyzing portfolio choice and offers greater insights into results from aggregate studies of demand for money than the motives approach. This is achieved by incorporating restrictions of demand theory in such a manner as to assure consistency with the optimizing behaviour of economic agents (Barnett *et al.*, 1992: 2088, Feige and Pearce, 1977: 441). This allows for a tractable approach and provides for testing of the key axioms of choice theory, hence a better interpretation of the role of nominal interest rates, inflation, and wealth in the demand for money function.

## **2.2.4 Conclusion**

Having provided a comprehensive theoretical review, it can be concluded that these diverse demands for money theories share common important scale variables. They establish a relationship between the quantity of money demanded and a set of economic variables. The developments started with the classical economists, who stated that money serves as a numeraire. For the classical economists, the quantity of money provided an explanation of movements in the price level: movements in the price level result solely from changes in the quantity of money. Then, the Cambridge economists explicitly stressed the demand for money as a public demand for money

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<sup>9</sup> See Goldfeld and Sichel (1990: 683-730) for a detailed explanation on this.

holdings and formally established the relationship between the demand for real money and real income. The Keynesian theory further developed the money demand theory based on the three motives that prompt people to hold money and introduced the role of interest rates in determining the demand for real money balances.

The post-Keynesian theories, starting with the inventory-theoretic approach, emphasised the transactions costs under certainty while the precautionary demand for money approach introduced the concept of uncertainty. The buffer stock models or portfolio approach evaluated the demand for money under the portfolio optimisation framework. Lastly, the consumer demand theory analysed the demand for money under the utility maximisation framework.

Although these theories analyse demand for money differently, they consider a similar set of variables to explain demand for money. The main variables that drive money demand are income, interest rate, the price level, wealth of the economic unit and the changes in these variables over time. The differences arise in terms of using the proper scale variables and opportunity cost of holding money. Therefore, empirical investigation may shed some light on these matters and provide an indication on which specification is more likely to be better. The next section therefore looks at the empirical literature on demand for money.

## **2.3 EMPIRICAL LITERATURE REVIEW**

### **2.3.1 Introduction**

There are wide ranging discussions in the literature about the estimation of money demand function in developed and developing countries. However, the initial work was primarily confined to industrial countries, especially the United Kingdom and the United States of America, while much work has and is still been done in developing countries. The ever changing financial reforms and advancement made in time series econometric investigation stimulated the revisiting of the money demand functions.

The purpose of this section is to review relevant issues concerning the empirical studies on demand for money in order to help in the formulation of the demand function for Botswana. There are, however, differences in the demand functions between countries due to a number of factors including but not limited to, the level of financial development, existing financial assets, macroeconomic and institutional environment.

A lot of empirical work has been done by different scholars on demand for money and these include Laumas and Mehra (1976), Barnett (1990), Hafer and Jansen (1991), Adam (1991), Cuthbertson and Barr (1991), Baba *et al.* (1992), Wesche (1996) and Sriram (1999a), among others, in developed countries. The majority of these empirical works identified three main issues in empirical literature relevant to modelling and estimation of demand for money. The three main issues are: (1) Monetary aggregation, that is, the definition of money stock; (2) appropriate scale and opportunity cost variables; and (3) functional forms or the framework chosen (Sriram, 1999a: 17, Laumas and Mehra, 1976: 463). These issues are discussed in some detail in the sub-section that follows. This section is divided into four sub-sections: empirical issues, studies conducted in developed countries, studies in developing countries and some work on Botswana.

### **2.3.2 Empirical issues**

The following three sub-sections discuss the issues involved in the estimation of demand for money function as identified by various studies and the summary of results in such studies, especially in developed countries.

#### **2.3.2.1 Monetary aggregation**

Many empirical studies contributed to the debate about the correct measure of money to be used in estimating the demand for money function, especially from a policy standpoint. Therefore, from a policy maker's perspective, the importance of a measure of money is only insofar as how it conveys information about the behaviour of objective variables, such as prices and output (Pill and Pradhan, 1994, in Wesche,

1996: 8). There are extensive discussions in the demand for money literature regarding which measure of money yields a stable demand for money function.

In countries where the banking system is weak and the level of financial sector development is low, narrow money seems to indicate a reliable stable demand for money function. However, the narrow money function shifts over time as a result of evolving financial system and institutional structure, hence researchers argue for the use of broad money as it yields a more reliable long run relationship in a changing financial system (Hafer and Jansen, 1991: 156, Sriram, 1999b: 7). With this unsettled question in mind, researchers have investigated several measures of money to establish the one which can serve as a better guide to monetary policy, that is, the measure that produces a reliable and predictable stable demand for money function.

The different types of measures are M1, M2 and M3, for example. Different studies used either one of the above or a combination of two and in some cases all three measures have been used. Baba *et al.* (1992) used M1 in their study of demand for money in United States of America; Adam (1991) used M3 in his study of financial innovation and demand for money in the United Kingdom from 1975 to 1986. Data availability also plays a significant role in the measure of money used.<sup>10</sup> Some studies investigated both M1 and M2 demand function in their analysis. Hafer and Jansen (1991) and Laumas and Mehra (1975) are examples of such studies.

The narrow money (M1) is generally the form of monetary aggregate which includes currency plus demand deposits at the commercial banks. The broad money (M2) includes items in M1 plus time and saving deposits. Some studies estimated the demand for money function by exclusively using M1 and argued that broader aggregates might muddy the interest rate's effects. The other argument was that M1 is more amenable to control by the monetary authorities (Sriram, 1999a: 19). As a result of the innovation in the financial system and the changes in institutional framework, most empirical studies shifted from using M1 to using M2 in order to capture the effect of new instruments. Broader money produces a more stable function than narrow money when new financial instruments are included in the estimation

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<sup>10</sup> This is especially true in developing countries where the financial system is not well developed and data availability is very limited.

(Goldfeld and Sichel, 1990: 317). M2 is considered to be a preferable measure with which to evaluate the long run economic impact of a change in monetary policy (Hafer and Jansen, 1991: 166).

These unresolved issues of which monetary aggregation result in stable demand for money function led to the introduction of the study of demand for money using the divisia index aggregates, which are indices that are considered to be alternatives to the existing conventional monetary aggregates of M1, M2 and M3. The supporters of this theoretical approach to money demand argued that the simple-sum monetary aggregation (mostly M1, M2 and M3) does not capture the theoretical notion of money adequately (Wesche, 1996: 2). Their argument is that the simple sum aggregates do not take advantage of the results of the possible influences of financial innovation and regulatory changes (Barnett *et al.*, 1992: 2087).

The other weakness of simple sum aggregation is that it has been found not to be consistent with microeconomic theory. This is because the simple addition of components is justified only when all components are perfect substitutes for each other. A typical example of this is that broad money aggregates include components held for saving motives that are only imperfect substitutes for transactions motives (Wesche, 1996: 1). The simple-sum aggregates assume perfect substitutability of all monetary assets and this makes it possible for the simple sum monetary aggregates to likely give a wrong expression of the stock of money in the economy (Wesche, 1996: 4).

The divisia index for monetary services makes an attempt to separate the transactions role of money from the other functions performed by money. Instead of measuring the stock of money held in the economy like the simple sum aggregate, the index assesses the utility the consumer derives from holding a portfolio of different classes of monetary assets (Barnett *et al.*, 1992: 2087). Therefore, this argument presents money regarded as a consumer durable, yielding a flow of monetary services.<sup>11</sup> The use of divisia monetary aggregates rather than simple sum aggregates produces functions that are much more stable than those of simple sum aggregates, but at the cost of

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<sup>11</sup> See Barnett *et al.*, (1992), Barnett (1990) and Wesche (1996) for a detailed argument about monetary aggregation.

greater interest elasticity. Barnett (1990: 246) states that when divisia monetary data are used, the economic variables in the models explain the demand for and the supply of monetary services adequately, and tests for structural change reject the hypothesis of shifts in the economy's structure. When the conventional simple sum monetary data are used, the interest elasticities of the demand and supply functions are usually lower than those found with the divisia data, although the functions estimated with simple sum aggregates experience frequent unexplained structural shifts (Barnett, 1990: 246, Baba *et al.*, 1992: 57).

Simple sum aggregations have several advantages over the divisia index number theory. Firstly, simple aggregates are also simple to use (Wesche, 1996:12). The controllability of a divisia index is also impeded as it is influenced by changes in interest rates changes (Stein, 1994, in Wesche, 1996: 12). The divisia measure is also not easier to control as is the case with simple sum aggregate measure (Wesche, 1996: 13). Ericsson (1998: 298) argues that the divisia indexes seem singularly unsuitable to address the ubiquitous phenomena of financial innovation and deregulation. The weakness of a divisia approach is that it implies that liquidity changes suddenly when interest rates move upon deregulation, even when the quantities of aggregate's component and the characteristics of those component remain unchanged (Ericsson, 1998: 298).

The monetary aggregate used, however, varies from study to study and is selected based on the objectives of the study and other variables included in the estimation. The next sub-section therefore looks at scale and opportunity costs variables used in various studies of demand for money.

### **2.3.2.2 Scale and opportunity cost variables**

The choice of scale and opportunity cost variables used in the study of demand for money is generally similar, with some slight differences depending on the chosen monetary aggregation. The scale variable is a measure of transaction relating to the economic activity and this includes using the level of current or permanent income (Laumas and Mehra, 1976: 464).

The use of Gross Domestic Product (GDP) or Gross National Product (GNP) as a variable representing wealth or income is common in some studies.<sup>12</sup> Adam (1991) used income, gross financial wealth, changes in price level/inflation and interest rates<sup>13</sup> as variables in the study of demand for money in the United Kingdom from 1975-1986. However, most empirical studies use the level of income to represent the scale variables because it has few measurement problems compared to other representations such as wealth (Sriram, 1999b: 21). The other problem with the use of wealth as a scale variable is that it is difficult to construct a long time series data for most countries.

Although GNP is the most prominently used representation, GDP has also been commonly used as a substitute and this does not show any significant difference in the results obtained (Laidler, 1993: 99). In order to capture the total transactions in an economy dependent on imports some studies used an expenditure based indicator like gross domestic expenditure (GDE) to represent income, that is, a scale variable.<sup>14</sup> Most studies use GNP as the relevant scale variable because of readily available data and as it also satisfies both income and wealth representations, directly and indirectly. The scale variable can, however, be left out in situations where the speed of adjustment of monetary aggregates used is too rapid or when high frequency data is used for which there is no data for the scale variable chosen (Sriram, 1999a: 22-23).

The specification of the opportunity cost variables is however the most important determinant of getting very meaningful results in the estimation of the demand for money function (Ericsson, 1998: 304). As earlier explained in the theoretical literature, the opportunity cost of holding money involves two things, the own-rate of money and the interest rate of return on alternative assets to money. The omission of the variable, own-rate of money can lead to misspecification of the opportunity cost variable. This misspecification often leads to a breakdown of the estimated demand for money function, especially when financial innovation occurs in the economy (Aziakpono, 2000: 131, Baba *et al.*, 1992: 26). In case of a closed economy the rate of

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<sup>12</sup> See Table A1 in the appendix for such studies.

<sup>13</sup> Interest rates included interest on deposits, negotiable certificates and return yield on government bonds.

<sup>14</sup> See Aziakpono (2000: 133) for example.

return on assets represents yields on domestic financial and real assets, whereas for an open economy, yields on foreign assets are included to capture the effects of currency substitution on domestic money holdings.

There are a number of instruments used to represent yields on domestic financial assets and the use of these instruments as variables largely depend on the state of the domestic financial sector, the extent to which interest rates have been liberalized and the availability of data (Sriram, 1999a: 18). The alternative assets to money include yields on government securities, commercial paper, or savings deposits and return on foreign securities. The general view is that these instruments are very close substitutes for money and their returns are especially relevant among alternatives that are forgone by holding cash (Sriram, 1999a: 23).

The yields on real assets are mostly proxied by the expected inflation, whereas that of foreign assets is proxied by foreign interest rate or some form of exchange rate equivalent variable. The argument for inclusion of expected rate of inflation in the demand for money function is that if money is a way of holding wealth then the demand for money should be viewed as demand for services it provides. That is why the expected rate of change in the price level should be included among the variables in the demand for money function (Sriram, 1999a: 24). In most developing countries, the use of the expected rate of inflation as an opportunity cost variable is common. This is because the financial sector is not well developed and in most cases data on the expected rate of inflation is readily available. The other reasons for this are that there is limited substitution possibility between money and other financial assets due to under-developed markets and interest rates are also regulated, hence there is very little variation in interest rates for long periods of time. Therefore, since the choice of individual wealth holder is limited to holding money and real assets (Fielding, 1994: 18, Simmons, 1992: 29). The individual will thus look at the possibility of investing in real assets that include land, consumer durables and livestock.

The inclusion of a foreign financial assets variable in the demand for money function depends on the openness of the domestic economy. In an open economy the domestic demand for money can be influenced by external monetary and financial factors such as increases in rates of return in foreign securities and depreciation of domestic

currency. The direct currency substitution can happen if the domestic currency is expected to depreciate. In that case domestic portfolio holders will find an incentive to switch to foreign assets. The exchange rate can be used as a variable under this circumstance. Likewise, if there is an increase in rates of return in foreign securities there is a window for alternative investment and foreign interest rate becomes a useful variable (Simmons, 1992: 31-33).

The discussion above shows that there are two important components acting as the opportunity cost of holding money, namely: the own-rate of money and returns on alternative assets for money. The latter component further comprises return on domestic financial and real assets and return on foreign assets.

The study by Baba *et al.* (1992) also included a risk element/variable in their estimation of demand for M1 in the United States of America from 1960 to 1988. Their variable was represented by a moving average standard deviation of holding period yield of a bond (Baba *et al.*, 1992: 29). The argument presented is that, where the wealth holder has no net position on the Treasury bill or bond market, since bills or bonds are not held or owed, the risk-return trade-off on bonds enters the money holding decision. Therefore, the trade-off is safe money versus risky bonds. This makes the demand for a safe asset, e.g. money; depend on a risk-return trade-off against higher yielding risky assets.

The choice of variables, however, depends much on the financial development of a country, the macroeconomic development, the extent to which interest rates are liberalized, the openness or otherwise of the economy and data availability. For developing countries characterised by underdeveloped financial sectors with limited financial assets and data set, the choice of variables in the money demand function might be limited. Therefore, the selection of a combination of variables to be used in the estimation of the demand for money function is an empirical issue. It is an empirical issue because the selection of these combinations and measures to represent these variables depends mostly on the macroeconomic development, the status of the domestic financial system, the extent to which interest rates are liberalised, the openness or otherwise of the economy and the availability of data (Sriram, 1999b, 28).

### 2.3.2.3 Functional forms and framework

In the study of demand for money the functional form and framework chosen should be free from the theoretical and estimation problems, and should be able to work well in an empirical setting (Sriram, 1999b: 37). Presently, economic theory does not state the correct mathematical form of the demand for money function. There are however, generally three functional forms dominating the literature: linear-additive, log-linear and linear-nonadditive (Feige and Pearce, 1977: 446). The linear-additive functional form assumes that money shifts associated with unit changes in the independent variables are constant over time while elasticities are allowed to change over time. The log-linear demand function imposes constant temporal elasticities while allowing the money shift responses to vary over time. Lastly, the linear-nonadditive functional form allows both the money shifts and elasticities to vary over time (Feige and Pearce, 1977: 446).

Although there are several functional forms of specifying money demand function, there is general consensus that the log linear version is the most appropriate functional form because it performs better than the other forms (Sriram, 1999a: 28, Laumas and Mehra, 1976: 463 and Cuthbertson and Barr, 1991: 859, Barnett *et al*, 1992: 2086, Bossogo-Egoume, 2000: 10). Bossogo-Egoume (2000: 10) also states that the log linear form allows for interpretation of coefficients of variables in logarithms as elasticities.<sup>15</sup>

The specification of demand for money function evolved from the partial adjustment models (PAM) to varying regression approach then buffer stock models and most recently to the error correction mechanism approach. Under partial adjustment models, demand for money is assumed to be a function of scale variable and a vector of opportunity cost variables (Sriram, 1999b: 30). These models determine that due to adjustment costs, there is a lag involved for the desired level of holdings to match the actual levels of money. The partial adjustment model basically introduced two

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<sup>15</sup> This can be interpreted as percentage change leading to a one percent change in the modelled variables (Bossogo-Egoume, 2000: 10).

concepts: (1) the difference between the desired and actual money holdings and (2) the mechanism by which the actual money holdings adjust to the desired levels.

The partial adjustment model is typically motivated by cost-minimizing behaviour, wherein the costs of disequilibrium are balanced against adjustment costs (Goldfeld and Sichel, 1990: 325). Following Hwang (1985, in Goldfeld and Sichel, 1990: 325) the partial adjustment model can be derived by considering a quadratic cost function of the form:

$$C = \alpha_1 \left[ \ln M_t^* - \ln M_t \right]^2 + \alpha_2 \left[ (\ln M_t - \ln M_{t-1}) + \delta (\ln P_t - \ln P_{t-1}) \right]^2 \quad (2.7)$$

Where

$$M_t = m_t P_t$$

$$M_t^* = m_t^* P_t$$

$m_t^*$  is the desired stock of real balances

$P_t$  is the price level.

In the equation (2.7) the first and second terms correspond to the disequilibrium and adjustment costs, respectively. If  $\delta = 0$ , then (2.7) posits that the adjustment term is solely a function of nominal magnitudes, while for  $\delta = 1$  the second term in (2.7) takes the form  $\alpha_2 (\ln m_t - \ln m_{t-1})^2$ . The intermediate values of  $\delta$  correspond to hybrid models but when costs are minimised with respect to  $M_t$  it results in:

$$\ln M_t - \ln M_{t-1} = \mu (\ln M_t^* - \ln M_{t-1}) + \tau (\ln P_t - \ln P_{t-1}) \quad (2.8)$$

Where

$$\mu = \frac{\alpha_1}{\alpha_1 + \alpha_2}$$

$$\tau = \delta \alpha_2 / (\alpha_1 + \alpha_2) = \delta (1 - \mu).$$

Therefore, when  $\delta = 1$ , (2.8) reduces to the real partial adjustment model in which real balances are adjusted. Likewise, when  $\delta = 0$ , (2.8) reduces to the nominal partial

adjustment model in which nominal balances are adjusted. A standard specification for  $m_t^*$  is therefore given as follows:

$$\ln m_t^* = \phi_0 + \phi_1 \ln y_t + \phi_2 \ln r_t + \phi_3 \pi_t \quad (2.9)$$

Where

$y_t$  is a transactions variable such as real GNP or GDP

$r_t$  represents one or more interest rates

$\pi$  is the inflation rate measured by  $\pi = \ln\left(\frac{P_t}{P_{t-1}}\right)$

By combining the equations (2.8) and (2.9) and rearranging terms, we get:

$$\ln m_t = \mu\phi_0 + \mu\phi_1 \ln y_t + \mu\phi_2 \ln r_t + (1-\mu)\ln m_{t-1} + \beta \ln\left(\frac{P_t}{P_{t-1}}\right) \quad (2.10)$$

Where

$$\beta = \mu\phi_3 + (1-\mu)(\delta-1) \quad (2.11)$$

From equation (2.11) we notice that it is impossible to identify simultaneously  $\delta$  and  $\phi_3$ . If it was known *a priori* that  $\phi_3 = 0$ , an estimate of  $\delta$  could be inferred from estimates of  $\beta$  and  $\mu$ . In this case,  $\delta = 0$  would yield the nominal partial adjustment model and  $\delta = 1$  would yield the real partial adjustment model. This is also true if the value of  $\delta$  were known *a priori*, then an estimate of  $\phi_3$  could be inferred. Without an *a priori* knowledge about  $\delta$  or  $\phi_3$ , it is impossible to simultaneously determine whether the real or nominal adjustment mechanism is appropriate (value of  $\delta$ ) and to determine whether inflation has an independent effect on the demand for desired real balances (value of  $\phi_3$ ). The simple partial adjustment model above incorporates the adjustment lags in the model and it shows that individuals adjust their real money balances only partially towards their desired levels (Maddala, 2001: 406). In the partial adjustment framework, the actual money balances adjust to close the gap between the

desired or long run demand for real money balances and the previous period's holdings.

The partial adjustment models (PAMs) however, have been criticised for being ad hoc in nature.<sup>16</sup> The PAMs framework was also not able to explain the apparent instability in the demand for money function experienced during the post war period. This instability was commonly known as the “missing money” episode and was experienced in the post-war period especially the early 1970s (Mizen, 1997: 1203).<sup>17</sup> The instability of the demand for money function under the partial adjustment framework was a result of two factors: the ongoing financial innovation and the inadequacy of the partial adjustment model framework as an empirical tool to estimate the demand for money (Sriram, 1999a: 3, Mizen, 1997: 1203, Baba *et al.*, 1992: 32).

The PAMs failed on theoretical and empirical grounds. They experienced econometric problems of serial autocorrelation, simultaneity bias, model misspecification such as restrictive dynamic structure, and spurious regressions due to non-stationarity of data (Sriram, 1999a: 32). The empirical estimates of partial adjustment models produced inaccurate predictions of real money balances, they generally showed very low short run elasticities for income (about 0.1) and interest rate elasticities of around -0.05 and a coefficient of the lagged dependent variable was close to unity (Sriram, 1999b:32). Having a small interest elasticity coefficient in the short run and a larger one in the long run meant that, after a change in money stock, interest rate overshooting should occur in the short run. In contrast a larger change in the interest rate is needed in the short run to clear the money market and a small change is necessary in the long run (Sriram, 1999b: 32).

The limited dynamics of the partial adjustment models was also the cause of the instabilities and statistical problems that led to their breakdown (Sriram, 1999b: 32). The excessive restriction of the lag structure at the beginning of the empirical investigation by the PAMs assumes that the adjustment costs and expectations could

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<sup>16</sup> Partial adjustment model is a form of log-linear specification.

<sup>17</sup> Missing money episode was when conventional money demand equations systematically over predicted actual money balances.

be captured in a very specific and simple way. This dynamic specification may result in residual autocorrelation or heteroskedasticity because omission of the important lagged variables result in model misspecification. Although the partial adjustment models failed, their most important contribution to the empirical work on the demand for money function was the introduction of the lagged real money balance variables as this variable became even important in the later competing models.

