EXPLAINING BASE MONEY DEVIATIONS FROM TARGET : THE CASE OF KENYA

BY

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DECLARATION

This research paper is my original work and has not been presented for the award of a degree in any other university

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This work could not have come into fruition without the continued supervision of my two supervisors who have been patient with me throughout this study. I salute them.

DEDICATION

I am dedicating this work to my family for their continual encouragement and the sacrifices they made towards the completion of the work.

TABLE OF CONTENT

LIST OF TABLES AND CHARTS

LIST OF ABBREVIATIONS AND ACRONYMS

BR -	Bank Reserves
BR^D -	Estimated demand for bank reserves
CB -	Clearing account balances of commercial banks
CBK -	Central Bank of Kenya
CIC -	Currency in circulation
CIT -	Cash in Till of commercial banks
COB -	Currency outside Banks
COB^D -	Estimated demand for currency outside banks
KNBS -	Kenya National Bureau of Statistics
OMO -	Open Market Operations
REPO -	Repurchase Agreement Securities
RM -	Reserve Money (Base Money)
RM^D -	Estimated demand for reserve money
RM^T -	Reserve money target
RR -	Required Reserves

ABSTRACT

In a bid to explain the cause of the frequent deviations of base money (reserve money) from programmed targets, the demand for reserve money in Kenya is studied. Two models on the demand for currency outside banks and bank reserves, both components of reserve money, are estimated using Engel-Granger and Johansen approaches and an implied reserve money demand derived. The results suggest that the targets for reserve money have mostly been tighter than expected resulting in the frequent overshooting of the set monetary programme targets. However, even though the actual reserve money was in most cases above the reserve money demand, the deviations were no more than 5 percent and hence unlikely to have jeopardized the monetary programme by causing inflationary pressures.

CHAPTER 1: INTRODUCTION

The use of reserve money or base money (RM) in monetary policy formulation and implementation is well acknowledged. RM is the operational target for monetary policy operations in most countries and it is considered to be related to an intermediate target variable which for the case of Kenya is money supply (Currency plus deposits) via the money multiplier. Money supply relates the operating target to the ultimate target which is low and stable inflation for most countries, Kenya included. Thus in pursuit of this monetary policy objective, the setting of RM targets and the implementation thereof are of great concern since they determine the success of monetary policy.

The setting of RM targets is done as part of the broad financial programming exercise which involves the setting of macroeconomic targets aimed at ensuring the attainment of specific government macroeconomic objectives such as a high and sustainable economic growth and a low and stable inflation. For Kenya, the targeted level of economic growth and inflation are exogenously determined by the government and the task of the CBK is to provide adequate money supply to support the achievement of these objectives. Based on the quantity theory of money, the money supply growth target is set after taking into account the expected future path for the velocity of money. After setting the money supply target, an assumption is also made on the expected future path for the money multiplier.

The RM target is then set as a ratio of the money supply target and the expected level of the money multiplier. The targets on the components of RM – bank reserves (BR) and currency outside banks (COB) – are also set. The target for BR is inferred from targets on required reserves (RR), clearing balances at CBK (CB) and cash in till (CIT). The RR target is set as a ratio of the deposits in money supply, M3, while the target on CB is determined as an average of past observations over a specified period. The target on currency in circulation (CIC) – COB plus CIT – is computed as the difference of the RM target and the sum of targets on CB and RR. CTT target is then computed as a ratio of CIC (based on the average of past observations over a specified period). The target on COB is computed as the difference between actual targets on CIC and CTT.

1.1 Forecasting the Daily CBK Balance Sheet

In a bid to implement the above monetary programme, the CBK on a daily basis forecast its balance sheet. The daily balance sheet of the CBK is essential because it includes the operating target of monetary policy which is RM as one of its liabilities. For analytical purposes, the balance sheet is structured in such a way that the RM becomes the sole liability to be equated to the total net assets (net foreign assets and net domestic assets of the CBK).

The net foreign assets of the CBK comprises of the official foreign exchange reserves (foreign currency deposits abroad, SDR allocations and Gold holdings) less foreign liabilities (IMF loans and other external central banks' deposits at the CBK). The forecasting of these items takes into account the daily revaluation of the existing foreign exchange reserves, purchases and sales of the same and repayments of IMF loans.

The net domestic assets of the CBK include net borrowing by government from CBK (overdraft loans, rediscounting of government securities less government deposits at the CBK), net borrowing by commercial banks from CBK (overnight loans to banks; loans to banks secured through reverse repurchase agreement securities (reverse REPO) less loans from banks secured through repurchase agreement securities (REPO); and other domestic assets (other assets less other liabilities of the CBK). Each of these three items with their respective components is forecasted separately on a daily basis.