The breakdown of partial adjustment models due to the econometric problems they encountered led to the rise of buffer stock models (BSMs). Buffer stock models explain the demand for money in the context of individual optimisation and the microeconomics of adjustment in the market for money. They recognise the possibility that current period departures from equilibrium in the money market are based on commonly accepted principles (Mizen, 1997: 1204).<sup>18</sup> Buffer stock imply that the money holdings in these models are considered as shock absorbers to take care of unforeseen daily expenses, that is, this reserve money allows temporary deviations from the desired money holding level. Therefore, they introduce expectations into the analysis such that unexpected events (shocks) in the present or expected events in the future induce deviations from the long run equilibrium.

A buffer stock model based on Cuthbertson and Taylor (1987, in Mizen, 1997: 1205) incorporates forward looking behaviour allows the individual money balances to be influenced by surprises to current monetary policy and expectations of future monetary policy.<sup>19</sup> The departures from current period equilibrium result not solely from the unexpected events but also from the anticipated events ahead of the current time period. The model is derived from the same type of cost function as the PAM in equation (2.7) but it is generalised to allow for the cost of departures from equilibrium and the cost of actually adjusting balances in the future as well as the present (Handa, 2000: 143). Money holdings are hence, made up of two components: (1) planned components based on the minimisation of an intertemporal cost function and (2) unplanned parts due to unanticipated shocks. The buffer stock model function can be represented as:

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<sup>18</sup> For a very detailed argument see Mizen (1997).

<sup>19</sup> An alternative but similar explanation of the model can be seen in Handa (2000: 142-145).

$$m_t = \lambda m_{t-1} + (I - \lambda)(I - \lambda D) \sum_{i=1}^{\infty} (\lambda D)^i E_{t-1} m_{t+i}^* + m_t^u + \ell_t \quad (2.12)$$

Where

$m_t$  is money holdings

$m_t^u$  is the unexpected shocks to money balances modelled as part of the equation.

$\lambda$  is a parameter of the model

$D$  is a discount factor.

The second term in the equation reflects the anticipated future changes to the desired level of the demand for money. This will affect the current money balances in such a way that the adjustment will happen slowly, minimising the cost function, in advance of the expected change. Money balances are, however, affected by the shock terms immediately and the effect decays over time as the individual moves back to long run equilibrium by a slow real balance effect (Mizen, 1997: 1206). The shock absorber and “forward looking”, explained above, introduced expectations. The introduction of expectations about the future and the allowance for the impact of unexpected and surprise events on the demand for money became the hallmark of the buffer stock models.

The buffer stock model framework explains the monetary policy transmission mechanism in the short run and gives an alternative view of the short-run dynamic relationships between money, income, prices and interest rates in comparison with the conventional demand for money functions. The major contribution of the buffer stock models over the partial adjustment models was that it allows money shocks to be explicitly modelled as part of the determination of money demand. The inclusion of the money shock variable in the demand for money function explains the specification bias of the PAMs and presents the BSM as a better model (Sriram, 1999b: 34).

The major drawback of buffer stock models is that the estimates of the coefficient of the long run money demand equation are conditional upon the correct specification of the entire model (Cuthbertson and Barr, 1991: 865). The buffer stock models have also been criticised for their relevance in empirical estimation in that although the

short-run dynamics structure is much more advanced than in PAMs, it is still somewhat restrictive. The other weakness with the BSMs is their assumption that money stock is exogenous as some studies have shown that it is a dependent variable (Laidler, 1993: 128).

The downfall of buffer stock models led to the introduction of the error-correction models in estimating demand for money function. Error-correction models (ECMs) are basically a result of improvement in the dynamic structure, the character which was lacking in the PAMs. Studies which used error correction modelling (ECM) in the estimation of demand for money function include among others: Adam (1991), Hafer and Jansen (1991) and Baba *et al.* (1992) in their analysis of the United Kingdom and United States of America, respectively. Others studies are by Wesche (1996) in analysis of five European countries.

The error-correction framework is described as a representation in which the long-run equilibrium relationship between money and factors that determine it are embedded in an equation that captures short-run variation and dynamism. The error-correction models have been seen to be successful tools in money demand, because they contain information on both the short and long run properties of the model with disequilibrium as a process of adjustment to the long run model.<sup>20</sup> Under the error-correction models, economic theory is allowed to define the long-run equilibrium, while the short-run dynamics are determined from the data. The ECM allows data characteristics to be carefully examined before selecting the appropriate econometric estimation technique and this does not happen under PAMs and BSMs. The lag structures are selected based on the data generating process of the economic variables and not on an *a priori* economic theory or naïve dynamic theory, as was the case under PAMs and BSMs (Sriram, 1999b: 37).

Sriram (1999b: 38) summarises the work of several other authors in their statement of advantages of ECM as follows: (1) it avoids the possibility of spurious correlation among strongly trended variables; (2) the specification attempts to distinguish

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<sup>20</sup> See Adam (1991), Sriram (1999b), Hafer and Jansen (1991), Baba *et al.*, (1991) and Brooks (2002).

between short run (first differences) and long run (lagged-levels) effects and (3) it provides a more general lag structure which does not restrict the model specification.

The two most commonly used cointegration estimation procedures in estimating demand for money function are those of Engle-Granger (1987) and Johansen (1988), further developed by Johansen and Juselius (1990, 1995). Cointegration vector in the error correction model is interpreted as a long run demand for money function since, mathematically, a vector is a linear combination of elements in a set i.e. a set of variables. Tests for cointegration, such as those proposed by Engle and Granger (1987), do not distinguish between the existences of one or more cointegration vectors (Hafer and Jansen, 1991: 157, Adam, 1991: 407 and Sriram, 1999a: 38).

The Engle-Granger (1987) relies on convergence to equilibrium and it applies OLS estimation to obtain parameter estimates of the cointegrating vector. In practice this type of OLS estimate will differ with the arbitrary normalization implicit in the selection of the left hand side variables for the regression equation (Hafer and Jansen, 1991: 157). In practice, different arbitrary normalizations can alter the Engle and Granger test results. The drawback of the Engle-Granger method, however, is that if the sample size is small there is a bias in estimated relationships. It has also been criticised for its low power of estimation (Brooks, 2002: 395, Ericsson, 1998: 307). The main advantage of Engle-Granger's procedure is, however, its simplicity.

To demonstrate the problem of OLS based Engle-Granger (1987) technique, assume that there are only two variables in an equation, say  $y_t$  and  $x_t$ . In this case there can be at most one cointegrating relationship. However, if there are more than two variables say,  $k$  variables in a system, for example,  $y_t, x_{2t}, \dots, x_{kt}$ , then there may be more than one linearly independent cointegrating relationships, say  $r$ . Therefore,  $r \leq k - 1$ . This situation potentially presents a problem for the OLS regression approach because the OLS approach is only capable of detecting at most one cointegrating relationship no matter how many variables are present in the system (Brooks, 2002: 393). If there is more than one cointegrating relationship, there is no way the researcher can know whether the best possible cointegrating relationship has

been found. This problem can be solved by the Johansen's approach, which allow for the determination of all the ( $r$ ) cointegrating relationships.

The Johansen and Johansen and Juselius approach is based on maximum likelihood technique used to determine the number of cointegrating vectors and for estimating and conducting inference about the cointegrating vectors. It yields maximum likelihood estimators of the unconstrained cointegrating vectors and also allows the researcher to explicitly test for the number of cointegrating vectors (Hafer and Jansen, 1991: 157). In the study of the demand for money there may be a number of such cointegrating vectors, for example: money demand (between real money, interest rates, inflation rate), term structure (between the interest rates), real interest rates (between inflation and nominal interest rate), and aggregate demand (between interest rates, inflation) and identifying the cointegrating vectors is of interest (Ericsson, 1998: 307).

Within the two prominent procedures of cointegration the majority of recent studies use Johansen (1988), Johansen and Juselius (1990 and 1995) because it has more advantages than the Engle-Granger's procedure. The main advantages are that the Johansen procedures provides an opportunity to evaluate the presence of multiple cointegration vectors and has proved to be more efficient than the Engle and Grange approach as it has a greater power to detect cointegration (Adam, 1991: 407, Hafer and Jansen, 1991: 157, Ericsson, 1998: 307).<sup>21</sup> It provides an opportunity to explicitly test for the number of cointegrating vectors instead of assuming one cointegrating relationship among variables (Hafer and Jansen, 1991: 157). It also does not rely on arbitrary normalisation. Mizen (1210: 1997) also argues that on its own ground the error-correction model can outperform other models in forecasting experiments. This is because the error-correction models have extreme flexibility in terms of functional form, lag length and explanatory variables can be construed as a reduced form of many different types of theoretical model.

The use of ECMs is perhaps the most celebrated innovation in modelling demand for money. From a methodological perspective, it seems to be preferable to model the

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<sup>21</sup> My study will use this approach because of its several advantages over the other econometric estimation techniques.

interaction among variables within a multivariate cointegration context than the bivariate context, because the multivariate cointegration framework includes a broad number of variables, hence it provides full characterization of the long-run determinants of demand (Sriram, 1999a: 39). This multivariate cointegration therefore uses the procedures developed by Johansen (1988) and Johansen and Juselius (1990 and 1995).

The weaknesses of the error-correction model however is that it is singularly useless in explaining transmission mechanisms and micro-economic theory behind the demand for money (Mizen, 1997: 1210). Since it is an approach that focuses on reduced form, it cannot give a theoretical argument, using microeconomic reasoning, for the success of the partial adjustment model in the 1960s and 1970s.

This section presented a discussion of empirical issues involved in the estimation of demand for money from various studies, therefore, the next sub-sections gives an overview of the results obtained from such studies.

### **2.3.3 Results of studies in developed countries**

The majority of the studies on the demand for money found cointegrating relationships existing between the monetary aggregate and the scale variables used. Wesche (1996) found a single cointegrating relationship existing between vectors in the study of demand for money for five European countries, namely; Germany, France, Netherlands, Belgium and Austria; the study used quarterly data from 1973:1 to 1994:4. The study used vector error correction mechanism and compared the results obtained from a divisia index aggregates to that where real M3 monetary aggregation was used. For divisia index the error correction showed a reasonable speed of adjustment towards equilibrium and was significant. For simple sum M3, the error correction term was much lower and insignificant. The study however did not test the stability using some form of stability test, like the Chow test.

Ericsson (1998) found one cointegrating vector in the study of demand for money using M1, total final expenditure (TFE), three month authority interest rate, retail

deposit interest rate and inflation as variables, based on the United Kingdom quarterly data from 1963:1 to 1989:2 and using parsimonious conditional equilibrium model with all variables in logarithms except interest rates (Ericsson, 1998: 307). The income elasticity was found to be unitary in the long run and coefficients of interest rates and inflation were sensibly signed. In the short run, elasticities of money with respect to prices and income were both close to zero.

Adam (1991) found more than one cointegrating vector in the study of M3 for the UK and chose the economically meaningful results. The study found that all variables were significant and the scale variables have the expected positive signs while the interest rate/opportunity cost variables had negative signs. The variables that showed a rapid speed of adjustment to equilibrium were inflation, income and foreign interest rates. Using the Chow test, the demand for money equation was tested for structural stability and it proved to be stable. The major weakness of the study however, as noted by the author, was the use of monthly data over a relatively short time period (ten years). Despite the fact that monthly data increased the number of observations with which to conduct statistical analysis, high frequency data is relatively noisy, hence, there can be a problem of extracting efficient signals from it (Adam, 1991: 401).

Another study which used a similar econometric approach as Adam (1991) was Hafer and Jansen's (1991) analysis of narrow money (M1) and broad money (M2) in the United States of America from 1915:1 to 1988:4. Using the Johansen (1988), Johansen and Juselius (1990) method of analysis and real output, commercial paper rate, corporate bond rate as variables, the study found income elasticities of 0.89 and 1.08 for M1 and M2 respectively (Hafer and Jansen, 1991: 163). The interest elasticity for the M1 function was -0.36 while for M2 was very low at -0.12 and both interest rate variable were statistically significant (Hafer and Jansen, 1991: 164). The analysis of the stability of both functions provided evidence that M2 is the preferable measure with which to consider the long run economic impacts of changes in monetary policy.

Baba *et al.* (1992) confirmed the results by Hafer and Jansen (1991) study by finding a stable cointegrating money demand function for real M1 and variables: real GNP,

one month Treasury bill rate, inflation rate, yield on M1 and moving standard deviation of holding periods on long term bonds. By using Johansen and Juselius (1990) approach and having all variables in logarithms to ensure that the model was equivalent under a range of transformations of dependent variables, Baba *et al.* (1992: 41) found that the treasury bill rate elasticity was -39%, own rate 12% and inflation - 14%. The long run income elasticity was, 0.5 and therefore, consistent with the Baumol (1952) - Tobin (1956) theory (Baba *et al.*, 1992: 41).

The majority of the studies such as Ericsson (1998), Baba *et al.*, (1992), Treichel (1997), Adam (1991), Simmons (1992), Fielding (1994) and Sriram (1999b), among others used cointegration error-correction models and found stable money demand functions when tested by using the Chow test. The outline of the studies discussed in this section was to give some insight on some empirical issues in demand for money especially in the studies done in developed countries. Although some aspects might be similar, below is a presentation on studies done in developing countries and some work done on Botswana. This will provide further insights in specification and estimation issues on demand for money function for Botswana.

#### **2.3.4 Studies in developing countries**

There are several peculiar features that make research on the demand for money function in developing countries, especially Africa, a subject of major discussion. First, most African countries are characterised by underdeveloped money and asset markets and a limited array of financial assets (Fielding, 1994: 17, Simmons, 1992: 29, Treichel, 1997: 4). It is argued that financial assets in some developing countries are either absent or inadequate and this results in the choice of asset holding being limited to either money or real physical goods. This implies that there is very little substitution between money and financial assets (Sriram, 1999a: 8).

The second major feature is that many financial and macro-economic reforms have been taking place over the past decades. The liberalisation of several domestic financial sectors which foster financial innovation in the past decades require further estimation of the money demand function. Although models of demand for money in

Africa were initially argued to be outside the mainstream, the availability of data in present days has led to the construction of time series econometric models that are equal in sophistication to those currently used in economic literature elsewhere (Fielding, 1994: 17).

The controllability of interest rates<sup>22</sup> and high rising inflation which characterise most developing countries have caused higher variability in the return on the financial asset to be even negative in real terms. The high degree of price instability also makes asset prices unpredictable and this entails greater risk for savers. The greater risk might also be a factor that acts as deterrence to the holding of financial assets (Fielding, 1994: 18).

Despite the relative paucity of African economic data, Simmons (1992) investigated money demand for a set of five African countries using error correction mechanisms. The models estimated had generally good statistical attributes and passed a wide range of diagnostic and stability tests. Simmons (1992: 42) argues that the error correction model used, which was derived from a two-period dynamic distributed lag model, allows for a richer lag structure than the typical one-period model imposed on annual data. This approach is also unlike the partial adjustment model (which it nests) used in earlier demand for money studies developing countries. The partial adjustment model unduly constrains a uniform lag structure on regressors and does not permit a distinction between, short run and long run inflation effects, for example.

In the study of M1 for Congo, Cote d'Ivoire, Mauritius, Morocco and Tunisia, Simmons (1992) used real income, interest rate on alternative domestic financial assets, price level, rate of interest on foreign financial asset and exchange rate (measured in units of local currency per dollar, that is, the price of foreign exchange) as variables and all were natural logarithms.<sup>23</sup> Due to limitations in degrees of freedom a choice had to be made for inclusion of either foreign interest rate or

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<sup>22</sup> This leads to little variation of interest rates over time.

<sup>23</sup> Other studies also used expected inflation but in some countries where the financial institutions are highly unorganized and fragmented, the degree of credit restraint in the economy is introduced as a proxy for opportunity cost of holding money (Sriram, 1999b: 25).

expected exchange rate depreciation as an external opportunity cost variable (Simmons, 1992: 43).

The choice of variable between expected exchange rate depreciation and foreign interest rate is determined by the significance or level thereof between the two. This is achieved by using non-nested hypothesis test, by adding the predictions from one model to those from another. If predictions from the exchange rate model are significant in the foreign interest rate model but those of the foreign interest rate are insignificant in the exchange rate model, then the latter is preferred over the former (Simmons, 1992: 39). Using the Wald test, Simmons (1992) found 2.72 and 1.92 for exchange rate model and foreign interest rate model. Since the encompassing *F*-test generated 5.78 and 2.26 respectively, the exchange rate model was preferred to the foreign interest rate model. This scenario is relevant when the exchange rate model and foreign interest rate model are alternatives to each other.

The main finding of the study was that domestic interest rates play a significant role as a relevant opportunity cost variable in explaining the long run demand for M1 in three countries, namely; Cote d'Ivoire, Mauritius and Morocco (Simmons, 1992: 41). The study also found that there was sluggish adjustment to shocks in the financial systems of all countries. Simmons (1992: 42) stated that it would be a very serious mistake to rely upon expected inflation as the sole relevant variable capturing opportunity cost of holding money in African economies. Omission of additional or alternative opportunity cost variables can result in biased estimates of the money demand function.

The major drawback of Simmons (1992) study was the imposition, *a priori*, in the model of a unit long run elasticity of income and zero elasticity on other variables without confirming cointegration. This is in direct contradiction with Engle and Granger's (1987) representation theorem<sup>24</sup> which states that cointegration is a necessary condition for an error correction dynamic representation (Fielding, 1994:

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<sup>24</sup> However, in finite samples, this procedure does not work well as usually indicated by relatively low  $R^2$  from cointegration regression; the long run coefficient estimate can also be badly biased (Sriram, 1999b: 40).

17). The other major setback of Simmons (1992) study is the failure to distinguish between different expectations hypothesis and the properties of dynamic adjustment.

The studies of demand for money in other developing countries by Fielding (1994), Sriram (1999b), Jonsson (1999) and Treichel (1997) were able to remedy the deficiencies of the Simmons (1992) study. They used the multivariate cointegration following the approaches of Johansen (1988), and Johansen and Juselius (1990, 1995). Prior to testing cointegration, they employed a number of tests, namely Dickey Fuller (DF), Augmented Dickey Fuller (ADF), and Durbin Watson statistic, among others, to investigate the time series properties of the data.

Fielding (1994) estimated the demand for money (M2) in four African countries, namely: Cameroon, Nigeria, Ivory Coast and Kenya, using quarterly data from 1974:1 to 1992:4. The study found three independent cointegrating relations for the variables used and these are real stock of money on real income, inflation, central bank discount rate (Fielding, 1994: 18-24).

Among the three vectors found for Cameroon, in two the value of the parameters were, although these vectors were linearly independent. Fielding (1994: 25) argues that it was likely that the Johansen and Juselius procedure picked up the same stable relationship twice. In choosing a vector which correctly represents the data generating process, Fielding (1994) based his conclusion on the previous theoretical and empirical work on demand for money, which suggests that demand for money is approximately homogeneous in income. Therefore, the vector which had income elasticity closer to unitary was chosen. The third vector had a very high coefficient that may indicate that it is an artefact of the data, hence, it was not economically interpretable. For income and inflation variables, the size of the coefficient increased with the order of the lag, implying that there is a smooth adjustment to the long-run equilibrium (Fielding, 1994: 27).<sup>25</sup>

In the study of demand for broad money in Tunisia by Treichel (1997), a stable long run relationship between real money (M2), real GDP and interest rates was found. The

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<sup>25</sup> Because of space I chose to report only Cameroon results as they are more elaborate, also the results for other countries in the study are generally the same and do not introduce anything new.

study used real M2, real GDP, inflation rate and interest rate (money market rate or rediscount rate) as variables. More importantly, the error-correction coefficient was much higher in the period 1990-95 than 1962-95. This indicated that the speed of adjustment towards the long run equilibrium was much faster in the period 1990-95. The author attributed this to the financial sector reforms that included increased availability of banking services and higher returns on financial assets (Treichel, 1997: 17).

Bossogo-Egoume (2000), in the study of demand for money in Guyana, found that there were three cointegration relationships, but chose the theoretically consistent relation. The price variable had unit elasticity as expected and the income elasticity was close to one. The interest on deposits was positively related to money whereas interest rates on alternative assets negatively affected money demand (Bossogo-Egoume, 2000: 26). Nominal exchange rate depreciation and inflation had an insignificant role. The parameter constancy is a key feature that a money demand model has to exhibit. The coefficients of variables estimated were found to be stable indicating that the model was well-specified. Thus events that were capable of creating outliers or structural breaks were captured appropriately.

Sriram (1999a) estimated the demand for money function in Malaysia, a small open economy, initially by applying a closed economy model framework and later an open economy model by allowing for possibilities of currency substitution. Based on the cointegration and weak exogeneity tests, the study found that the long run income elasticity is close to one and the opportunity cost variables were negatively (interest rates on alternative assets and inflation) related to money as expected. However own rate of money was positive (Sriram, 1999a: 19). These results are therefore, consistent with theory.

Ikhide and Katjomuise (2000) estimated the demand for narrow and broad money in Namibia using the Engle and Granger (1987) approach with quarterly data from 1990 to 1998. The variables included in their model were the South African Treasury Bill rate (representing return on alternative assets), a six month's Namibia commercial bank deposit (representing own rate of return on money), real exchange rate between Namibian dollar and South African rand, Namibia Treasury bill rates, real GDP,

expected rate of inflation and either narrow money (M1) or broad money (M2). All variables were in logarithms except the inflation rate. In a similar study of demand for broad money (M2) in Lesotho, Aziakpono (2000) used quarterly data from 1981:1 to 2000: 4 and employed the variables real income represented by GDE, rate of inflation, domestic interest rate represented by nominal savings deposit rate, foreign interest rate represented by the South African Treasury bill rate and the exchange rate as represented by the Rand/Loti to US dollar.

Although Ikhide and Katjomuise (2000) used two-step Engle Granger approach, Aziakpono (2000) used the four step technique but both studies found a stable long run relationship in their analysis of money demand function in Namibia and Lesotho, respectively. Ikhide and Katjomuise (2000: 10) found income elasticity in M1 to be varying between 1.3 and 1.4 while that of M2 to be lower at 0.4 and 0.6. The interest rate elasticity ranged between -0.05 and -0.09 for M1 while for M2 was between -0.2 and -0.5. The income elasticity of 0.6 for M2 was not very different from that found by Aziakpono (2000: 138) of 0.7 for Lesotho.

The studies by Aziakpono (2000) and Ikhide and Katjomuise (2000) found statistically significant error correction term indicating a strong feedback effect of deviation of demand for money function from its long run growth path. The coefficient of error correction model for M1 indicated a speed of adjustment of about 60.4% per quarter and it was 61.4% for M2 in the study by Ikhide and Katjomuise, whereas Aziakpono (2000) found a speed of adjustment of 45% for M2 in Lesotho. Both studies found no major shifts in the demand for money functions. These results are very important for the purposes of monetary policy since stability is a crucial determinant of the effectiveness of monetary policy. The next section discusses some work on Botswana.

### **2.3.5 Existing works on Botswana**

The literature on demand for money in Botswana is rather scanty. There are two notable studies by Kganetsano (2001) and Mosweu (2003). Kganetsano (2001) estimated the demand for money function by error correction mechanism, using the

Engle-Granger two step estimation procedures. Based on the theories of the demand for money, especially the three Keynesian motives for holding money (transactions, precautionary and speculative and assuming no money illusion). Kganetsano (2001) specified the equation as:

$$(m - p)_t = \beta_0 + \beta_1(y - p)_t + \beta_2 p_t + \beta_3 R_t + \varepsilon_t \quad (2.7)$$

Where demand for real money balances  $(m - p)$  is a function of real income  $(y - p)$ , the price level  $(p)$  and nominal interest  $(R)$ , with lower case letters denoting logarithms of the variables (Kganetsano, 2001: 1).

Kganetsano (2001) used the real rand/pula exchange rate as a proxy for the currency substitution effect, since South Africa is Botswana's largest trading partner and the South African rand even carries more weight in the basket of currencies to which pula is pegged. Therefore, the demand function was re-specified as:

$$(m - p)_t = \beta_0 + \beta_1(y - p)_t + \beta_2 R_t + \beta_3 \Delta p_t + \beta_4 \ell_t + \varepsilon_t \quad (2.8)$$

Where  $\ell$  is the natural logarithm of the rand/pula exchange rate and other variables as already defined, his *a priori* expectations were  $\beta_1 > 0, \beta_2 < 0, \beta_3 < 0$  and  $\beta_4 < 0$ .

Kganetsano (2001) found cointegrating relationship for both functions of the two monetary aggregates of M1 and M2. The coefficients also had the expected signs. The inflation elasticities were less than one, while exchange rate elasticities were relatively high. For both regressions the income elasticities were significant at 5 % level of significant, and the author attributed this to the importance of the transaction motive for holding money in Botswana (Kganetsano, 2001: 5).

The major weakness of Kganetsano's (2001) study is the use of Engle-Granger procedure. The Engle-Granger technique and the single equation dynamic model inherently assume the existence of one cointegrating vector even though there may be more than one (Brooks, 2002: 394). The Engle-Granger method also has a low power of estimation (Brooks, 2002: 395).

The study by Mosweu (2003) estimated a long run demand for money function (M1) for Botswana using Johansen error correction mechanism (VECM). He employs the log form for real GDP and real M1, but annual inflation and real interest rates were in levels. Mosweu then estimated his model by the Johansen maximum likelihood technique. Using econometric technique, he found theoretically consistent and stable cointegrating relationship existing among money, income, interest rates on bank deposit and inflation that can be interpreted as a demand for money function in Botswana. The cointegrating relationship showed high income elasticity, which indicates the strong transaction motive for holding real money balances in Botswana. This is in agreement with earlier work by Kganetsano (2001).

Mosweu (2003) used annual data with a sample size of twenty seven (27) from 1975 to 2002. Since the Johansen cointegration analysis procedure is sensitive to small samples, his observations may be susceptible to the small sample bias as a result of over rejecting the null hypothesis when it is in fact true. Another weakness with the use of annual data is that it often loses seasonality and consequently, impulse responses may take longer to converge towards the steady state. The longer period arises because the effects of that less than one cannot be derived since the data is only in yearly form (Wang and Dunne, 2000: 6). A good example is that in Mosweu's (2003) study, the impulse responses show that it takes eight years for the economy to return to equilibrium after a shock and obviously, this might be exaggerated due to the use of annual data in the study.

The measure of demand for money function by narrow money (M1) has also been heavily criticised as it does not capture the necessary development in the financial system like the broad money (M2) (Sriram, 199b: 7). Broad money captures long run economic impact of the change in monetary policy better than narrow money since it takes cognisance of some important financial developments and innovations occurring in the economy.

## 2.4 CONCLUSION

This chapter was concerned with a review of both theoretical literature and various existing work on demand for money function in developed countries, and developing countries especially Botswana.<sup>26</sup> The literature discussed proposes a similar set of variables to explain the demand for money, but differs in terms of specific roles assigned to each of them. The two very important points in modelling and estimating the demand for money functions are: (1) variable selection and representation and (2) the framework chosen.<sup>27</sup> These two largely depend on the macroeconomic environment and financial sector development and the extent of openness of an economy. The next chapter therefore, looks at the macroeconomic environment and financial sector developments in Botswana. The observation drawn from the reviewed studies is that the transaction motive models seem to be dominant in explaining money demand functions in developing countries, especially in Africa. A summary of studies reviewed is provided in Table A1 in the appendix.

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<sup>26</sup> The summary of reviewed studies is attached as Appendix 1 at the end of the thesis.

<sup>27</sup> Also as identified by Sriram (1999b: 4).

## CHAPTER THREE

# BOTSWANA'S ECONOMIC BACKGROUND

### 3.1 INTRODUCTION

This chapter presents an overview of Botswana's macro-economy, the composition of the financial sector, the development in the financial sector and the monetary policy framework. As it has been stated in the literature review, the variables used in the estimation of demand for money varies from country to country. An analysis of the various macroeconomic and financial sector developments in Botswana will help in the identification of variables that can be included in the demand for money equation. The various policies changes in the financial sector are also discussed below as it may help to suggest the possibility of structural breaks in the demand for money function.

### 3.2 MACROECONOMIC PERFORMANCE

Botswana is a small open economy whose financial sector is still at an infant stage; however, the country still maintains one of the highest economic growth rates in the world. Botswana was able to transform itself from being one of the poorest countries in the world, having a *per capita* income estimated at about US\$80 in 1966, the year of independence, to a middle-income country with a *per capita* income of US\$3600 in 1998 (World Bank, 2000: 3).

Although not many countries have been able to transform mineral wealth into sustained economic growth, Botswana has been able to dramatically transform from being essentially a cattle rearing and rural based economy to a modern economy. According to the International Monetary Fund (IMF) (2004: 17) the long record of fiscal prudence is a key factor in Botswana's overall strong economic performance over the last three decades. Economic growth averaged 9.3 percent per year between 1980 and 2000 and real income per person grew at an annual rate of 6.0 percent (Bank of Botswana, 2001: 80). In 2002/3 the country had a growth rate of 6.7 percent

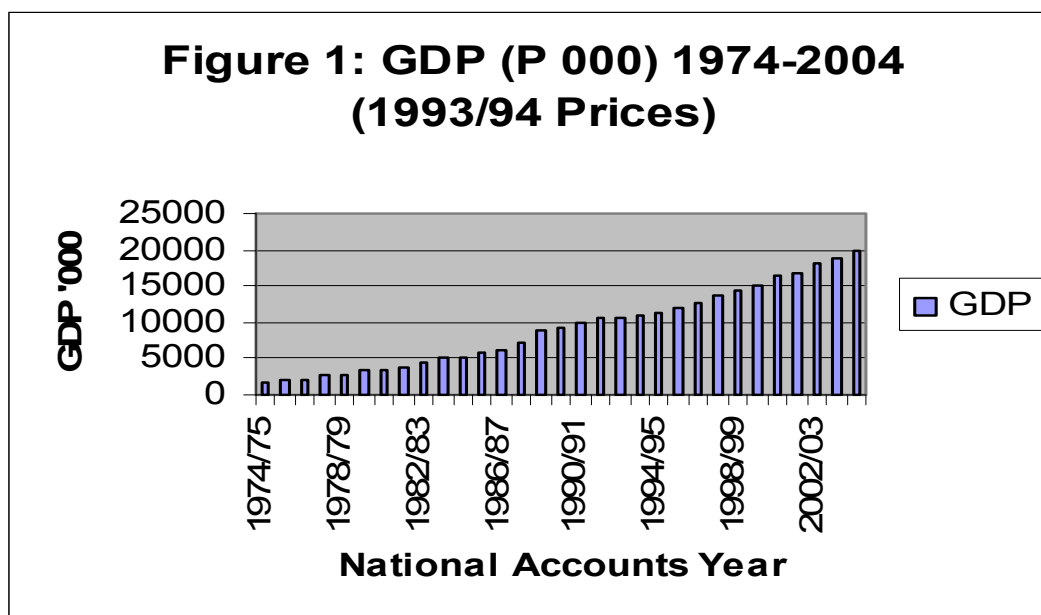
(Ministry of Finance and Development Planning, 2004: 6). The country's economic growth record is mainly attributed to mineral wealth, especially diamonds, which account for about 35 percent of GDP, 72 percent of exports of goods and services and 50 percent of government revenue (IMF, 2004: 18). Table 3.1 below shows how the structure of the GDP has been changing over the years, from year of independence in 1966 to 2004 and Figure 1 shows the GDP from national accounts year 1974/75 to 2004/5.

**Table 3.1 Changes in the Structure of GDP: 1966, 1976, 1986 and 2004**  
(Percentages)

	1966	1976	1986	2004
Agriculture	39	24	4	2.3
Mining	0	12	47	33.9
Manufacturing	8	8	6	4.1
Construction	6	7	3	5.3
Trade and Hotels	18	16	18	11.3
Government	13	14	13	21.5
Other	16	19	9	21.6

Source: Bank of Botswana, various issues

It can be observed from the table above that the discovery of minerals, especially diamonds some years after independence completely transformed the structure of Botswana GDP from being dominated by agriculture to be led by mining.



The country’s macroeconomic growth trend is reflected in the government budget, which has shown substantial surplus over years. Domestic excess liquidity and foreign exchange reserves peaked at US\$4 billion as at the end of 1993. The country’s surpluses averaged about 9 percent of the GDP between mid-1980 and 2000, and the government accumulated savings with the central bank as deposits reached a high of 29 percent of the GDP at the end of 2003 (IMF, 2004: 17). The budget deficits emerged in recent years mainly due to the HIV/AIDS related expenditures, which have risen sharply since 2001/2002. The other factors that led to recent budget deficits are: growing expenditures in education, increased recurrent expenditures and downward revenue trend, mainly due to sluggish performance of the non-mineral revenue (IMF, 2004: 17).

The decline in diamond revenue in the 1990s has made the authorities to look for ways of diversifying the economy and the government recognised the need for an efficient financial sector, with the private sector playing a major role. Economic theory postulates that the success of any economic diversification will rely on a financial system that efficiently mobilizes private savings to finance investment. This vital issue became evident when the government partially privatised the public officers pension scheme in July 2001. Since then, the government transferred part of the accumulated civil servant’s pension funds of about P 10.5 billion (about 27 percent of GDP) to the private fund managers. This resulted in a very large injection

of finance in the domestic financial system. The large liquidity in the domestic market could not be adequately absorbed due to very few investment opportunities in the local capital market, hence, investments abroad and investments in the Bank of Botswana Certificates (BoBCs) increased significantly. The investments in BoBCs increased two folds to P10.2 billion between 2001 and 2003 (IMF, 2004: 29). The Bank of Botswana then offered high return on BoBCs to stem inflationary pressures that resulted from the excess liquidity.

In order to increase and diversify the revenue base, the government introduced value-added tax (VAT) in July 2002 and this contributed about 1.5 percent of GDP in the 2003/2004 financial year. The other major sources of non-mineral revenue for the government are the Southern African Customs Union (SACU) receipts, income from Bank of Botswana (BoB) profits from foreign reserve investments, personal income and company taxes (IMF, 2004: 20).<sup>28</sup> The income from the BoB profits has greatly declined in recent years because of the low equity prices and interest earnings on financial investment in the world of financial markets, as well as the drawings on the BoB reserves, as the government used its deposits with the central bank to establish a privatized government employees pension fund to the tune of P10.5 billion (27 percent of GDP) (IMF, 2004: 23).

### **3.3 OVERVIEW OF BOTSWANA'S FINANCIAL SECTOR**

It is important to understand the nature and structure of the Botswana's financial sector in order to infer its possible impact on the demand for money. This section presents an overview of Botswana's financial sector for the period under study, since understanding the financial system is essential in formulating appropriate money demand function.

The fairly robust expansion of the Botswana economy in the past decades, which has been fuelled by diamond production, is the major factor that led to the earlier rapid

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<sup>28</sup> The SACU comprises Botswana, Lesotho, Namibia, South Africa and Swaziland. Customs and excise duties collected are paid into South Africa's National Revenue Fund, and the revenue is shared among members according to an agreed revenue-sharing formula (IMF, 2004: 19).

growth of the financial sector in the country. This growth can be traced to the establishment of a central bank (Bank of Botswana) in 1975 and the launch of Botswana's own currency, the Pula, in 1976 (Harvey and Lewis, 1994: 54). The main functions of the Bank of Botswana are to conduct monetary policy, provide banking services to the government and banks, to supervise commercial banks and to issue currency. The Bank also implements the exchange rate policy, manages foreign exchange reserves and provides monetary and financial policy advice to the government of Botswana (Bank of Botswana, 2004: 15-16).

The structure of the financial system in Botswana is presently made up of the central bank (BoB), five commercial banks,<sup>29</sup> two investment banks and other financial institutions.<sup>30</sup> The Botswana Stock Exchange was established in 1989 and a total of 25 companies and 32 securities firms are listed (IMF, 2004: 32). There is also an active insurance industry and pension fund management in Botswana, with a total of 13 insurance companies and over 100 pension funds (IMF, 2004: 31). The Botswana government also owns the Botswana Development Corporation, a National Development Bank and the Public Debt Service Fund (PDSF).<sup>31</sup>

The commercial banks dominate the financial system in Botswana and the majority of them are subsidiaries of foreign banks. The commercial banks accounted for over 90 percent of total deposits and advances of deposit-taking institutions in 2002 (IMF, 2004: 32). Banking outlets increased considerably in the 1990s. At the end of the year 2000, the four commercial banks had among them 59 branches and sub-branches, 17 agencies, 6 encashment points and 112 automatic teller machines (ATMs) countrywide (Bank of Botswana, 2001: 95). The banking sector is financially sound, solvent, profitable and highly liquid, with banks maintaining ratios in excess of the statutory requirement and low ratios of non-performing loans. The majority of commercial bank lending is overdrafts and short-term loans (IMF, 2004: 33, Bank of Botswana, 2001: 68).

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<sup>29</sup> Commercial banks are Barclays Bank, Standard Chartered Bank, Stanbic, First National Bank and Bank of Baroda.

<sup>30</sup> Botswana Savings Bank, Botswana Building Society, Botswana Stock Exchange (BSE) and several micro lenders.

<sup>31</sup> The PDSF was the government's direct lending facility to public enterprises until 2002 and it has been the country's largest lender.

There has been a major increase in the flow of funds to non-banking financial intermediaries, especially to savings institutions. These financial intermediaries include insurance companies, brokers/agents, private pension funds and fund managers. Contractual savings institutions managed assets valued at P64 million in 1998, but this increased to P10.5 billion in 2003 due to the partial privatisation of the public pension fund scheme (IMF, 2004: 34, Bank of Botswana, 2001: 83). The pension and life assets increased from 35 percent of households deposit held by banks to surpass the household's bank deposits in 2000 (IMF, 2004: 34, Bank of Botswana, 2001: 83). This indicated a diversification of household savings held as financial assets, hence the importance of alternative investment assets in the economy.

The analysis of data on financial savings shows that during 1980-2000, an average of around 11 percent of non-mining GDP has been added annually to the stock of financial assets. This has led to a rapid increase in the ratios of total savings to non-mining GDP from 29 percent in 1980 to over 80 percent in 2000 (Bank of Botswana, 2001: 80). Botswana government however, is the major net saver, accounting for well over 65 percent of the central bank's total liabilities in 2001 despite the decline caused partially by privatisation of public officer's pension fund scheme (IMF, 2004: 32). By August 2003 the government's savings accounted for about 40 percent of the BoB's total liability.

Although the partial privatisation of the civil service pension fund was the right move by the government, it also contributed to the decline in the country's international reserves in months of import cover from 33 months to 25 months due to the demand for foreign exchange by private fund managers seeking international investment opportunities (IMF, 2004: 29). The government was forced to draw on international foreign exchange reserves to fund shortages in domestic foreign exchange.

### **3.4 FINANCIAL SECTOR DEVELOPMENT**

In Botswana, before the late 1980s, the financial sector was not well developed and not diversified. It had a limited range of financial instruments and it was associated with lack of competition. The central bank exercised a considerable degree of direct

control over financial operations (Bank of Botswana, 2001: 66).<sup>32</sup> It was only during the late 1980s that a number of financial reforms took place and much financial development also occurred. Indeed, much of the financial reform in Botswana occurred from 1989 onwards (Bank of Botswana, 2001: 66).

Before 1986, there were interest rate ceilings and floors, that is, banks were not allowed to set their own interest rates and bank charges. The interest rates were set in line with the central bank's directives. The interest rates were repressed in that it was constrained in its ability to generate and respond to market based prices. The real interest rates were negative or low and the deposit rates were generally negative in real terms, which tended to discourage the accumulation of financial savings (Bank of Botswana, 2001: 66). In 1986, the controls on maximum interest on lending and minimum interest rates on deposits were removed and commercial banks were allowed to set interest rates freely.

After interest rates were liberalised in 1986, they tended to move upwards and are presently high. The spread is widening despite the excess liquidity in the market caused by partial privatisation of the public officer's pension funds. The high interest rates and widening interest rate spread is attributable to the absence of domestic absorptive capacity, low levels of commercial banks<sup>33</sup> competition and an informal arrangement of inter-bank rates set at 1 percent below the Bank rate by commercial banks (IMF, 2004: 36). The interest rates therefore do not reflect the true picture of the market liquidity condition in the financial system.

There are a number of reasons why the interest rates in Botswana do not give a true picture of the liquidity condition in the market. Firstly, the inter-bank rate has been set at 1 percent below the bank rate by an informal agreement between commercial banks. Secondly, banks prefer to make transactions with the central bank in repurchase agreements (repo) and reverse repurchase agreements to meet their daily liquidity requirement and this makes inter-bank activities low. The repos and reverse repos are offered at the same rate as the inter-bank rate. Thirdly, the short term interest rate, the Bank of Botswana Certificates (BoBCs) rate, moves closely and in

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<sup>32</sup> There was more control especially with respect to maximum lending and minimum deposits rates.

<sup>33</sup> Low levels of bank competition are reflected by the rising bank charges (IMF, 2004: 36).

the same direction as the bank rate. Fourthly, the prime lending rate has been consistent at 1.5 percent above the bank rate for a long time and this makes interest rates in Botswana to closely reflect the direction of the monetary policy and be systematically linked to the bank rate. They do not reflect the true liquidity condition in the market (IMF, 2004: 38). These arrangements have not been the most efficient way to channel liquidity in Botswana's financial sector and might have disrupted the transmission of monetary policy adjustments (IMF, 2004: 38).

In 1989 the Botswana Stock Exchange (BSE) was established and it made available alternative investment instruments. Between 1989 and the end of 2003, the domestic company index (DCI) rose from 100.0 to 2,394.5, and market capitalization rose from P120 million to P15.6 billion (IMF, 2004: 35, Bank of Botswana, 2001: 84). A fundamental problem of the BSE is that assets traded are illiquid; the total value of stocks traded during the year relative to average market capitalization is generally low. This has been attributed to the fact that the majority of the shares in BSE are held by either controlling interests or local investors, who are unwilling to sell shares for fear of loss of control in companies and also because of a lack of alternative investment opportunities in the economy (IMF, 2004: 35, Bank of Botswana, 2001: 84).

The activities of the BSE have been enhanced in recognition of the importance of a stock exchange in the development of the capital market. Some of the measures taken include the easing of the stock market listing requirement, favourable treatment of capital gains on the disposal of shares, abolishing the double-tax burden on dividends and setting up of a Central Securities Deposit (CSD) to improve securities transactions (IMF, 2004: 39). The government also sold the public loan book of the PDSF, which amounted to 2.8 percent of the GDP, to the private sector. All these measures were taken to encourage capital market development in the country which will bring about a variety of investment instruments in the economy.

The growing role of capital markets, the wider range of savings and borrowings and the increase in flow of funds to non-banking financial intermediaries have led to the strengthening of the regulatory and supervisory framework. The government is in the process of establishing a financial supervisory authority, an independent watchdog for

the non-banking financial sector, which will regulate the activities of the non-banking financial institutions and oversee the operations of the capital markets (IMF, 2004: 40). All these are to ensure the safety of funds of investors. Although the financial sector in Botswana has not experienced any serious systematic crisis, a few financial institutions that had problems in the early 1990s were helped by the timely interventions by the authorities.

In 1990 there was the liberalisation of commercial bank licensing requirements. This increased competition in the banking sector because more banks were allowed into the financial sector. As this happened, there was enhancement of prudential supervision and improvements in the payments system (Bank of Botswana, 2001: 67).

The Bank of Botswana Certificates (BoBCs) were introduced in 1991 and the financial intermediaries have invested heavily in the BoBCs. This is due to their attractive high return and very low risk. On the other hand, secondary market trading in BoBCs is very slow to develop (IMF, 2004: 38). The unavailability of alternative investment opportunities makes investors hold the BoBCs. Secondary market activities for the BoBCs have also been dominated by transactions with the Bank of Botswana rather than amongst commercial banks. The main reason for this is because the BoB has made a commitment to buying the BoBCs along a yield curve based on the auction cut-off rate. This made participants in the BoBC market have no incentive to seek out buyers in the private market.

The attractiveness of the BoBCs, due to their high return, burdened the Bank of Botswana with high interest rate costs and also led to disruptions in the efficient allocation of financial resources. The resources that could otherwise be used to finance private investments and enhance diversification were now concentrated in BoBCs. The central bank, as from 2004, was gradually withdrawing from the secondary market by restricting trades to P 25 million per deal and was working to reduce the high BoBC rate.

In 2001, the Bank of Botswana shortened and standardised the BoBC maturity period to only 91 days because shorter maturities attract lower interest rates. The central bank also introduced weekly BoBC auction schedules; hence there was an increase in

flexibility in liquidity management. From May 1, 2004, BoBCs auction was conducted using multiple price formats. This form of auction ensured that counterparties submitted competitive bids that reflected conditions in the money market, therefore, better mirroring expectations about future interest rates (IMF, 2004: 38).

Removal of all foreign exchange controls happened in 1999. Before then, the financial sector was characterised by exchange controls on capital transactions, especially offshore borrowing and overseas investments by residents, and capital inflows by non-residents. This was abolished, since it discouraged off shore investments (Bank of Botswana, 2000: 103). Since then, there is free movement of capital save for the 30 percent required of institutional investors to hold as domestic assets in their portfolio.

In 2000 the International Financial Services Centre (IFSC) was introduced. The main objective of its establishment was to increase employment and skilled personnel in financial services that will make Botswana a financial hub for sub-Saharan African countries (IMF, 2004: 29). The IFSC was expected to play a leading role in the development of the local financial market. The services of IFSC include banking, funds management and administration, captive insurance and financial intermediation. At the end of 2003, there were about 20 companies operating under the IFSC (IMF, 2004: 31).

A historic moment came in 2003 with the introduction of Botswana government bonds, for the first time in Botswana (Bank of Botswana, 2003: 64). This was government's aim: to develop the domestic capital market. The introduced bonds were the 2-, 5-, and 12-year government bonds. The importance of this was to widen the availability of alternative investment instruments and to enable the establishment of a relatively risk free yield curve which will serve as a benchmark for other bond issues. All bonds issued were oversubscribed and this indicated high demand for these investment assets.

The secondary market transactions, however, remain very limited and the government's plan was to list the bonds on the Botswana Stock Exchange to facilitate bond trading (IMF, 2004: 39). It should be noted, that between 1997 and 2000, the Botswana Development Corporation (BDC), Botswana Telecommunications

Corporation (BTC), Investec South Africa and Botswana Building Society (BBS) floated four bonds with different nominal values (Bank of Botswana, 2001: 84, BIDPA, 2003: 1). Table 3.2 shows a summary of the financial reforms that occurred in Botswana from reform period 1986 to 2003.

**Table 3.2: Summary of Botswana’s Financial Sector Reforms, 1986-2003**

<b>Year</b>	<b>Reform Measures</b>
1986	Removal of control on interest rates
1989	Establishment of Botswana Stock Exchange (BSE)
1990	Liberalization of commercial bank licensing requirements
1991	Introduction of BoBCs
1995-96	Modernization of legislation (revised BoB Act; Banking Act)
1999	Removal of foreign exchange controls
1999	Introduction of repos and reverse repos
2000	Launching of IFSC operations
2001	Privatization of pension scheme for public officers
2002	PDSF wound up
2003	Introduction of 2-, 5- & 12-year government bonds

Source: IMF: 2004: 36

### **3.4.1 Exchange rate regime**

Since its independence, Botswana used the South African rand as its currency until 1976 when it introduced its own currency, the Pula. By 1976 when the Pula was introduced, it was, together with the Rand, pegged to the United States dollar (USD). The exchange rate policy was to protect external competitiveness because it provided a stable relationship between the Pula and the foreign exchange rate of Botswana’s major trading partners. The South African authorities then introduced a floating exchange rate regime for the Rand in 1979 and by then the Pula also was depreciating against the Rand. The Botswana authorities then decided to adopt a basket pegged currency to control inflation, which was at double digits by 1980 (IMF, 2004: 44).

The Botswana Pula exchange rate was then determined with reference to a weighted basket of currencies comprising the Special Drawing Rights (SDR) and the South African Rand. The monetary authorities occasionally change the composition of the basket and made adjustments to the peg weightings when circumstances required (IMF, 2004: 44). Although the introduction of currency basket helped to curb inflation, it also exposed the country to a number of external shocks that are linked to the South African economy and international diamond market. These prompted authorities to devalue the pula against the basket on few occasions to make up for the eroded external competitiveness. The pula was devalued against the basket by 5 percent in 1984 and 15 percent in 1985. The table below gives a summary of pula devaluations since 1982.

**Table 3.3: Summary of Pula Devaluations (percentages)**

<b>Year</b>	<b>Devaluation in %</b>
1982	10 %
1984	5%
1985	15%
1990	5%
1991	5%
Feb. 2004	7.5%
May 2005	12%

Source: Bank of Botswana, various annual report issues.

Since the late 1980s, the Botswana Pula exchange rate had several adjustments. Between 1988 and 1989 the authorities allowed a significant real appreciation of the pula in order to reduce imported inflation and absorb some of the demand pressures through higher imports. In the 1990s there was an implementation of a policy aimed at maintaining a broad stable real exchange rate against the rand. From 1994 to 2000, the exchange rate was made to move in the range of R1.25 – 1.35 per pula.

The policy of *de facto* rand targeting was abolished in the second half of 2000. The reason behind the decision was the Rand had taken a deep dive against the SDR currencies. In 2004, the Rand took a reverse movement and due to the concerns of

eroding external competitiveness by the appreciating rand, the authorities depreciated the pula by 7.5 percent (IMF, 2004: 46). The effective pegging index of the Botswana Pula is calculated as a geometric average of the exchange rate indices of the major trading partners and the weight given to South Africa is three-fourths in Botswana's effective exchange rate, because South Africa is the largest trading partner (IMF, 2004: 46). The Bank of Botswana however, does not use the exchange rate policy as a nominal anchor for inflation but export sector competitiveness (Masalila and Phetwe, 2001: 7).

### **3.4.2 Monetary policy framework in Botswana**

After its independence in 1966, Botswana chose to remain part of the Rand Monetary Area, which included South Africa, Lesotho, Swaziland and Namibia, with the first being the dominant partner. This was until 1976, when Botswana attained monetary independence by setting up its own central bank and issued its own currency. Under the Rand Monetary Area, only the South African Rand was the common currency used by all countries. When monetary independence was attained it was in the context of legislated administration of interest rates, credit controls and exchange controls (Masalila and Phetwe, 2001: 3). Monetary independence supported three broad objectives: (1) supporting balance of payments, (2) maintaining a liberal foreign exchange regime, and (3) avoiding sharp shifts in aggregate demand (Masalila and Phetwe, 2001: 3).

The conduct of monetary policy was influenced by the central bank's use of the Bank rate and primary and liquid assets requirements. At the time Botswana attained monetary independence, the traditional monetary policy instruments, such as open market operations (OMO) and bank reserve requirements were not readily available to the Bank of Botswana or were not effective in an environment of excess liquidity, except for the interest rate (Masalila and Phetwe, 2001: 4). The interest rates were therefore adjusted downwards in order to alleviate the cost of borrowing and stimulate investment in the economy. Due to the decision to adjust interest rates downwards, they then remained low and negative in real terms for most of the period up to 1993.

The exchange rate policy was also used to reduce the impact of imported inflation, mainly from South Africa.

In the 1990s, Botswana moved towards a market oriented monetary policy and this was influenced by many factors, like financial liberalisation. During this time, interest rates and exchange rate controls were fully liberalised and banks were free to set their own deposit and lending rates. There is also free movement of capital except for foreign portfolio investment which is limited to 70 percent of funds (Masalila and Phetwe, 2001: 5). Foreign economic entities are not allowed to purchase the open market operations (OMO) (central bank securities), which are used as a way of mopping up excess liquidity. The exchange rate is fixed to a basket of currencies comprising the rand and the SDR. This makes move in line with these currencies to the extent of the weight of each in the basket.

There are two main objectives in the current monetary policy in Botswana. The first principal objective is to ensure price stability as reflected in a low and stable rate of inflation over the medium to long term. The second objective is to maintain positive real interest rates comparable to those prevailing in international markets especially major trading partners (Masalila and Phetwe, 2001: 6). The factors that influence Botswana's inflation are; (1) imported inflation<sup>34</sup>, (2) administered prices like rentals on public housing; electricity, water, public transport, health care, petroleum, and (3) aggregate demand pressures; mainly generated by government expenditures of the huge mineral revenues<sup>35</sup> and credit expansion to the private sector (Masalila and Phetwe, 2001: 7).

The Bank rate and the auctions of BoBCs are presently the key tools in the conduct of monetary policy. The Bank uses BoBCs in open market operations to influence the amount of liquidity in the economy by adjusting supply and in the process determining a discount rate which translates into a market interest rate. Therefore, this influences the level of liquidity and interest rates in the economy via the market. The

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<sup>34</sup> Botswana's imported inflation is mainly from South Africa since about 80% of imports originate from South Africa (Masalila and Phetwe, 2001: 6). Imported tradeables also make up 47% of CPI basket.

<sup>35</sup> Government is an important economic agent because government expenditure account for 40% of the GDP.

Bank rate applies to short term (over-night) financing of commercial bank liquidity needs. The BoB uses it to signal the desired level and direction of interest rates. The Bank rate is adjusted by monetary authorities in order to keep real interest rates in Botswana in line with those of major industrialised countries. Thus, the real money market rate in Botswana is measured appropriately by the real effective yield on the three-month BoBC.

The other monetary policy instruments used by BoB are the reserve requirements and the exchange rate management. The reserve requirement is considered an alternative to enhance the efficacy of open market operations and given excess liquidity in the banking sector; it does not have much impact (Masalila and Phetwe, 2001: 8). The current monetary policy framework uses exchange rate arrangement mainly towards the promotion of export competitiveness to enhance economic diversification than as an anchor for inflation.

The impact of excess liquidity in Botswana created a policy dilemma for the central bank of Botswana. The existence of excess supply in a market will normally signal a fall in the price, which is interest rate, until the excess disappears. The fall in interest rates in Botswana would have meant that funds would be available at substantially lower real interest rates than in the rest of the world. This will have created a disincentive to save, inducing investment in low productivity investment and inhibiting the development of domestic capital markets all of which were contrary to monetary policy stance. At the same time, however, as a matter of policy, the Bank of Botswana was not willing to regulate interest rate administratively.

The solution to this policy dilemma was the introduction and issuance of BoBCs to absorb the excess liquidity. Hence, the Bank of Botswana adopted a real interest rate policy that aimed to achieve approximate equality between real interest rates in domestic and world major markets. Thus, the mopping up of excess liquidity through the issuance of BoBCs, and the maintenance of positive real interest rates made the Bank of Botswana effectively handle the monetary effects of excess liquidity (Bank of Botswana, 2001: 63- 124).

### **3.5 CONCLUSION**

This chapter notes that financial institutions such as banks play an important role like accepting deposits from households to channel them into productive investment funds. It also shows that in Botswana the financial markets, such as the stock and bond are playing a small but significant role in the economy, where finance flows from savers to investors hence providing alternative financial investment opportunities to idle money balances.

There is however, a need to further encourage the development of both money and capital markets in order to ensure that a broader range of financial instruments is available to meet the needs of both savers and investors, and thus improve the efficiency and effectiveness of the financial sector. The chapter also highlighted the financial sector situation in the pre-reform period (1980-89) and the reform period (1990-2004). All these will be important in the study of demand for money in Botswana since they have a bearing on the empirical estimation of the demand function.

Having reviewed the financial sector in Botswana, the next chapter, looks at the implications of these financial developments in modelling demand for money in Botswana. It also presents the methods used in the estimation of the demand for money function in Botswana and the variables to be included in the equation.

## CHAPTER FOUR

# MODELLING BOTSWANA'S MONEY DEMAND FUNCTION

### 4.1 INTRODUCTION

This chapter presents an overview of model, variable selection, analysis and other issues in the specification of demand for money function. It also provides detailed estimation techniques and model evaluation tests applied in the study.

### 4.2 MODEL SPECIFICATION

From the literature reviewed, it is clear that the conventional money demand models express the demand for money function as a function of a scale variable which can be real income, wealth or permanent income. It is also expressed as a function of the opportunity cost of holding money. The opportunity cost variable can be represented by domestic and/or foreign variable(s). The two domestic variables that capture opportunity costs are the expected rate of inflation, which captures the forgone yield on real assets and the rate of interest, which captures the yield foregone on financial assets. In addition, attempts can be made in an open economy to incorporate a foreign opportunity cost variable by introducing either a foreign rate of interest and/or expectations of currency depreciation when modelling the demand for money in the developing countries (Fielding, 1994: 18, Simmons, 1992: 29).

The relationships can simply be depicted using the following general functional representation:

$$M^d = f(P, Y, R) \quad (4.1)$$

+ + -

Where

$M^d$  is aggregate nominal demand for money

P is the current price level

Y is a measure of nominal income (scale variable)

R is a set of opportunity cost variables (domestic interest rate, measure of return on foreign assets, rate of inflation and the exchange rate).

The “+” symbols below the price level and income are the expected signs of a positive relationship between changes in that respective variable and changes in the demand for money. On the other hand, a “-” symbol below the interest rate variable indicates that changes in interest rate (R) in one direction will cause money demand to change in the opposite direction (Ericsson, 1998: 297, Laumas and Mehra, 1976: 464). The equation (4.1) indicates that money demand will depend positively on the level of real income (Y), and the price level (P) due to the transactions demand for money. Money demand will depend negatively on average interest rate due to speculative concerns of economic agents

#### **4.2.1 Definitions and analysis of variables**

This section discusses the specification, measurement and the analysis or justification of the variables which are used in estimating the demand for money in equation (4.1). Money demand is estimated for simple sum monetary aggregate M2 as reported by the Bank of Botswana. M2 is defined as M1 (currency outside banks plus demand deposit) plus call, savings, notice and time currency accounts deposits of resident sectors other than the government. The broad definition has a dual function as it acts as a means of payment and acts as store of value. It is therefore likely to be held for portfolio investment and transactions purposes.

Several studies have established that the demand for money is a demand for real balances. To obtain a measure of real money, the nominal money stock must be deflated by an appropriate price index. Although the GNP or GDP deflator can be employed as a proxy of the true price deflator<sup>36</sup>, in an open economy such as

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<sup>36</sup> The study by Lutkepohl and Wolters (1998) used GDP deflator.

Botswana, the use of the GDP deflator may not be very appropriate. This is because it might be influenced heavily by mining, particularly diamonds, which constitute approximately 34% of the total output, but which does not enter into the domestic consumption basket.

Alternatively, the Consumer Price Index (CPI) deflator can be used, but in an economy characterised by tight price controls it will tend to be distorted by being heavily weighted by officially set prices. However, Botswana's economy has to a large extent been devoid of price controls and this makes the CPI a good proxy as a deflator. The other advantage of using consumer price index as a deflator is that unlike GDP deflator, it includes imports (which domestic residents consume) but excludes exports (which are not consumed by residents) (Fielding, 1994: 23). Data on the CPI deflator is also readily available in monthly and quarterly series, whereas the GDP deflator is reported only on annual basis, hence, will require some manipulations that can result in a loss of some other properties of the data. The consumer price index, CPI 1993=100, is therefore used to deflate the nominal M2 and GDP. The disadvantage of using the consumer price index is that it excludes investment expenditure, but this is normally only a small component of total domestic expenditure and so will have minimal effect on the result (Fielding, 1994: 23).

As seen in the literature review, there is considerable controversy over the selection of the suitable scale variable as a determinant of the demand for money. The choice of scale variable may itself affect the existence of cointegration in the empirical money demand function (Ericsson, 1998; 299). The use of current income measure may suggest a greater emphasis on the role of money as a medium of exchange, whereas employment of wealth or permanent income as variables is assumed to place greater emphasis on the role of money as a productive asset or a durable consumer. There is no clear cut evidence in favour of the use of either current or permanent income (Laumas and Mehra, 1976: 464).

However, in developing economies, the uses of Gross Domestic Product (GDP), Gross National Product (GNP) or Gross Domestic Expenditure (GDE) are common. These measures have been traditionally employed as a proxy for real income (Wesche, 1996: 8). In this study, following the practice in most studies in developing

countries, real GDP is used as a measure of real income. The choice of real GDP is motivated by two factors: first, GDP data series have been consistently reported in Botswana, secondly, although wealth could be used as a proxy variable, there is no official statistics for wealth variable in Botswana. In this study it is used as an indicator of economic activity. This study is very aware of the shortcomings in the use of this variable as a measure of wealth, but the non-availability of data for other measures of wealth precludes their use in this study.

The other major issue in the model representation is the measurements of opportunity cost variables. The appropriateness of opportunity cost variable is a major issue because in developing countries there is a very limited degree of substitutability between financial assets and money. This is brought about by the limited range of the domestic financial assets available and the undeveloped nature of money and capital markets in most developing countries. Therefore, since financial assets are poor substitutes for money in these economies, the choice of individual wealth holder is limited to either holding money or real assets (Fielding, 1994: 18, Simmons, 1992: 29). Real assets include land, houses, consumer durables and livestock. The other notable feature is that interest rates in developing countries are in most cases not market determined, but rather are regulated by authorities (Simmons, 1992: 29). Botswana portrays all these features to some degree.

As mentioned, Chapter Three, interest rates were administered by the Bank of Botswana until 1986. After liberalisation of interest rates, commercial banks were allowed to set prime lending rate, but a ceiling was imposed on the rate of interest that could be charged on loans and Bank of Botswana also set a minimum deposit rate. This made interest rates negative in real terms for most periods. In fact, the real interest rate would have been even more negative if it had not been liberalised, because of the excess liquidity in the banking system. The Bank of Botswana had to play an unusual role of a deposit taker of the last resort at times in an attempt to mop up the huge money surplus in the economy. Thus, to capture the return on money (own rate of return on money), the savings deposit rate is used as proxy. The savings deposit rate is used as a measure of own rate of return on money and not as a measure

of return to alternative assets to money.<sup>37</sup> This is because of the limited range of financial assets available in the domestic economy and the widespread use of cattle as a traditional form of storing wealth in Botswana. The inclusion of own rate of return variables is justified since its exclusion might lead to non-constancy and lack of cointegration (Ericsson, 1998: 304).

The inclusion of the rate of inflation as a variable has been emphasised in the study of demand for money in developing countries, where there are underdeveloped financial systems and non-market determined interest rates. Therefore, physical assets represent one major hedge against inflation and alternative financial assets (Simmons, 1992: 32). The rate of inflation is seen as a measure of opportunity costs for holding money. It may also represent the kind of adjustment process used by agents and may capture whether agents actively adjust their nominal portfolios only or also passively adjust their assets induced by the changes in the price level (Lutkepohl and Wolters, 1998: 373, Baba *et al.*, 1992: 57). Basically, inflation rates reflect the store of value motive of money holdings (Treichel, 1997: 7). It is used as a relevant measure of opportunity cost of holding money as it indicates return on domestic real assets (Sriram, 1999a: 9).

Botswana has also followed a relatively liberal exchange control policy since the inception of the Bank of Botswana. Controls of the current account have been minimal. There have been virtually no parallel markets in foreign exchange in Botswana; multinationals can easily transfer money out of the country. Being an open economy without foreign exchange controls makes it possible for foreigners residing outside Botswana to hold domestic currency (Botswana Pula) while domestic residents can hold foreign currency in form of bank deposits and/or any other financial assets. This means that there is movement of currencies in and out of Botswana. Therefore, the interest rates on foreign securities may have an influence on the demand for money. An increase in foreign interest rates may potentially induce the domestic residents to increase their holdings of foreign assets and that increase will be financed by drawing down on domestic money holdings.

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<sup>37</sup> See a similar approach in Fielding (1994: 18) and Sriram (1999a: 8).

Furthermore, there is a scope for foreign currency substitution effects as nationals working abroad speculate with their foreign exchange earnings (Simmons, 1992: 32, Bossogo-Egoume, 2000: 9). For example, according to 1993 official figures there were about 12 755 Botswana nationals employed in the South African mines alone and there were close to 4090 non-citizens in the services of the Botswana government (Bank of Botswana, 1994: S17 and S16). Thus, excluding a foreign opportunity cost variable may lead to a misspecification of the domestic money demand (Sriram, 1999b: 13).

To capture the influence of foreign opportunity cost variable and to give attention to the open nature of Botswana's economy, a foreign opportunity cost variable is incorporated in an attempt to test whether external monetary development significantly affects the demand for money in Botswana. The substitution effect stemming from foreign financial assets is captured by including a short term foreign rate of interest, which is proxied by the South African Treasury Bill rate. The choice of the South African Treasury Bill rate has been motivated by two major factors: Firstly, the bulk of Botswana's imports originate from the SACU and South Africa remains the dominant trading partner of Botswana with about 80% of the country's imports originating from South Africa (Masalila and Phetwe, 2001: 6). Secondly, South Africa is geographically close to Botswana, hence, proximity and the fact that the South African interest rates have remained consistently higher than Botswana's interest rates may have implications for short term movements of funds. Another reason it is chosen is because the maturity structure of the South African Treasury Bill is in line with that of own rate money variable.

A variable that captures the currency substitution effect is also included in the model. The importance of such a variable is justified by the tendency of economic entities to hold foreign currency when it is considered a valuable alternative to domestic currency (Fielding, 1994: 18). This variable can be proxied by the expected depreciation of home currency and/or foreign interest rates (Simmons, 1992: 32). Nevertheless, in this study, it is proxied by the exchange rate between the American dollar and Botswana pula. It is proxied by the exchange rate because for countries with the similar monetary policy regime as Botswana it has been proved to be a

relevant opportunity cost of holding money variable, which is holding foreign currency as a substitute for domestic currency.<sup>38</sup>

The exchange rate can either be the expected rate of depreciation, nominal or real effective exchange rate, or nominal or real exchange rate (Sriram, 1999b: 12). The choice is merely an empirical issue (Sriram, 1999b: 12). Its coefficient will represent the opportunity cost of holding foreign currency other than the domestic one (Fielding, 1994: 18, Simmons, 1992: 29). The dollar/pula bilateral exchange rate is chosen since United States of America (USA) is Botswana's largest trading partner as a source foreign exchange earning, when trade in diamonds is included. The other reason is that the USA dollar is the principal intervention currency between the pula and other foreign currencies.<sup>39</sup> An exchange rate coefficient is expected to be negative, relative to M2 (to domestic money holdings). An increase in expected depreciation means that the expected returns from holding foreign money increases and agents will be able to substitute the domestic currency for foreign currency (Sriram, 1999b: 13, Bossogo-Egoume, 2000: 9).<sup>40</sup>

Using logarithms, equation (4.1) can be rewritten as:

$$LRM2 = f(LRY, DER, TBSA, INF, ER) \quad (4.2)$$

Where

*LRM2* is the real stock of money (M2)

*LRY* is real income (GDP)

*DER* is domestic interest rate (interest on 88-day commercial bank deposit)

*TBSA* is foreign interest rate ( South African treasury bill rate)

*INF* is the rate of inflation

*ER* is the exchange rate (United States of America dollar and Botswana pula).

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<sup>38</sup> See studies by Fielding (1994) and Simmons (1992).

<sup>39</sup> In the estimation the South African Rand was also tried in the place of the USA dollar but the results were not robust.

<sup>40</sup> The impact can be negative if the domestic currency depreciation leads the public to anticipate a further depreciation, hence making them demand more of foreign currency against the domestic currency. The positive impact can also occur if depreciation lifts up expectation that the domestic currency would appreciate, thus enticing people to hold more domestic money (Sriram, 1999b: 13).

Implicit in the equation (4.2) is the assumption that the demand for money is the demand for real balances (Simmons, 1992: 32, Baba *et al.*, 1992: 26, Adam, 1991: 403). This model forms the basis of the dynamic specification of demand for money function, which is estimated in this study.

From the foregoing our empirical money demand function can be expressed algebraically as:

$$LRM2_t = \alpha + \beta_1 LRY_t + \beta_2 DER_t + \beta_3 TBSA_t + \beta_4 INF_t + \beta_5 ER_t + \mu_t \quad (4.3)$$

Where

$\alpha$  is a constant

$\beta_i$  are the parameters

$\mu_t$  is an error term, while other variables are as described above.

All variables are in logarithms except the interest rate and the inflation rate. The interest rates can enter in either logs or levels (Ericsson, 1998: 297). In the equation (4.3) interest rates are not in logarithms. This result in a semi-log demand for money specification. As a result the coefficients on the interest rates are not elasticities; instead they show the percentage change in the quantity of money demanded from a percentage point change in the interest rate (Georgopoulos, 2000: 11). Sriram (1999a: 12) also argues that interest rates enter in level than in logarithms as they can be negative. The error term is assumed to be white noise with zero mean and the  $\beta$  s are the parameter estimates.

*A priori*, the underlying theory predicts  $\beta_1 > 0$ ,  $\beta_2 > 0$ ,  $\beta_3 < 0$  and  $\beta_5 < or > 0$  but preferably negative.<sup>41</sup> The inflation rate measures the return to holding goods, therefore the coefficient  $\beta_4$  on  $INF_t$  is expected to be negative because goods are an alternative to money, therefore it enter as level (Ericsson, 1998: 298, Laumas and

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<sup>41</sup> The possibility of obtaining a positive sign is however envisaged. The positive impact would result if a depreciation expectation that the domestic currency would rebound, hence prompting people to hold more domestic money.

Mehra, 1976: 464, Sriram, 1999a: 10). Inflation rate may also have a positive relationship with demand for money because when it is expected to rise, economic agents could increase the money holdings expecting their planned nominal expenditures to move up (Sriram, 1999a: 10). Therefore, it is merely an empirical issue, but we prefer a negative relationship as explained earlier. Table (4.1) shows a summary of expected signs of the coefficients in the general model (4.3).

**Table 4.1 Summary of Expected Signs of the Coefficients in the General Model**

<b>Variables</b>	<b>Signs (justification and magnitude)</b>
LRY = ln (real economic activity, GDP)	+ (coefficient = 1, assumed homogeneity of income)
DER = interest rate 88 day deposit	+ (interest rate on a component of money)
TBSA = 3 month RSA T-bill rate	- (Interest rate on competing foreign assets)
INF = inflation rate	-/+ (Opportunity cost of holding money rather than goods)
ER = US dollar to Pula exchange rate	-/+ (Opportunity cost of holding Pula rather than foreign currency)

#### 4.2.2 Data sources

The variables used in this study are broad money (M2), nominal interest rates (interest on 88 day commercial bank deposit for domestic and three month South African Treasury bill for foreign interest rates), Income (GDP), Consumer Price Index (CPI), and the US dollar/pula exchange rate. Specifically; M2 is derived from adding the values of line 34 and 35 of the Botswana data series in the International Financial Statistics (IFS) CD-ROM<sup>42</sup>, the US dollar/pula bilateral exchange rate is the end of period bilateral rate corresponding to line (ae). The data for 88 day commercial bank deposit rate, CPI, Inflation rate and the South African rand/pula exchange rate were all obtained from various Bank of Botswana annual reports. The figures for the three month South African Treasury bill was obtained from the South African Reserve

<sup>42</sup> Published by the International Monetary Fund.

Bank website. The quarterly GDP from 1993: 1 to 2005:2 was obtained from line 99b.p of the IFS CD-ROM and the figures for 1978: 1 to 1992: 4 were interpolated from the annual series provided by various Bank of Botswana annual reports.

For real income (GDP), where only annual data are available, the annual series was converted to quarterly series using Quadratic match sum interpolation method as provided by Eviews software. The choice of this interpolation method was made following a study by Aziakpono (2005: 163); where after careful experimentation with other methods the choice ensures that the resultant interpolated series reflects as much as possible the pattern of the original series.

The frequency of observation may have an effect on both exogeneity and cointegration of variables. If economic agent's decisions occur over a relatively shorter time period than the data frequency, dynamics may be confused and inferences about cointegration altered, hence the use of quarterly data will yield better results than when annual data could have been used (Ericsson, 1998: 299). The data is also seasonally unadjusted to avoid problems linked with pre-filtering.<sup>43</sup> The period covered by the study is between 1978: 1 and 2005: 2 giving a quarterly series of about one hundred and six (106) observations. The starting period coincides with the time when the Bank of Botswana was launched and the pula currency was starting to be in circulation. Although the aim of the study was to start at first quarter of 1975 to last quarter of 2005, it could not be possible due to data limitations. A dummy variable *dum1* is also introduced to pick the effect of policy change and impact of financial liberalisation. This dummy variable is set as a zero before the third quarter of 1991 and one thereafter, as this is the period when BoBCs were introduced and the liberalisation measures were starting to make an impact.

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<sup>43</sup> See Bossogo-Egoume, 2000: 8, for example.

## **4.3 ESTIMATION TECHNIQUES**

### **4.3.1 Introduction**

The main focus of this section is to provide the general framework for the analysis. Some description of the econometric technique is presented. To establish and estimate a cointegrating relationship and an error correction model, the Johansen (1988) and Johansen and Juselius (1990) procedure is followed in this study. Once the cointegration relationship has been found and the test of exogeneity shows that money is endogenous, the model will be reduced from a systems formulation to a single equation to analyse the short run characteristics adjustment behavior of variables. This will be achieved by following a general to specific approach. This section is subdivided into tests for stationarity, cointegration and weak exogeneity. The stability testing procedure is also presented.

### **4.3.2 Unit root test**

A useful preliminary step to performing any regression analysis is to uncover the properties and characteristics of the actual data involved. Such an analysis of the individual time series variables is important because the properties of the individual series have to be taken into account in modelling the data generation process of a system of potentially related variables (Lutkepohl and Kratzig, 2004: 8). Some of the characteristics may have an impact on the statistical inference used in modelling and analyzing the underlying economic system. The first step is the notion of whether a series is stationary or not. Stationarity of the series is a desirable property for an estimated model. A series is considered stationary if it has a constant mean, constant covariance and constant autocovariances for each given lag (Brooks, 2002: 367, Lutkepohl and Kratzig, 2004: 11). The stationary or otherwise of a series can have a strong influence on the behaviour and properties of the data.

If a series is stationary, the unexpected shock<sup>44</sup> to the system will die away rapidly, that is, the effect of a shock during the time  $t$  will have a smaller effect in time  $t + 1$  and so on. In comparison to a non-stationary series where the effect of a shock to the system will not die away with time, the effect of a shock during time  $t$  will not have a smaller effect in time  $t + 1$ , and in time  $t + 2$  (Brooks, 2002: 367). The use of non-stationary data in analysis can lead to spurious regressions. If two variables are trending over time, a regression of one on the other could have a high  $R^2$  even if the two variables are totally not related to each other. If the standard regression techniques is applied to non-stationary series the results may appear good, with significant coefficient estimates and high  $R^2$ , but in actual fact they will be valueless because they are spurious.

The use of non-stationary variables in a regression model can make the standard assumptions for asymptotic analysis invalid. This means that the usual t-ratios will not follow a t-distribution, and the F-statistic will not follow an F-distribution (Brooks, 2002: 368). In order to induce stationarity in a series, the series must be differenced a certain number of times (Harris, 1995: 22). For example, if a non-stationary series  $y_t$  must be differenced  $d$  times before it becomes stationary, then it is said to be integrated of order  $d$  i.e.  $y_t \sim I(d)$ . So if  $y_t \sim I(d)$  then  $\Delta^d y_t \sim I(0)$ . This means that using the differencing operator,  $\Delta$ ,  $d$  times, leads to an  $I(0)$  process, that is a process with no unit roots (Brooks, 2002: 375). Applying the difference operator  $d$  times to an  $I(d)$  process will result in a stationary series. An  $I(0)$  series is a stationary series, while an  $I(1)$  series contains one unit root and an  $I(2)$  series contains two unit roots and it will require differencing twice to induce stationarity.

To determine the time series characteristics of the data, the study uses Augmented Dickey Fuller (ADF) and the Phillips-Perron (PP) tests described in the subsection that follows.

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<sup>44</sup> A shock means a change or an unexpected change in a variable or the value of an error term during a particular period (Brooks, 2002: 367).

### 4.3.2.1 Augmented Dickey Fuller

The Augmented Dickey Fuller test is formulated by the following equation:

$$\Delta X_t = \alpha_0 + \alpha_1 X_{t-1} + \alpha_i \sum_{i=1}^n \Delta X_{t-i} + \mu_t \quad (\mu_t \sim IID(0, \sigma^2)) \quad (4.4)$$

Where

$$\Delta X_{t-1} = (X_{t-1} - X_{t-2})$$

$$\Delta X_{t-2} = (X_{t-2} - X_{t-3})$$

$\mu_t$  is the error term (Brooks, 2002: 380, Aziakpono, 2000: 133).

The null hypothesis to be tested is  $H_0 : \alpha_1 = 0$  against the alternative that  $H_1 : \alpha_1 \neq 0$ .

Under the null hypothesis that  $\alpha_1 = 0$ , the computed t-statistic is known as the  $\tau$  statistic and does not have the standard t-distribution because the variance is unlimited. The critical values of the  $\tau$  are provided in Dickey and Fuller (1979). If the computed absolute value of the  $\tau$  is less than the critical value, the series is non-stationary, whereas if it exceeds the Dickey Fuller critical value, we do not reject the hypothesis that the given time series is stationary.

The only problem which arises will be how to determine the number of optimal lags of the dependent variable. The purpose of lag length is to ensure that the residual is not serially correlated. It is very important to use an optimal number of lags of the dependent variable in the test regression because if too few lags are included not all of the autocorrelation will be removed and if too many are included there will be an increase in the coefficient standard errors (Brooks, 2002: 380, Harris, 1995: 34). Although the number of lagged difference terms to be included is determined empirically, the idea is to include enough terms so that the error term in equation (4.4) is serially independent (Aziakpono, 2000: 135). The lag length was selected using the Final Prediction Error (FPE) and Akaike information criterion (AIC).

#### **4.3.2.2 Phillip-Perron**

Phillips-Perron (PP) is a more comprehensive test of unit root. Although it is similar to ADF tests, it incorporates an automatic correction to the Dickey Fuller procedure to allow for autocorrelated residuals (Brooks, 2002: 381). The Phillips-Perron test is carried out using the t-statistic following the same procedure as the Augmented Dickey Fuller approach. The major criticisms of the ADF and PP tests are that their estimation power is low if the process is stationary but with a root close to the non-stationary boundary. They have the tendency to over-reject the null hypothesis of non-stationarity when it is in fact true, and under-reject the null when it is false (Brooks, 2002: 382, Harris, 1995: 80). After establishing the stationarity status of the data, the next step is to carry out the cointegration analysis as outlined in the following subsection.

#### **4.3.3 Cointegration analysis**

The cointegration analysis is carried out using the Johansen (1988) and Johansen and Juselius (1990) procedure. This procedure is preferred to the Engle-Granger approach, because the Engle-Granger does not provide the researcher with the opportunity to evaluate the presence of multiple cointegrating relationships among variables. Secondly, it has been criticized for low power in estimation due to the usual finite sample problem as a significant small sample bias is known to exist in estimates of its cointegrating relationships (Brooks, 2002: 395, Adam, 1991: 407, Hafer and Jansen, 1991: 157, Sriram, 1999b: 38). Therefore, Johansen (1988), Johansen and Juselius (1990) is chosen mainly because it provides an opportunity to evaluate the presence of multiple cointegrating vectors and has proved to be more efficient than the Engle-Granger approach (Adam, 1991: 407, Hafer and Jansen, 1991: 157). The approach does not rely on an arbitrary normalization. It applies maximum likelihood estimation to a vector autoregressive (VAR) model to simultaneously determine the long run and short run determinants of a set model. It estimates the long run relationship and the dynamic adjustment in form of a vector error correction model (VECM) (Wesche, 1996: 9).

To derive this alternative method for the analysis of cointegrating vectors and following Johansen and Juselius (1990), consider a vector autoregressive process (VAR) of the form:

$$X_t = \Pi_1 X_{t-1} + \dots + \Pi_k X_{t-k} + \mu + \varepsilon_t \quad (4.5)$$

( $t = 1, \dots, T$ )

Where

$X_t$  is a  $p \times 1$  vector of  $I(1)$  variables (vector of all endogenous variables in the system)

$\mu$  is a vector of constants (the intercept)

$\varepsilon$  denotes stochastic error term (independently normally distributed).

If the variables in  $X_t$  are cointegrated, then using the difference operator,  $\Delta$ , equation (4.5) may be reparametrized as follows:

$$\Delta X_t = \phi_1 \Delta X_{t-1} + \dots + \phi_k \Delta X_{t-k} + \Pi X_{t-k} + \mu + \varepsilon_t \quad (4.6)^{45}$$

$$\phi = -(1 - \Pi_1 - \dots - \Pi_k), \Pi = -(1 - \Pi_1 - \dots - \Pi_k) \quad (4.7)$$

Where  $\Pi X_{t-k}$  contains some information about the long run relationship between the variables represented in the vector,  $X$ . The only difference between a standard version of a VAR model and equation (4.6) is the term  $\Pi X_{t-k}$ . This term conveys information about the long run relationship between the  $X$  variables. If  $X_t$  is non-stationary in levels but  $\Delta X_t$  is stationary,  $X_t$  is integrated of order one. If there is at least one linear combination of the variables of interest in the equation which is stationary, then the term  $(\Pi X_{t-k})$  will be consistent with a stationary VAR (only if it is itself stationary). Such a linear combination would represent a stable long-run

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<sup>45</sup> Equation (4.6) is derived by first subtracting  $X_{t-1}$  from both sides of equation (4.5) and collecting terms on  $X_{t-1}$ . Then zero is added to the right hand side of the equation; that is, add  $-(\Pi_1 - 1)X_{t-1} + (\Pi_1 - 1)X_{t-1}$ . Repetition of this procedure and collection of like terms yield equation (4.7)

relationship between the variables in an equation. If the elements of  $\Pi$  can be estimated efficiently, equation (4.6) provides an efficient way of estimating the short-run parameters,  $\phi_i$ , since all the variables in this equation are stationary. It should however be noted that equation (4.6) includes  $r$  separate regressions, of which we are particularly interested in one: the regression for  $\Delta(m-p)_t$  from equation (4.3). The main focus of Johansen-Juselius technique is on the parameter matrix  $\Pi$  and it is this matrix in which cointegration can be detected.

In estimating the elements of  $\Pi$ , we follow Johansen and Juselius (1990). We consider a process of the form given in equation (4.5). The order of integration, both of the elements of  $X$  and the VAR itself, are unknown in equation (4.5). The rank of the matrix,  $\Pi$ , will be determined by the number of stationary linear combinations represented by  $X$ . If there are  $n$  such combinations in the equation, then  $\Pi$  is of full rank. The variables represented by  $X$  are  $I(0)$  (Corhay *et al.*, 1995: 13, Harris, 1995: 79). If there are no such combinations in the equation, then it means that the variables are all  $I(1)$ , but they are not cointegrated, in which case the  $\Pi X_{t-k}$  term is redundant. The error correction isomorphism cannot then be employed. If, however, the rank of  $\Pi$  is positive but less than  $n$ , then  $\Pi$  can be factorised as  $\Pi = \alpha\beta'$ , where  $\alpha$  and  $\beta$  are  $(n \times r)$  and  $(r \times n)$  matrices, respectively.

The matrix  $\alpha$  contain corresponding feedback parameters, that is, a matrix of error correction parameters (Fielding, 1994: 21, Adam, 1991: 407, Hafer and Jansen, 1991: 158). The coefficients of estimated  $\alpha$  vector are interpreted as the weights with which the variables enter the equations in the VAR system. The signs and magnitudes of these coefficients give valuable information about the characteristics of the short run dynamics of the system, that is, its stability as well as the direction and speed of adjustment towards the long run equilibrium path (Islam and Ahmed, 1999: 100). The matrix  $\beta$  represents the parameter of economic interest in the VAR, that is, it is interpreted as a matrix of cointegrating vectors (the long run coefficient). The cointegration vectors  $\beta$  have the property that  $\beta' X_t$  is stationary even though  $X_t$  itself is non-stationary (Johansen and Juselius, 1990: 170).

There are three steps involved in the estimation of equation (4.6). The first step is to determine the appropriate order of the VAR.<sup>46</sup> The idea in principle is to use a minimum lag length, which is sufficient to remove autocorrelation in the residuals. The second relates to the assumption regarding the trend underlying the time series to be used in testing for cointegration. The determination of the rank ( $r$ ) of the matrix,  $\Pi_j$ , which is the cointegrating rank or the number of cointegrating relations, is the last task (Wang and Dunne, 2000: 9).

Before applying the Johansen and Juselius method and observing the characteristics of the  $\Pi$  matrix in the equation, we have to specify the appropriate lag length ( $k$ ) of the VAR system to make the residuals uncorrelated. Several methods have been used in the literature to determine the VAR order, such as the Sequential Modified Likelihood Ratio (LR), the Final Prediction Error (FPE), Akaike Information Criterion (AIC), the Schwarz Information Criterion (SC) and the Hannan-Quinn Information Criterion (HQ). Although these criteria may produce conflicting VAR order selections, the aim is to use the criterion that produces the best possible results. The reason is that the VAR order chosen can significantly affect the conclusion reached about the number of cointegrating relationships. The best possible results are those that produce the number and form of cointegration relation(s) that conforms to economic theory and all the *a priori* knowledge associated with the theory (Seddighi *et al.*, 2000: 309, Wong, 2004: 12).

To check whether to include an intercept or trend, we consider the five deterministic trend assumptions. These are: (1) the level data  $X$  has no deterministic trend and the cointegrating equations do not have intercepts; (2) the level data  $X$  has no deterministic trend and the cointegrating equations have intercepts; (3) the level data  $X$  has a linear trend but the cointegrating equations have only intercept; (4) Both the level data  $X$  and the cointegrating equations have linear trends; and (5) the level data  $X$  has quadratic trends and the cointegrating equations have linear trends (Eviews 5 manual: 722- 725).

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<sup>46</sup> Note: this happens before running Johansen procedure.

The choice of the deterministic trend assumption is based on the nature of the data generating process (DGP), which is determined from the unit root test and the visual inspection of the graphs of the relevant series. The rough guide provided by Eviews 5 in choosing assumptions is as follows; to use case 2, if none of the series appear to have a trend, and for trending series, to use case 3, if there is a belief that all trends are stochastic and case 4 can be used if some of the series are trend stationary. Case 1 is normally used if all series have zero mean and case 5 may produce a good fit in-sample but will produce implausible out of sample forecast (Eviews 5 manual: 722-725).

The rank of the matrix  $\Pi_i$ , which is the number of cointegrating relation(s), will be determined using the two commonly used likelihood ratio (LR) test statistics as provided in Johansen (1990). These are trace statistic ( $\lambda_{trace}$ ) and the maximum Eigenvalues ( $\lambda_{max}$ ) with their test statistics given as:

$$\lambda_{trace} = -T \sum_{i=r+1}^n \log \left( 1 - \hat{\lambda}_i \right) \quad (4.8)$$

$$\lambda_{max} = -T \log(1 - \hat{\lambda}_{r+1}) \quad (4.9)$$

Where  $\lambda_i$  is the  $i$ -th largest Eigenvalues of the  $\Pi_i$  matrix in equation (4.6) stated earlier, that is  $\Pi = \alpha\beta$ ,  $T$  is the number of the usable observations. This likelihood ratio (LR) test, which is based on Trace and Maximum Eigenvalue statistic, tests the null hypothesis that there are  $r$  or fewer cointegration vectors against the alternative hypothesis that there are  $r+1$  and at least  $r+1$  cointegrating vectors for the Maximum Eigen value and Trace statistics, respectively. In these likelihood ratio tests, the null hypotheses are accepted if the estimated values are less than the critical values at the appropriate significance level and the degrees of freedom.

When cointegration relationships are found, weak exogeneity tests are done by normalising each vector on the variable for which clear evidence of error correction is

found, that is, where the coefficient of  $\alpha$  is negative and significant (Aziakpono, 2006: 16, Arestis and Demetriades, 1997: 788, Luintel and Khan, 1999: 388). Given the objective of our study we will be inclined to normalise on the variable real stock on M2. Weak exogeneity tests are done to explore whether the model can be reduced from a system to a single equation to analyse the short run dynamics (Jonsson, 1999: 18, Harris, 1995: 77). Another issue involved in weak exogeneity is whether the variables should be treated as exogenous or endogenous. The exogeneity issue is addressed by placing a zero restrictions on the  $\alpha$  vector in  $\Pi = \alpha\beta'$  matrix (Jonsson, 1999: 16).

The null hypothesis is usually examined by restricting the particular  $\alpha$  equals to zero; hence, weak exogeneity involves testing whether or not the corresponding row of  $\alpha$  is zero (Sriram, 1999a: 21). Sriram (1999a: 22) suggests that if the null hypothesis is not rejected, disequilibrium in the cointegrating relationship does not feed back onto that variable, although any disequilibrium of a given variable will have an impact on the cointegrating relationship.

Recall that the coefficients in the  $\alpha$  matrix capture the speed of adjustment of a particular variable to a deviation from the long run equilibrium; therefore, a zero restriction on any coefficient in this matrix corresponds to the null hypothesis that the particular variable does not adjust to restore the long run equilibrium, and thus can be treated as weakly exogenous.

Based on the cointegration test and weak exogeneity test the next step will then be to take the model further by modelling it along the general to specific framework as explained in the section that follows.

#### **4.3.4 General to specific approach**

In the general-to-specific modelling, the modeller simplifies an initially general model that adequately characterizes the empirical evidence within his or her theoretical framework to a specific parsimonious congruent representation (Campos *et al.*, 2005: 1, Hendry and Richard, 1982: 6). Then, that general model is reduced by sequential

elimination of statistically insignificant variables and checking the validity of the reductions at every stage to ensure congruence of the finally selected model (Harris, 1995: 67, Campos *et al.*, 2005: 3).

The simplification from general-to-specific can proceed in many ways and consequently the selection rule involves the use of *a priori* specifications and common statistical criteria such as using t-tests (Rose, 1985: 444, Gilbert, 1986: 287). This means that to have a viable empirical approach, these *a priori* specifications require knowledge of the answer before starting. The possibility of deleting irrelevant variables is relatively high and there is also a greater difficulty in retaining relevant variables, hence the use of t-test for sequential elimination of such (Campos *et al.*, 2005:18). The process of reduction to a specific model is necessarily one of trial and error, involving the examination of a variety of models. In carrying out this procedure, the same lag length as explained earlier is used. The advantage of general to specific approach is that the investigator starts with a very general hypothesis that is acceptable and then narrows it down by looking for simplifications that are acceptable on the data used (Gilbert, 1986: 287). Therefore, this implements the theory of reduction in an empirical practice and makes the approach have excellent model selection abilities (Campos *et al.*, 2005; 78).<sup>47</sup>

To be specific, having obtained the long run cointegration relationships using the Johansen approach explained in the earlier section and if the weak exogeneity test confirms that money is endogenous, it becomes possible to reformulate a partial model as shown by the equation that follows:

$$\Delta z_t = \Gamma_1 \Delta z_{t-1} + \Gamma_2 \Delta z_{t-2} + \Gamma_i \Delta z_{t-i} + \alpha \left( \beta_1' z_{t-1} + \beta_2' z_{t-1} \right) + \psi D_t + \mu_t \quad (4.10)$$

In this equation  $z_t = [LRM2_t, LRY_t, INF_t, DER_t, TBSA_t, ER_t]$ . It makes no difference whether it enters the error correction term with a lag of  $t-1$  or  $t-k$ , since two forms of equation (4.10) can be shown to be equivalent (Harris, 1995: 134). After identifying the true cointegration, using weak exogeneity tests, the OLS will be an

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<sup>47</sup> Refer to Campos *et al.*, (2005) for details on theory of reduction.

efficient way to estimate each equation present in (4.10) given that each has a common set of lagged regressors. Having established that all variables in the ECM are now  $I(0)$ , statistical inferences using the standard t-tests are valid (Harris, 1995: 134). The established model can then be checked in terms of diagnostic tests on residuals and checks on whether parameter constancy holds in the system as a whole.

### **4.3.5 Structural stability testing**

The stability test determines whether a statistically significant structural breakpoint can be identified over the estimation period. The test traces the time path of any impact that may have occurred in the estimated parameters. This impact might be due to some financial sector developments or policy changes that occurred at a particular time period. Therefore, this plot of recursive coefficient parameter is done to investigate whether the demand for money function has remained stable after some major financial sector reforms.

In this study recursive coefficient estimates are used to examine the structural stability of the estimated demand for money function. The recursive coefficient estimates are plotted in graphs which will enable us to view and trace the evolution of any structural breaks that may have occurred in the estimated period. The recursive coefficient estimates also show the two standard error bands around the estimated coefficients. If the coefficient plots show dramatic jumps, it is a sign of a potential structural break.

## **4.4 CONCLUSION**

This chapter provided a construction of the demand for money model for Botswana. It identified and explained various relevant variables which can explain the demand for broad money in Botswana. The chapter also describes different sources of data from which variables were obtained. The procedures involved in the Johansen (1988), Johansen and Juselius (1990) approach were presented. Based on the cointegration approach and weak exogeneity testing, the modelling procedure is taken a step further by the Hendry's type of general to specific approach. The chapter also explained the steps involved in structural stability test. The next chapter deals with the actual

estimation of the demand for money function using the various tests explained in this chapter.

## CHAPTER FIVE

# EMPIRICAL RESULTS

### 5.1 INTRODUCTION

This chapter presents the graphical analysis and the results of the unit roots tests for the variables in the model from Augmented Dickey-Fuller and Phillip-Perron tests. Then, cointegration was tested among the variables entering the demand for money equation using the Johansen (1988) and Johansen and Juselius (1990) maximum likelihood procedure, with a view to establishing the long run relationship. The error-correction models are thereafter estimated. After estimation and discussion of the cointegrating vector the model is reduced to a parsimonious one by the general to specific approach. The stability of the model is finally examined to check for any major structural breaks in the model.

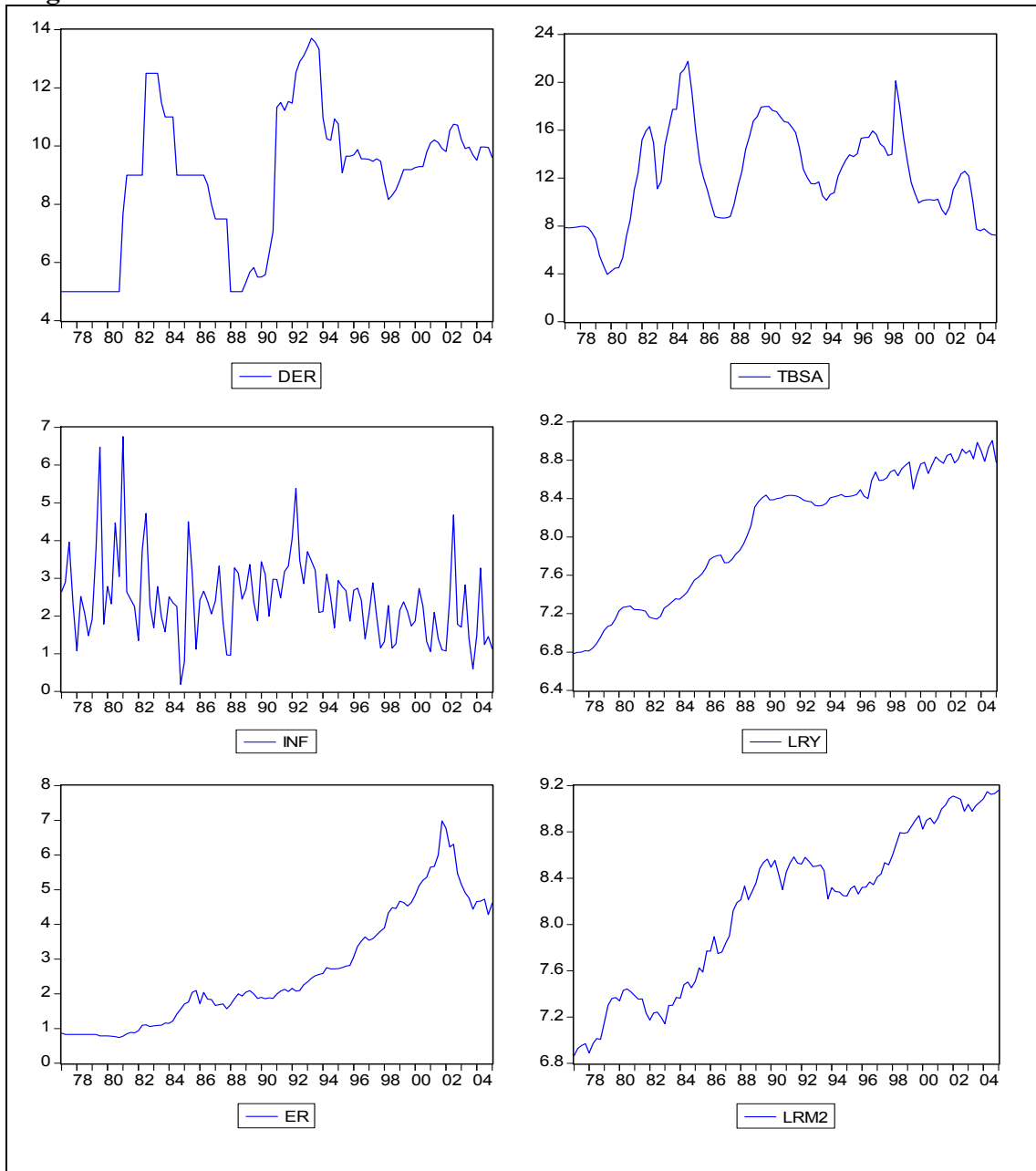
### 5.2 GRAPHICAL ANALYSIS

The graphical examination of the series is very important before any form of analysis. This graphical examination allows for detection of any data capturing errors, and checking of structural breaks or drifts that may bias the unit root tests. It also allows us to have an idea of the trends and stationarity of the data. Figure 2 shows plots of all variables used in the model in their logarithm form, except interest rates and inflation, which are in level. All the variables are plotted against time to have an idea of their behaviour.

The visual inspection of the plots shows that none of the variables seem to be following a specific pattern, except for the LRY and LRM2. The LRY and LRM2 seem to be following an upward moving pattern. However, this pattern does not seem to be defined or predictive. The rapid increase in monetary aggregate (LRM2) in the late 1980s could be attributed to the widening and deepening of the financial system,

which resulted from the opening up of vast areas of the country for productive and financial activities after the starting of financial liberalisation that started in the very late 1980s. The changes in real money balances are also closely associated with the changes in economic activities as represented by the LRY. Although for most periods the growth rate of real GDP far outpaces the growth in real money balances, the patterns in both variables seem on average to be that of an upward movement.

**Figure 2: Plot of Variables**



Looking at the graphs of Figure 2, it is apparent that the series are non-stationary at levels, except inflation rate variable; however its stationarity is not very clear. The

conclusion of non-stationarity is arrived at after observing that none of the graphs fluctuate around a zero mean, an indication of stationarity. The other characteristic of the series DER, TBSA, INF and LRY is that they seem to have an intercept; however, this will be confirmed by some formal test for the conditional hypothesis. The problem with the visual inspection technique is that the approach is very subjective. The graphical analysis serves as a benchmark for the formal measure of unit root. The ADF and PP tests are therefore used to determine if a unit root exists in each of the series.

### 5.3 UNIT ROOT TESTS AND RESULTS

In order to carry out any multivariate cointegration analysis, stationary time series data is required. It is therefore essential for us to formally test for stationarity of each series used in this study. In this study, we employ the ADF and the Phillips-Perron (PP) tests in order to determine if a unit root exists.

The ADF and the PP can be estimated with no intercept and no trend, with intercept but no trend, and with intercept and trend. Following Aziakpono and Obasa (2004: 326-327) and Seddighi *et al.* (2000: 267-277) we run regressions to determine which trend or intercept assumption is relevant in our estimations. Given an ADF model as follows:

$$\Delta X_t = \alpha + \beta_t + \delta X_{t-1} + \sum_{j=2}^q \delta_j \Delta X_{t-j+1} + \varepsilon_t \quad (5.1)$$

Where

$\Delta$  is the difference operator

$\alpha$  is the constant term or the drift

$\beta$  is the linear deterministic trend (or time trend)

$\varepsilon$  is a white noise error term.

When the difference term in equation (5.1) is not included, the ADF reduces to a Dickey Fuller model (DF). However, in both cases, the series is said to be stationary if the coefficient  $\delta = 0$  using the  $\tau$  (tau) statistics. Therefore, the test for conditional

hypothesis for unit root relating to whether the  $\alpha$  and/or  $\beta$  in the model is individually significant is conducted. Dickey and Fuller (1981, in Seddighi *et al.*, 2000: 272) provided us with three symmetric critical  $\tau_{ij}$  values,<sup>48</sup> called  $\tau_{\alpha\tau}$ ,  $\tau_{\beta\tau}$ , and  $\tau_{\alpha\mu}$ , for testing the drift parameter  $\alpha$  and the linear time trend parameter  $\beta$ , conditionally upon  $\delta = 0$ . These conditional hypotheses are the following:

- (1) When regression equations of the form (5.1) are used without the difference term:

$$H_o : \alpha = 0 \text{ given that } \delta = 0, \text{ if } |t| < |\tau_{\alpha\tau}|$$

$$H_a : \alpha \neq 0 \text{ given that } \delta = 0, \text{ if } |t| > |\tau_{\alpha\tau}|$$

- (2) When regression equations of the form (5.1) are used without the difference term:

$$H_o : \beta = 0 \text{ given that } \delta = 0, \text{ if } |t| < |\tau_{\beta\tau}|$$

$$H_a : \beta \neq 0 \text{ given that } \delta = 0, \text{ if } |t| > |\tau_{\beta\tau}|$$

- (3) When regression equations of the form (5.1) are used without the difference term and the linear trend terms:

$$H_o : \alpha = 0 \text{ given that } \delta = 0, \text{ if } |t| < |\tau_{\alpha\mu}|$$

$$H_a : \alpha \neq 0 \text{ given that } \delta = 0, \text{ if } |t| > |\tau_{\alpha\mu}|$$

Table 5.1 presents the results for the testing of conditional hypotheses for unit root for each variable, and reports whether the variable has a drift and /or a deterministic trend and the value at which the null hypothesis was rejected or accepted. As it can be seen in the results in Table 5.1, the variables that show a stochastic trend (intercept) in the series are: DER (domestic interest rate), INF (Inflation rate) and TBSA (South African Treasury Bill rate). All variables are interpreted at 5 percent level of significance; however the DER calculated value was rejected at 10 percent level of significance since it was not significant at 5 percent. The test was carried out in levels.

<sup>48</sup> Tables for these critical values are reproduced in Seddighi *et al.* (2000: 272).

**Table 5.1: Conditional hypothesis results**

Variable	Stochastic trend ( $t_{\alpha\tau}$ )	Deterministic trend ( $t_{\beta\tau}$ )	Intercept only ( $\tau_{\alpha\mu}$ )	Decision rule
LRM2	2.048355	1.647809	1.425859	None
LRY	2.020819	1.428976	2.124631	None
DER	2.394395	0.602824	2.412787*	Intercept
INF	6.836358***	2.444249	7.051659***	Intercept
TBSA	2.597638**	0.338390	2.683161**	Intercept
ER	0.717580	1.730123	1.400464	None

Note: \*\*\*, \*\* and \* denote the rejection of the null hypothesis of intercept at 10%, 5% and 1% level of significance, respectively.

In all other variables, since  $|t_{\alpha}| < |\tau_{\alpha\tau}|$  and  $|t_{\beta}| < |\tau_{\beta\tau}|$ , we accepted the null hypothesis in case 1 and 2 respectively, that is, we accept that given that the variables LRY, LRM2, ER are non-stationary, there is neither a stochastic trend nor a deterministic trend in the series. For example, considering variable LRM2, with  $n = 106$  observations, we obtain  $t_{\alpha} = 2.048355$  and  $t_{\beta} = 1.647809$ . Therefore, for testing hypotheses (1) and (2) we have to compare these  $t$  values with the corresponding  $\tau_{ij}$  critical values from Table 7.9 (in Seddighi *et al.*, 2000: 272). In that Table 7.9 we have  $\tau_{\alpha\tau}(n = 100) = 3.11$  and  $\tau_{\alpha\tau}(n = 250) = 3.09$ , and  $\tau_{\beta\tau}(n = 100) = 2.79$  and  $\tau_{\beta\tau}(n = 250) = 2.79$ , hence, there is neither a stochastic trend (intercept) nor a deterministic trend generating the series. The decision rule was taken considering the critical values sample to be  $n = 100$  and  $n = 250$  as shown in Seddighi *et al.* (2000: 272). The critical values were compared to the observed values at the actual sample of 106.

The option with intercept in cointegrating vectors was then adopted, since three series indicated intercept. Therefore, throughout this study, assumption 3 is used in the estimations. Table 5.2 reports the unit root tests results using both the ADF and PP with an intercept only. The ADF and PP test statistics from the unit root regressions were tested under the null hypothesis that the variables are not stationary against the alternative that they are stationary after taking first differences.

The results in Table 5.2 show that the null hypothesis of non-stationarity cannot be rejected when variables are at levels, except for inflation rate variable (INF). The non-stationarity of inflation rate variable is expected since inflation is a first difference of consumer price index, hence cannot be anything else other than  $I(0)$  (Aziakpono, 2000: 138; Harris, 1995: 80). However, after taking first differences, all variables become stationary. Therefore, we can conclude that all the variables in our cointegration regression are first difference stationary, that is, each series is characterised as integrated of order one  $I(1)$ , with the exception of inflation series. This is understandable, since it has already been differenced. Its inclusion in our model will pose no problems (Harris, 1995: 80).

**Table 5.2: Unit root test (with intercept)**

Variables	ADF Test		Phillips-Perron Test	
	Level	1 <sup>st</sup> difference	Level	1 <sup>st</sup> difference
LRM2	-1.184011	-10.95159***	-1.183351	-10.94390***
LRY	-1.947526	-3.706276***	-1.837377	-10.22109***
DER	-2.373763	-8.724116***	-2.221263	-8.713125***
INF	-7.767458***	-5.366921***	-7.953051***	-29.56163***
TBSA	-2.829807	-6.519104***	-2.379222	-6.486242***
ER	-0.516365	-9.021237***	-0.687661	-9.209043***

Notes: \*\*\* and \*\* denote the rejection of the null hypothesis of unit root at the 1% and 5% level of significance, respectively. The lag order for the series was determined by the Schwartz information criterion.

The results in Table 5.2 serve to confirm the conclusions reached via graphical analysis. Therefore, all the series are considered as  $I(1)$ , except inflation rate series. The results of graphical examination and formal unit root tests confirm that a standard regression model is not appropriate for estimating the relationship between broad money and the other variables specified in the model, hence the need for cointegration technique (Islam and Ahmed, 1999: 103; Sriram, 1999a: 16). The non-stationarity of the data and the notion that none of the variables *a priori* can be regarded as exogenous suggest that an appropriate methodology would start with a non-structural vector auto regression model (VAR), and use cointegration tests to examine whether any long run relationship exists among the variables (Jonsson, 1999: 8). The next step,

therefore, is to identify whether or not there is a cointegration relationship among the variables. This is done in the following section.

## 5.4 COINTEGRATION ANALYSIS

Since we are now certain that the variables are integrated of order one, the next step is to test if a long run relationship exists among the variables in our model. The Johansen maximum likelihood procedure is applied for this purpose to a vector autoregression (VAR) version of the equation. Variables LRM2, LRY, DER, INF, TBSA and ER are entered as endogenous variables in that order. However, to implement Johansen we are not only required to determine the order of integration among the variables, the  $(r)$ , but also an optimal lag length  $(k)$  must be chosen for the VAR system. In principle, we should use only a minimum lag length, which is sufficient to remove auto-correlation of the residuals (Wong, 2004: 11).

The specification of the lag length of the VAR is tested sequentially, using the five information criteria reported in E-views, which are multivariate information criteria: namely the Sequential Likelihood Ratio (LR), the Final Prediction Error (FPE), Akaike Information Criterion (AIC), the Schwarz Information Criterion (SC) and the Hannan-Quinn Information Criterion (HQ).

The decision to use trend assumption 3 has already been established under testing of conditional hypothesis. Therefore, we are only left with choosing the optimal lag length and this is done using the multivariate information criteria. The best decision is to choose the criteria that agree with theory underpinning the study of demand for money and all *a priori* expectations that are linked with the theory concerned. Table 5.3 shows the result of the lag length selection for the VAR by different information criteria.

Table 5.3 shows that the five information criteria report three conflicting results. It shows that lag length 1, 2 and 6 are identified. These three were explored and we preferred lag length 2 as identified by the Final Prediction Error (FPE) and the Akaike Information Criterion (AIC). The reason for the choice is that when we explored

cointegration using lag length 1 it showed that there is one cointegration among variables and the results were also not significant, contrary to economic theory of demand for money. Importantly the income elasticity was way below unity and insignificant.

**Table 5.3: Lag length selection**

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VAR Lag Order Selection Criteria  
 Endogenous variables: LRM2 LRY DER INF TBSA ER  
 Exogenous variables: C DUM1  
 Date: 06/04/06 Time: 18:18  
 Sample: 1977Q1 2005Q1  
 Included observations: 105

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-732.3007	NA	0.057840	14.17716	14.48047	14.30006
1	-131.3506	1110.327	1.23e-06	3.416202	4.629441*	3.907831*
2	-94.90132	63.17878	1.23e-06*	3.407644*	5.530812	4.267994
3	-67.55272	44.27868	1.48e-06	3.572433	6.605530	4.801504
4	-47.38570	30.34656	2.07e-06	3.874013	7.817040	5.471806
5	-18.98436	39.49140	2.53e-06	4.018750	8.871706	5.985263
6	28.54285	60.65377*	2.21e-06	3.799184	9.562069	6.134419
7	60.06314	36.62357	2.73e-06	3.884512	10.55733	6.588468
8	87.00297	28.22268	3.85e-06	4.057086	11.63983	7.129764

---

\* indicates lag order selected by the criterion

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

FPE: Final prediction error

AIC: Akaike information criterion

SC: Schwarz information criterion

HQ: Hannan-Quinn information criterion

When lag length 6, as identified by the sequential modified LR test statistic, was used we found that both the Trace statistics and Maximum Eigen value identified varying cointegrating relationships. By exploring the models we found that the error correction models produced using lag length 6 and assumption 3 as chosen earlier by conditional hypothesis tests yield positive and insignificant values for the variable LRM2 contrary to theory that the coefficient must be negative showing that it is correcting to equilibrium. We therefore concluded that lag length 2 is the optimal lag length as it produces economically meaningful results that conform to economic theory.

Having found that the optimal lag length is 2 and the conditional hypothesis to be used is 3, we employ the Johansen maximum likelihood procedure to find out the number of cointegration relationships in a VAR version of the estimated equation.<sup>49</sup> This approach uses likelihood (LR) tests based on Trace and Maximum Eigenvalue statistics. For the Maximum Eigenvalue and Trace statistics, the null hypothesis is that there are  $r$  or fewer cointegration vectors, and  $r+1$  cointegration vectors, respectively.

Using lag length 2 as chosen by information criteria and case 6 assumption, we perform the Johansen cointegration test and obtain results as shown in Table 5.4.

**Table 5.4: Summary of all assumptions with lag length 2**

Series: LRM2 LRY DER INF TBSA ER  
 Exogenous series: DUM1  
 Warning: Rank Test critical values derived assuming no exogenous series  
 Lags interval: 1 to 2

Selected (0.05 level*) Number of Cointegrating Relations by Model	None		Linear		Quadratic
	No Intercept No Trend	Intercept No Trend	Intercept No Trend	Intercept Trend	Intercept Trend
Trace	2	1	1	1	1
Max-Eig	1	1	1	1	1

\*Critical values based on MacKinnon-Haug-Michelis (1999)

The results show that the assumptions 2, 3 and 4 all confirm that there is only one unique cointegrating relation among the variables. Although assumptions 2 and 4 were explored, the results were not economically meaningful in that the elasticity of income was very high for assumption 4 and insignificant for assumption 2. But assumption 3 gave economically meaningful results, confirming our results of the conditional hypothesis testing discussed earlier. The conclusion therefore is that throughout the study lag length 2 and assumption 3 are used. We now proceed to

<sup>49</sup> We assumed that both the series and the cointegrating equations have intercept only.

perform formal cointegration test using lag length 2 and assumption 3 with Trace statistics and Maximum Eigenvalue criteria.

**Table 5.5: Johansen cointegration test results**

Series: LRM2 LRY DER INF TBSA ER  
 Exogenous series: DUM1  
 Warning: Critical values assume no exogenous series  
 Lags interval (in first differences): 1 to 2

Unrestricted Cointegration Rank Test (Trace)

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.426492	113.3636	95.75366	0.0018
At most 1	0.194912	52.20538	69.81889	0.5403
At most 2	0.116737	28.35692	47.85613	0.7980
At most 3	0.081594	14.70241	29.79707	0.7990
At most 4	0.045122	5.339673	15.49471	0.7717
At most 5	0.002368	0.260812	3.841466	0.6096

Trace test indicates 1 cointegrating eqn(s) at the 0.05 level

\* denotes rejection of the hypothesis at the 0.05 level

\*\*MacKinnon-Haug-Michelis (1999) p-values

Unrestricted Cointegration Rank Test (Maximum Eigenvalue)

Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	Prob.**
None *	0.426492	61.15826	40.07757	0.0001
At most 1	0.194912	23.84846	33.87687	0.4667
At most 2	0.116737	13.65451	27.58434	0.8457
At most 3	0.081594	9.362732	21.13162	0.8021
At most 4	0.045122	5.078862	14.26460	0.7318
At most 5	0.002368	0.260812	3.841466	0.6096

Max-eigenvalue test indicates 1 cointegrating eqn(s) at the 0.05 level

\* denotes rejection of the hypothesis at the 0.05 level

\*\*MacKinnon-Haug-Michelis (1999) p-values

The upper part of Table 5.5 presents the Trace statistics while the lower part shows the Maximum Eigen values. To accept the null hypothesis, the Trace and Maximum Eigen value statistic must be smaller than the 5 percent critical values reported for each. The results in Table 5.5 shows that the Trace statistics indicate that there is at most one cointegrating vector and this is also confirmed by the Maximum Eigenvalue

by showing one cointegrating vector. The results indicate that both the Trace and Maximum Eigen value tests reject zero in favour of at least one cointegration vector. The results are significant at 5 percent level. This result proves that the variables are tied together in a single way in the long run, that is, there is one unique long run equilibrium relationship.

In order to determine the unique cointegrating vector, we normalised on the LRM2, since the loading factor was negative and significant. The long run coefficients of the demand for money are reported in Table 5.6 and equation (5.2).

**Table 5.6: Results of long run cointegration**

Variable	Coefficient	Standard error	t-statistics
LRM2	1.000000	-	-
LRY	0.802100	0.36763	2.18181
DER	-0.032941	0.05447	-0.60472
INF	1.478266	0.17645	8.37774
TBSA	0.020660	0.03069	0.67314
ER	0.655154	0.13435	4.87663

$$\begin{aligned}
 LRM2 = & -3.6568 + 0.8021LRY - 0.0329DER + 1.4783INF + 0.0207TBSA + 0.6552ER \\
 & (2.18181) \quad (-0.060472) \quad (8.37774) \quad (0.67314) \quad (4.87663)
 \end{aligned}
 \tag{5.2}$$

The results shown in equation (5.2) indicate that the long run income elasticity is very close to one (0.8021) in agreement with the economic theory.<sup>50</sup> The lower than unitary income elasticity suggest that money demand has been rising at a rate lower than the changes in total transactions in the economy. The other variables behave in the manner suggested by money demand theory, except for the variables own rate of M2 (DER) and the proxy for foreign opportunity cost represented by the South African Treasury Bill rate (TBSA). The long run demand for real M2 is positively

<sup>50</sup> Bossogo-Egoume (2000) and Treichel (1997) found income elasticities of 0.8 for study of M2 in Guyana and Tunisia, respectively. Ikhide and Katjomuise (2000) found income elasticity of 0.4 to 0.6 in their study of demand for M2 in Namibia.

affected by real income (LRY), inflation rate (INF) and exchange rate (ER). The coefficients of these variables carry the expected signs and all these variables are significant in the long run.

The coefficient of inflation rate (INF) was expected, *a priori*, to be either negative or positive. It turned out to be positive and this means that when inflation increases, agents increase their money holdings with the expectation that their planned nominal expenditures will move up. Therefore, this confirms our earlier assertions that the sign of the coefficient of the INF is merely an empirical issue. The INF variable is also statistically significant; hence it plays a major role in the demand for real money. The positive and significant impact of the exchange rate variable (ER) results show that in the case of depreciation, people's expectation will be high or rise so that the domestic currency would rebound and this makes people hold more domestic money.<sup>51</sup>

The other opportunity cost variables shown in equation (5.2), however, do not behave in the manner suggested by theory. The coefficient of the own rate of money (DER) is negative and of foreign interest rate is positive, contrary to theory and *a priori* expectations. To be specific, the semi-elasticity of DER is -0.0329 and of TBSA is 0.0207. It is, however, worth noting that both variables are statistically insignificant in the long run, hence play no part in the long run demands for real money.

Assuming that the short term interest rate enters the long run money demand, a negative sign of the long run coefficient of this variable would indicate that a rise in the rate, for example, following a monetary policy tightening, might as a direct effect, lead to a decrease in the demand for M2. This is a satisfactory result from the point of view of a central bank. The argument is contrary to our earlier justification of an *a priori* positive sign. Fielding (1994: 18 and 32) argues that the coefficient of the domestic interest rate variable may be positive when it reflects the availability of domestic assets rather than money. It may be representing the availability of alternative domestic assets instead of representing own rate of M2 in our case, for example. It is, however, important to note that this variable proved insignificant and was therefore considered irrelevant in explaining the demand for money in Botswana.

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<sup>51</sup> See Tan (1997: 1204) and Sriram (1999a: 13) for a similar argument.

The wrong signs for both DER and TBSA can also be attributed to multi-collinearity problems between these two interest rates, that is, the interplay between the interest rate variables might be causing these counter-intuitive signs (Calza and Levy, 2001: 10; Aziakpono, 2000: 138; Handa, 2000: 205). This is indicative of the fact that short term interest rates in Botswana are very responsive to movements in the money market rates (Treasury bill rates) in South Africa.<sup>52</sup>

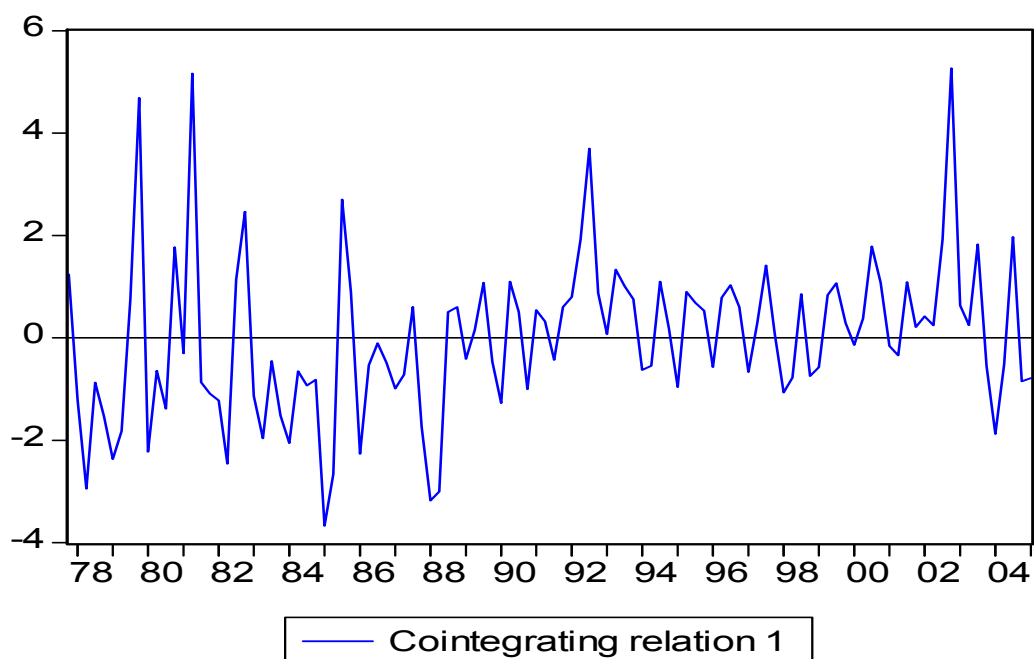
The results of cointegration tests can also be confirmed by plotting a graph of cointegration relation as shown in Figure 3. Since a summary of assumptions results shown in Table 5.4 indicated that assumptions 2, 3 and 4 confirm one cointegration vector, when all the three options are explored it was found out that only assumption 3 gives a fairly stationary cointegration vector as shown by a graphical result in Figure 3. Therefore, Figure 3 confirms our earlier finding of which intercept and/or trend assumption to use in order to obtain economically meaningful results and it also confirms our formal cointegration test since the figure shows that a plot of cointegration residual is stationary.

Thus, the cointegration vector represents the deviations of the endogenous variable from its long run equilibrium level. Figure 3 suggests that over the period 1977 to 2004 the deviations of the stock of M2 from equilibrium were stationary and this is critical for its use as an error correction model.

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<sup>52</sup> See Aziakpono (2006) for a detailed study on financial integration among SACU countries.

**Figure 3: Plot of cointegration graph**



Next we consider the coefficients of the ECM terms, which are presented in Table 5.7.

**Table 5.7: Error correction results**

Variable	Coefficient	Standard error	t-statistics
$\Delta LMR2$	-0.028731	0.00920	-3.12429
$\Delta LRY$	0.006679	0.00853	0.78336
$\Delta DER$	0.153307	0.10067	1.52283
$\Delta INF$	-0.747500	0.13220	-5.65439
$\Delta TBSA$	0.085260	0.16227	0.52543
$\Delta ER$	-0.067443	0.02557	-2.63779

The coefficient of  $\Delta LRM2$  (-0.028731) shows that the speed of adjustment is approximately 2.9 percent, that is, when there is deviation from equilibrium, only 2.9 percent is corrected in one quarter as the variable moves towards restoring

equilibrium.<sup>53</sup> Thus, there is no strong pressure on the stock of money to restore long run equilibrium whenever there is a disturbance. The low speed of adjustment may reflect the lack of sufficient availability of banking services and low returns on financial assets which can allow economic agents to re-establish equilibrium levels of money holdings faster (Treichel, 1997: 17, Hayo, 2000: 588, Sriram, 1999a: 20). It could also be attributed to the fewer alternatives to money in Botswana, a factor which was explained in detail under the financial development section.

The significance of the exchange rate variable (ER) shows the impact of public perceptions concerning the movements in the exchange rates. It indicates the sensitivity of the public to exchange rate movements. Therefore, money demand is affected in the short run by movements in the exchange rate. The corrections taking place for INF and TBSA are not significant, which implies that they might not play any role in the adjustment process of the money demand. The implications of the significance of the DER are that although own rate (DER) was unimportant in explaining the long run, it plays a significant role in the adjustment process.

#### **5.4.1 Weak exogeneity test**

Tests of weak exogeneity are carried out by placing a zero restriction on the loading factor (matrix of error correction terms) in equation  $\prod_i = \alpha\beta'$ , that is  $\alpha = 0$ . The coefficients in the  $\alpha$  matrix capture the speed of adjustment of a particular variable to a deviation from the long run equilibrium. Therefore a zero restriction on any coefficient in this matrix will correspond to the null hypothesis that the particular variable does not adjust to restore the long run equilibrium and hence can be regarded as weakly exogenous or otherwise, the variable is endogenous.

Since cointegration tests conducted confirmed one relationship, the weak exogeneity tests are conducted under the assumption of  $(r) = 1$ . The exogeneity tests checks whether the LRM2 should be treated as exogenous or endogenous. If it is endogenous, then the model can be reduced from a system formulation to a single equation to

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<sup>53</sup> Sriram (1999a: 20) found a speed of adjustment of 0.9% and 1.2% for closed and open economies, respectively in the first month for Malaysia. Hayo (2000: 587) found 3% for Austria using quarterly data from 1965:1 to 1987:4.

analyse the short run characteristics adjustment behaviour of the money demand without loss of information (Sriram: 1999a: 14; Bossogo-Egoume, 2000: 19).

The weak exogeneity tests reported in Table 5.8 confirm that we reject the null hypothesis for LRM2, INF and TBSA. Therefore, the short run model can be modelled with a set of three single system equations, with any of these three variables as endogenous and considering DER, LRY and ER as exogenous variables. However, since our intention is to model money demand and only one cointegrating vector was found, we consider the cointegration relationship to represent the demand for money model.<sup>54</sup>

**Table 5.8: Weak exogeneity test**

Variable	Chi-square	Probability
LRM2	9.033980	0.002650
LRY	0.646186	0.421480
DER	2.072868	0.149939
INF	26.31575	0.000000
TBSA	7.331932	0.006774
ER	0.238856	0.625034

## 5.4.2 The unrestricted and parsimonious models

This section begins with the estimation of unrestricted model. This is modelled in a single equation context. The model will then be reduced to a parsimonious framework following the general-to-specific modelling criteria. The general-to-specific modelling framework allows us to develop a parsimonious error correction model of real money balance in Botswana by re-running the estimations with all the possible sub-sets of the variables of the system, including real M2.

<sup>54</sup> This argument is consistent with other studies such as Sriram (1999a: 24) and Bossogo-Egoume, (2000: 15).

The parsimonious model contains an error correction term which ensures that the long run cointegrating vector found in the analysis holds in a steady state (Bossogo-Egoume, 2000: 19). This is achieved by eliminating insignificant variables with the idea of obtaining a better model than the previously specified ones. The characteristics and behaviour of the unrestricted and parsimonious models are also examined.

#### 5.4.2.1 The unrestricted model

A single equation form model is formulated to analyse the short run dynamics for  $\Delta LRM2$  and will contain all other variables on the left-hand side with each variable having two lags. The right hand side of the equation also includes an error correction term ( $RESM2$ ) obtained from the cointegration vector when normalised on  $LRM2$ . Since all variables are stationary, the model is estimated by OLS. The unrestricted reduced form model as follows:

$$\begin{aligned} \Delta LRM2_t = & \alpha_0 + \alpha_1 \Delta LRM2_{t-1} + \alpha_2 \Delta LRM2_{t-2} + \alpha_3 \Delta LRY_{t-1} + \alpha_4 \Delta LRY_{t-2} + \\ & \alpha_5 \Delta DER_{t-1} + \alpha_6 \Delta DER_{t-2} + \alpha_7 \Delta INF_{t-1} + \alpha_8 \Delta INF_{t-2} + \alpha_9 \Delta ER_{t-1} + \alpha_{10} \Delta ER_{t-2} \\ & + \alpha_{11} \Delta TBSA_{t-1} + \alpha_{12} \Delta TBSA_{t-2} + \alpha_{13} RESM2_{t-1} + \ell_t \end{aligned} \quad (5.3)$$

All variables are as defined previously. The results are indicated in Table 5.9. The results shown in Table 5.9 indicate that  $\Delta LRM2_{t-1}$ ,  $\Delta LRY_{t-2}$  and  $RESM2_{t-1}$  are significant, whereas all other variables are insignificant, therefore irrelevant. This shows that short run real money demand is affected by its first lag and the second lag of the change in income. The negative and significant error correction term is of particular importance as it validates the significance of the cointegration relationship. Sriram (1999a: 25) explains that a significant error correction term carrying a negative sign gives two pieces of information: (1) it shows that economic agents have corrected in the current period a proportion of previous disequilibrium in money balances; (2) it confirms that the cointegration relationship established is valid as per the Granger

Representation Theorem.<sup>55</sup> The negative sign shows that a fall in excess money in the previous period led to a higher level of desired money holdings in the current period.

From a statistical point of view the unrestricted model performed reasonably well in that the Durbin-Watson (DW) statistic indicate the absence of autocorrelation since it is 2.015175 as shown by Table 5.9, that is, it is near 2.<sup>56</sup>

**Table 5.9: Unrestricted OLS model**

Dependent Variable: D(LRM2)  
Method: Least Squares  
Date: 06/05/06 Time: 21:43  
Sample (adjusted): 1978Q1 2005Q1  
Included observations: 109 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-4.01E-05	0.009587	-0.004185	0.9967
D(LRM2(-1))	0.473150	0.278606	1.698278	0.0927
D(LRM2(-2))	0.108281	0.101372	1.068147	0.2882
D(LRY(-1))	0.157581	0.114492	1.376354	0.1719
D(LRY(-2))	0.248167	0.117372	2.114360	0.0371
D(DER(-1))	0.005381	0.009927	0.542092	0.5890
D(DER(-2))	-0.000747	0.009342	-0.080012	0.9364
D(INF(-1))	-0.007761	0.006982	-1.111613	0.2691
D(INF(-2))	-0.008086	0.006269	-1.289769	0.2003
D(ER(-1))	0.009284	0.037302	0.248889	0.8040
D(ER(-2))	-0.004306	0.039109	-0.110098	0.9126
D(TBSA(-1))	-0.008330	0.006015	-1.384867	0.1693
D(TBSA(-2))	0.002761	0.006257	0.441184	0.6601
RESM2(-1)	-0.649720	0.300497	-2.162153	0.0331
R-squared	0.172228	Mean dependent var	0.020086	
Adjusted R-squared	0.058954	S.D. dependent var	0.074158	
S.E. of regression	0.071938	Akaike info criterion	-2.306602	
Sum squared resid	0.491638	Schwarz criterion	-1.960924	
Log likelihood	139.7098	F-statistic	1.520459	
Durbin-Watson stat	2.015175	Prob(F-statistic)	0.124130	

<sup>55</sup> This argument is supported by other authors like Bossogo-Egoume (2000: 20) and Treichel (1997: 16).

<sup>56</sup> See Gilbert (1986:284), Treichel (1997: 10) and Brooks (2002: 157-166) for detailed explanations on this test.

#### 5.4.2.2 The parsimonious model

The unrestricted model equation is reduced to a parsimonious one by following the general-to-specific principles. This parsimonious model is attained by the sequential removal of those variables exerting no influence in the model. When we remove all variables found insignificant in the unrestricted model, the  $\Delta LRY_{t-2}$  and RESM2 still remain significant while  $\Delta LRM2_{t-1}$  becomes insignificant. The model was then re-estimated with all other variables but including only one lag. The result indicated that LRM2,  $INF_{t-1}$  and RESM2 become significant while  $\Delta LRY_{t-1}$  is not significant.

When the significant  $\Delta LRY_{t-2}$  is added into the model the results are not altered, but when the insignificant  $\Delta LRY_{t-1}$  is taken out of the model, the variable  $\Delta LRM2_{t-1}$  changes and becomes insignificant while  $\Delta TBSA_{t-1}$  becomes negative and significant at 10 percent as shown by Table 5.10. However as indicated a constant,  $\Delta LRY_{t-2}$ ,  $INF_{t-1}$  and  $RESM2_{t-1}$  also become significant.

The results of this parsimonious model supplement those of the unrestricted model in that two more variables are found to be significant that appeared insignificant in the unrestricted model, i.e.  $\Delta TBSA_{t-1}$  and  $INF_{t-1}$ . The results are presented in Table 5.10.

The significance of the INF variable in the parsimonious models has very important policy implications, in that they indicate that price anticipations are not entirely captured by any of the variables. The result of the parsimonious model in Table 5.10 shows that the Durbin-Watson statistic value is 2.027988. Therefore, since it is near 2 we conclude that the model does not suffer from serial correlation.

**Table 5.10: Parsimonious model results**

Dependent Variable: D(LRM2)  
 Method: Least Squares  
 Date: 06/06/06 Time: 00:05  
 Sample (adjusted): 1978Q1 2005Q1  
 Included observations: 109 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.053818	0.017271	3.116141	0.0024
D(LRM2(-1))	0.318011	0.218564	1.455001	0.1488
D(LRY(-2))	0.255116	0.110762	2.303287	0.0233
D(DER(-1))	0.007999	0.009334	0.856994	0.3935
INF(-1)	-0.018626	0.006678	-2.789284	0.0063
D(ER(-1))	0.007209	0.035229	0.204633	0.8383
D(TBSA(-1))	-0.008276	0.005065	-1.634124	0.1053
RESM2(-1)	-0.498380	0.243755	-2.044595	0.0435
R-squared	0.187230	Mean dependent var		0.020086
Adjusted R-squared	0.130900	S.D. dependent var		0.074158
S.E. of regression	0.069134	Akaike info criterion		-2.434983
Sum squared resid	0.482728	Schwarz criterion		-2.237453
Log likelihood	140.7066	F-statistic		3.323778
Durbin-Watson stat	2.027988	Prob(F-statistic)		0.003166

Taking into consideration the policy change of the second quarter of 1991 as explained with the introduction of variable Dum1, the parsimonious model was re-examined and the results are presented in Table 5.11. The introduction of the dummy variable generally improves the significance of most variables in the parsimonious model, except that it is insignificant.

**Table 5.11: Parsimonious model results with dummy**

Dependent Variable: D(LRM2)  
 Method: Least Squares  
 Date: 06/06/06 Time: 00:34  
 Sample (adjusted): 1978Q1 2005Q1  
 Included observations: 109 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.063515	0.019758	3.214589	0.0018
D(LRM2(-1))	0.271930	0.223254	1.218028	0.2261
D(LRY(-2))	0.246413	0.111085	2.218230	0.0288
D(DER(-1))	0.007897	0.009333	0.846139	0.3995
INF(-1)	-0.019230	0.006704	-2.868529	0.0050
D(ER(-1))	0.010631	0.035388	0.300413	0.7645
D(TBSA(-1))	-0.009105	0.005130	-1.774836	0.0790
RESM2(-1)	-0.448337	0.248716	-1.802607	0.0745
DUM1	-0.014127	0.013986	-1.010030	0.3149
R-squared	0.195438	Mean dependent var		0.020086
Adjusted R-squared	0.131073	S.D. dependent var		0.074158
S.E. of regression	0.069127	Akaike info criterion		-2.426784
Sum squared resid	0.477854	Schwarz criterion		-2.204563
Log likelihood	141.2597	F-statistic		3.036406
Durbin-Watson stat	2.043158	Prob(F-statistic)		0.004257

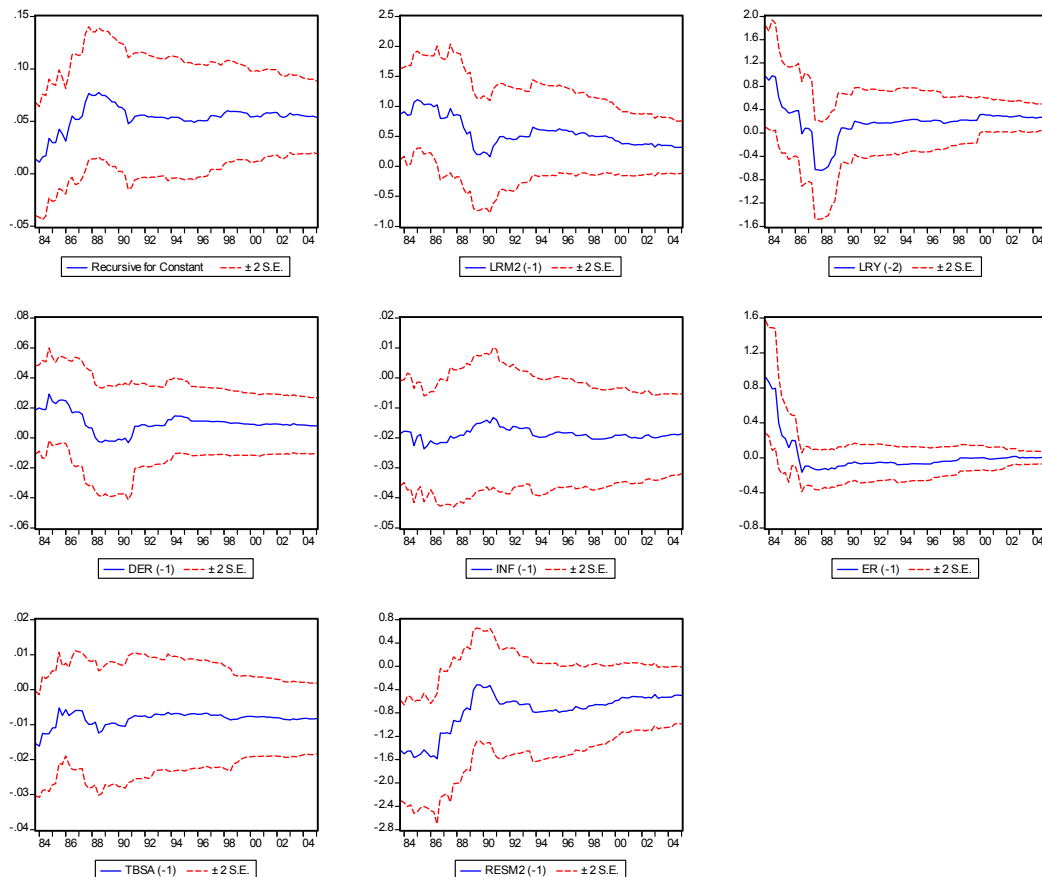
## 5.5 STRUCTURAL STABILITY TESTS

In order to test whether a structural break occurred we estimated a recursive model based on the parsimonious model. The recursive parameter estimates obtained are plotted against time to get a graphical representation. The visual inspection of the graphical representation of recursive model estimates enables us to trace the time path of each parameter, thus showing when structural break occurred in each variable included in the model. If the coefficient plots show dramatic jumps, it is a sign of the potential structural break.

The recursive estimations reported in Figure 4 show a generally stable demand for money function with only a break or parametric instability in the years 1988 to 1990. This is the period when government and the central bank introduced several policy changes to liberalise the financial system in Botswana to be more market oriented. As shown in Figure 4 the structural break is evident in all parameters. However, from

1990 (after the reform period) onwards, all the graphical representation shows virtually constant parameters and this is a strong indication of the stability of the model. This suggests that from 1990 onwards the money demand function was stable enough for it to be used to project liquidity needs of the economy for monetary policy purpose.

**Figure 4: Recursive stability tests**



## 5.6 CONCLUSION

This chapter presented the various results of the demand for money function in Botswana. The graphical presentations and unit roots tests indicated that most of the variables were stationary at their first difference. Therefore, this meant the cointegration technique such as Johansen (1988) and Johansen and Juselius (1990) is the appropriate framework that can be applied to evaluate the long run and short run characteristics of the demand for broad money function in Botswana. The test for

cointegration confirmed a unique relationship between real money and the variables included in the model and the nature of this cointegration was confirmed by the weak exogeneity test results. Therefore, this paved the way for the formulation of an appropriate error correction model (ECM), which was used to evaluate the short run properties of the demand for money function.

The cointegration tests and residual diagnostic tests indicate that the model is well specified with the income elasticity of close to one, although it is less than one. The value for income elasticity is 0.8021 and most importantly it is positive and significant in agreement with economic theory. Most of the variables in the model show the expected signs and acceptable magnitudes in comparison with other studies in developing countries. Most importantly, the ECM shows a significant error correction term with a negative sign, indicating a valid cointegration relationship. Generally, the model is found to accord quite well with accepted theoretical *a priori*.

The demand for money function appears to be stable as a whole, although all variables show some vulnerability during the 1988-90 periods. This structural break is understandable, since it coincides with the major financial liberalisation measures during that period. These measures were implemented to influence the financial system to be more market oriented. The instability, however, died out after 1990, and this supports the view that the estimated demand for money function can be an appropriate tool for determining a suitable target for monetary policy in Botswana. If the instability could have continued, the opposite would be true. The evidence presented in this study indicates that the broad money M2 aggregate can be used as a useful measure with which to gauge the long run economic impacts of changes in monetary policy.

## CHAPTER SIX

# CONCLUSIONS

### 6.1 SUMMARY OF FINDINGS

Recent academic literature has contributed immensely to the debate on the importance of demand for money and its stability on the conduct of monetary policy. This study has explored a broad range of theories and empirical literature on the demand for money. These theories focus on the relationship between the quantity of money demanded and a set of economic variables. The theoretical development on money demand evolved from the classical to the post-Keynesian economists and provided a foundation for empirical analysis of the demand for money.

On empirical grounds, a large literature supports the view that there exist a functional relationship between money, appropriate scale and opportunity cost variables. The extensive theoretical and empirical literature discussed showed that modelling and estimating money demand function largely depend on the macroeconomic environment and financial sector development and the extent of openness of an economy. The observation drawn from the studies reviewed was that the transaction motive of demand for money seems to be dominant in explaining the money demand functions in many developing countries, and Botswana was found not to be an exception.

This study conducted an analysis of the various macroeconomic and financial sector developments in Botswana and this helped in identifying the following variables as having possible influence on the demand for money (M2) in Botswana; (1) Gross Domestic Product, (2) the 88 day commercial bank deposit rate, (3) inflation rate, (4) the bilateral exchange rate between the US dollar and the Botswana pula, (5) South African treasury bill rate. The empirical estimations found a number of interesting results. Firstly, and most importantly, the results of this study confirmed that, indeed

there exists a unique cointegrating relation among the broad money (M2) and a set of variables as suggested by theory and other similar studies in other countries. Secondly, the long run income elasticity was found to be positive and close to one, in agreement with the economic theory. In the long run other variables were also found to behave in the manner suggested by money demand theory, except the own rate of money (88 day commercial bank deposit rate) and the proxy for foreign opportunity cost (South African Treasury bill rate). By following the general-to-specific principle and reducing the model to a parsimonious framework, the variables had an influence on the demand for money were real income (GDP), inflation and the proxy for foreign opportunity cost variable.

Coming back to the objectives raised in the introduction, we can now give the following answers. The first objective addresses the investigation and estimation of the demand for broad money in Botswana. The summary of the findings can be given as follows. The investigation and estimation of the demand for money function appear to produce a generally stable demand for money function. Although there is some vulnerability during the 1988-1990 periods, we find a stable long and short run money demand equation. The long run income elasticity is positive and close to unity. This is a reflection of a classical type of money demand, to some extent dominated by economic transactions.

The corresponding error correction term was found to be significant. A disequilibrium in the long run relationship has been found to exert a relatively mild pressure on broad money. This may be a result of the dependence of this monetary aggregate (M2) on transactions mostly and therefore economic activity. Therefore, the long run is considered not very significant in determining the short run dynamics of money growth for real broad money (M2) in Botswana. The pressure on money demand to return to its long run equilibrium is rather weak and the adjustment time has been found to be long.

The second objective was to examine the nature and stability of the demand for broad money function in Botswana. The stability of the relationship between money and other macroeconomic variables is typically evaluated in the context of a money demand equation. Using recursive stability tests the only structural break revealed in

the observations was during the period 1988-1990, as expected, which was due to the financial liberalisation that was taking place around that time. However, no serious structural break was uncovered. Our standard statistical properties and stability tests confirm the good overall performance of the model.

The exchange rate regime of fixing by adjusting the currency to restore foreign competitiveness does not show any effects on the stability of money demand. This is evidenced by the apparent stability of our money demand estimates for most of the study period, despite numerous devaluations that took place. But there is some evidence that the beginning of the liberalisation of the financial system in Botswana in the period from the late 1980s to the very early 1990s caused a structural break in the long run money demand equilibrium for M2.

Finally, this study successfully identified a well-specified demand for money function that shows an acceptable degree of stability. This finding provides a suitable basis for the design and implementation of monetary policy in Botswana. It enables us to get a more complete picture of the effects of monetary policy. Although the model portrays a rather slow speed of adjustment to equilibrium, a look at other studies of demand for money in developing countries, especially in Africa, suggests that this slow adjustment is nothing out of the ordinary, but is a typical process in the African financial system. We have therefore constructed a macroeconomic model for studying the dynamic relation between real money stock, scale variable and opportunity cost variables in Botswana based on quarterly data from 1977:1 to 2005:1.

## **6.2 POLICY IMPLICATIONS AND RECOMMENDATIONS**

Based on our finding of a stable money demand, we can be more precise in stating that targeting a monetary aggregate can be a viable policy for Bank of Botswana. In line with the Bank of Botswana's 2006 monetary policy of medium term inflation targeting, M2 would be a good target, because it is strongly tied to transactions purposes and displays rather tight medium term equilibrium behaviour. Although a stable money demand is a necessary, but it is not a sufficient condition for successfully switching to a different monetary policy regime, applying this reasoning

to the Bank of Botswana's emphasis on a medium term orientation of the monetary policy and the choice of a broad monetary aggregate suggests that this may be an optimal combination. Therefore, since the monetary policy focuses presently (2006) on the medium to long run, our results recommend the use of broad money M2 as appropriate.

Money is globally regarded as a key element in the monetary policy framework of most central banks. The reason for this is because based on the notion that inflation is ultimately a monetary phenomenon, and it follows that money constitutes a natural nominal anchor for the monetary policy of central banks aiming at price stability (this is the case with Bank of Botswana). In this regard, it is therefore argued that the existence of a well-specified and stable relationship relating demand for money to the price level and some explanatory variables is normally viewed as a prerequisite for the use of monetary aggregates in the conduct of monetary policy.<sup>57</sup> The existence of a stable money demand function is also important in that it means that the growth rates in broad money (M2) would not be ignored when monitoring and forecasting the developments in inflation levels.

The study provides evidence of the much-needed stability for the conduct of effective monetary policy. As noted in the introductory section, an effective monetary policy seeks to influence money, credit and prices through the liquidity position of the banks and other similar financial institutions. Since the demand for money function helps to ascertain the liquidity needs of the economy, the knowledge of the factors that determine this function and the existence of a stable long run relationship between these factors and money stock constitute valuable knowledge by the monetary authorities. Establishing an empirically constant, well-specified money demand function may thus shed light on what sorts of monetary policy are advisable and what sorts are not.

The other notable finding in our study which has policy implications is the role of the exchange rate variable in demand for money. The significance of the exchange rate

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<sup>57</sup> See Calza and Levy (2001: 2), Laidler (1993), Lutkepohl and Wolters (1998) and Goldfield and Sichel (1990) for this argument and Bank of Botswana 2006 monetary policy document for the objectives of monetary policy in Botswana.

variable in our demand for money function means that a more global perspective that takes into account the effects of international monetary development would have to be considered in the design and implementation of monetary policy in Botswana. The fixed exchange rate regime and its objective of maintaining external competitiveness means that developments in the foreign exchange markets play an important role in the dynamics of money demand in the domestic economy and failure to incorporate this phenomenon in the design of the policy may lead to failure to attain the policy objectives. The fairly stable exchange rate variable as shown by Figure 4 can be attributed to a number of policy measure introduced after 1988. These measures include the implementation of a policy aimed at maintaining a broad real exchange rate against the South African rand and making the exchange rate move in the range of R1.25 – 1.35 per pula.

In our study, we cannot ascertain if the changes in the monetary policy objectives and conduct have had an effect in money demand. As can be observed from the stability test in Figure 4, it becomes apparent that the function became much more stable after the more market-based instruments were introduced. Therefore it may also be the case that the objectives of the monetary policy have not changed, but that the monetary policy instruments introduced became much more market oriented and hence effective.

### **6.3 LIMITATIONS AND AREAS FOR FURTHER RESEARCH**

This study has identified several areas where further studies could be conducted in order to improve the quality of the results. First, constructing and using the divisia index aggregate could yield a better proxy for monetary aggregate, given the fact that all studies including this one identified that the demand for money in Botswana depends mainly on transaction motives. Since the divisia index makes an attempt to separate the transaction function of money from other functions performed by money, it can serve as a better representation when used in place of a monetary aggregation such as M2. Under this framework, it will also be worth trying to model the demand for money in a microeconomic approach. Considering the rapid financial innovation and regulatory changes taking place in Botswana, the divisia index aggregation might

also be explored as an option since to the best of our knowledge no such study has been conducted in Botswana. The shortcomings, however, do not eliminate the value of this study. This study also proves that money can play an active role in the transmission of monetary policy in Botswana and money demand function should be integrated into the policy making process. Further studies can also be re-estimated using data from the more stable period found by this study, which is from 1988. This will enable comparison with this study.

The other notable area which could be explored is that since the demand function for real M2 shows signs of stability over a long period of time, it might be possible that a broader monetary aggregate such as M3 may provide a more stable function. Although Kganetsano (2001) studied the demand for money (M3) in Botswana, the weaknesses of the Engle-Granger approach used makes it convincing enough to require another comprehensive study such as using the Johansen approach. The advantages of the latter approach compared to the former have already been explained in the previous chapters.

The other limitation of this study was the use of interpolated GDP data for the period 1978: 1 to 1992: 4. Although this was unavoidable, the shortcomings of interpolated data have already been alluded to in the previous chapters. The problem is also compounded by the fact that Botswana's GDP is heavily dominated by the mining sector, especially diamond production, hence might not be the best proxy for income. Future research should explore other representation of scale variables to make comparison with the results of this study. Data permitting, an alternative example will be the use of gross domestic expenditure (GDE).

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**APPENDIX 1: Table A1. Summary of Demand for Money Studies Reviewed**

Author/Country	Sample Period	Monetary Aggregates	Determinants			Unit Root test	Cointegration technique	Stability Test	Findings
			Scale Variable	Interest Rate(s)	Others				
Laumas & Mehra(1976)USA	1954:2 to 1973: 4	ln M1 &lnM2	Current Income GDP, Permanent Income	Short term interest rates, medium term interest rates & long term interest rates (Bonds yield)	-	-	Varying parameter estimates regression	-	Scale variables are positive in both equations using M1& M2. Interest rates are negative and significant
Adam C., (1991) U.K	1975:6 to 1986:6 Monthly	M3	Real wealth, Income (TFE)	Yields on bonds & NCDs, Yields on foreign assets	Inflation	ADF, Shargan-Bhargava DW test	Johansen Maximum likelihood procedure-general to specific	Chow test	3 cointegrating vectors. 1 economically meaningful
Hafer, & Jansen (1991) U.S.A	1915: 4 to 1988:4	M1 & M2	Real GNP	Commercial paper rate & corporate bond rate	-	DF (1979)	Johansen (1988), Johansen & Juselius (1990)	-	Mixed results for M1 & cointegration for M2.

Author/Country	Sample Period	Monetary Aggregates	Determinants			Unit Root test	Cointegration technique	Stability Test	Findings
Baba Y., Hendry D. F., Starr M. R., (1992) U.S.A	1960:3 to 1988: 3	M1	Real GNP	Money market rate, interest bearing deposit	Inflation, Risk(long term bond)	DF (1981)	Johansen (1988), Johansen & Juselius (1990). Hendry (1987) general to specific	Chow test	Risk and return variables significant. Single cointegration
Simmons R., (1992) Congo, Cote d Ivoire, Mauritius, Morocco & Tunisia	1972: 1 to 1988:4	M1	ln GDP	Domestic interest rate ( Central bank discount rate), short term foreign interest rate (proxied by US T-bill rate)	Inflation, Exchange rate (market rate per USD)	DF	ECM, general to specific	Chow test & Farley, Hinich & McGuire test	Cointegration and long run income elasticities varied between 1.0 to 1.5
Fielding D., (1994). Cameroon, Nigeria, Ivory Coast, Kenya	1974:1 to 1992: 4	M2	Terms of trade adjusted real GDP	Central bank rate (Cameroon, Ivory Coast), Interest rates & T-bill for Nigeria.	Inflation, Currency depreciation	DF	Johansen (1988), Johansen & Juselius (1990)	Chow test	3 cointegrating vectors but 1 economically meaningful.
Wesche K. (1996). France, Germany, Belgium, Austria,	1973:1 to 1994:4	Real Divisia	Private Consumption Expenditure on GDP.	Interest on Bonds	-	ADF	Johansen (1988) (VECM)	-	Single cointegrating vector exist

Author/Country	Sample Period	Monetary Aggregates	Determinants			Unit Root test	Cointegration technique	Stability Test	Findings
Holland. -	-----	Real M3	In GDP	Government Bonds	-----	ADF	Johansen (1988)(VECM)	-	Single Cointegrating vector exist
Treichel V., (1997) Tunisia	1962 to 1995 monthly	M2&M4	Real GDP	Interest rate (T-bill rate)	Inflation rate, re-discount rate & money market rate	ADF	Johansen, Maximum likelihood	Chow test	M2 cointegrated with real GDP but not interest rates.
Ericsson N., (1998) U.K	1963:1 to 1989:2	M1	Real Total Final Expenditure(TFE	3- month authority interest rates, retail sight deposit rate	Total Final Expenditure deflator (TFE)	ADF	Johansen procedure (1992)	Break point Chow statistic	One cointegrating vector.
Sriram S., (1999). Malaysia	1973:8 to 1995: 12	In Real M2	In Real Industrial Production Index	Interest on 3month Time deposit, Discount rate on 3-month T-bill, 3-month US T-bill	Inflation rate, Regime change dummies, Exchange rate depreciation	ADF, DF	Johansen (1988), Johansen & Juselius (1990)	Residual sum squares, One step residuals & Chow tests	One unique cointegration exists under both open and closed economy model. ECM has significant error correction term. Exchange rate variable insignificant in short run.

Author/Country	Sample Period	Monetary Aggregates	Determinants			Unit Root test	Cointegration technique	Stability Test	Findings
Jonsson G., (1999) South Africa	1970:1 to 1998:2	NC & M3	Real GDP	3month RSA T-bill, or, 10 year Govt. bond	Nominal Exchange rate, CPI, Effective CPI in foreign countries	ADF	Johansen & Juselius (1990), Johansen (1991)	-	Long run stable relationship exists.
Aziakpono M., (2000). Lesotho	1981:1 to 2000:4	In Real M2	In Real GDE	Nominal Savings deposit rate, RSA T-bill rate	Exchange rate, CPI	ADF, PP	Engle & Granger (1987) 4 step	Chow breakpoint & Chow forecast	Cointegration exists between variables, inflation variable insignificant.
Bossogo Egoume., (2000) Guyana	1990:1 to 1999:9 Monthly	M2	Indices of real economic activity (Prod. Vol of certain economic sectors)	Own rate of money = 3- month net deposit rate, 3- month T- bill=alternative domestic asset, interest rate on competing foreign asset.	CPI, Nominal exchange rate & dummy variables	ADF	Johansen (1988), Johansen & Juselius (1990)	Breakpoint & Forecast Chow test	3 to 4 cointegrating vectors. 1 theoretically consistent relationship. All variables significant except 3- month deposit interest rate.

Author/Country	Sample Period	Monetary Aggregates	Determinants			Unit Root test	Cointegration technique	Stability Test	Findings
Kganetsano A., (2001) Botswana	1978:1 to 1997:4	M1 & M2	Real GDP	Nominal interest rate (88day notice deposit)	CPI, Exchange rate	DF	Engle-Granger 2 step	Breakpoint & Forecast Chow test	Cointegrating relationship on both M1 & M2 equations.
Mosweu W., (2003) Botswana	1975 to 2001 Annual	M1	Real GDP	88 day deposit	Inflation	ADF	Johansen (1988), Johansen & Juselius (1990,1995)	Recursive graphics	Cointegration exists. Negative Coefficient for interest, inflation, positive for GDP

Note: The following abbreviations are used.

CPI = Consumer Price Index.

GDP = Gross Domestic Product

GDE = Gross Domestic Expenditure

GNP = Gross National Product

ADF = Augmented Dickey Fuller

DF = Dickey Fuller

ECM = Error Correction Mechanism

Ln = logarithms

NC = Notes and coins in circulation outside the banking system

PP = Phillip -Perron