For the net government borrowing, a forecast for overdraft and rediscounted securities is taken to be equal to the previous day's balances while the government deposits' daily forecast is the previous day's position plus the expected government receipts less government payments for the day. The forecasting of net borrowings of commercial banks from CBK follows the forecasting of overnight loans to banks and net repos positions separately. The forecasting of each of these takes into account the previous day's positions less repayment if any. Most of the items on the other domestic assets of the central bank are forecasted to remain unchanged throughout the month since most of the items involve revaluation which is done once a month.

On the liability side of the CBK analytical balance sheet, RM which is the sole liability is forecasted per component. CIC forecast is derived as a residue of the forecasted RM and the forecasted commercial banks' balances at the CBK. Commercial banks' balance at CBK is forecasted as the previous day's position plus the day's expected net liquidity position after all receipts and payments for the day. The day's net liquidity position is forecasted under a liquidity forecasting framework discussed in section 1.2 below. The structure of the daily analytical balance sheet of the CBK is as shown in Table 1 below.

Table 1: Structure of the Daily Analytical Balance Sheet of the CBK		
Assets	**Previous Day**	**Today's forecast**
1. Net Foreign Assets		
2. Net Borrowing by Government - Overdraft - Rediscounted securities - Less Government Deposits		
3. Net Borrowing by Commercial banks - Overnight loans - Reverse REPO securities less REPO securities		
4.Other Assets Other assets *Less* other liabilities		
Liabilities		
5. RM Commercial bank balances Currency in circulation Cash in Till Currency outside banks		

1.2 Daily Liquidity Forecasting Framework

The framework for forecasting liquidity on a daily basis is aimed at forecasting the net liquidity position of commercial banks at the end of each working day. This forecast is crucial since it is this net liquidity position of banks that brings about the day's closing level of RM. If this forecast is determined accurately then it is possible to realign RM outcomes to the desired level (target) on a daily basis.

The liquidity forecasting framework takes into account two types of transactions – those which inject liquidity into the system and those which withdraw. The net of the two gives the net liquidity position. Those transactions which inject liquidity include redemptions/maturities of government and REPOs securities, sale of reverse REPOs, purchases of foreign exchange from the domestic money market in exchange for Kenya shillings, overnight borrowing by banks from CBK and government payments. Those transactions which withdraw liquidity from the system include the sales of government and REPO securities, sale of foreign exchange to the domestic money market in exchange for Kenya Shilling, repayment of overnight loans from central bank and tax receipts

It is worth noting however that the use of REPOs and Reverse REPO is limited to policy purposes only. That is, in case the liquidity situation suggest the existence of excess liquidity, and that the RM is above target, then the CBK can perform open market operations (OMO) and use REPO instruments to withdraw the excess liquidity from the money market by selling them to commercial banks in exchange for cash. In a case where the liquidity situation is tight, CBK may opt to bail commercial banks out by injecting additional liquidity by way of reverse REPO instrument

Based on the forecasted net liquidity position for the day, forecasted RM for that day is computed as the previous day's position plus the net liquidity position for the day. The structure of the liquidity framework and how each item is forecasted is given in the Table 2 below.

Table 2: Structure of the Daily Liquidity Framework of the CBK		
	How to forecast	**Today's forecast**
1. Opening RM Position		X
a) Transactions increasing liquidity		
- Redemption of treasury bills	Amount of redemptions known	
- Redemption of treasury bonds	"	
- Maturing REPO	"	
- Sale of Reverse REPO	Unknown. Used as policy tool	
- Government payments	Based on government payment schedule from treasury	
b) Transactions decreasing liquidity		
- Sale of treasury bills	Amount of sales known	
- Sale of treasury bonds	"	
- Sale of REPO	Unknown. Used as a policy tool	
- Maturing Reverse REPO	Amount borrowed known	
Overnight loan repayment	Amount borrowed known	
- Tax collections	Estimated based on past trends	
c) Net Liquidity position (a)-(b)		Y
2. Closing RM Position = 1 + (c)		X+Y

1.3 Results of the Daily Implementation of Monetary Policy

Based on the above liquidity forecasting framework, the daily RM forecast serves as a guide for the day's monetary policy decision. In case the RM is above target, monetary policy actions taken may include the sale of REPO securities or the sale of foreign exchange reserves in the market in exchange for the Kenya shilling. However, when the RM is below target the CBK will gauge the extent of the liquidity shortfall in the market and take the appropriate action which may include staying out of the market, injecting liquidity into the system through the use of reverse REPO and purchase of foreign exchange from the domestic money market. It is worth noting however that the use of foreign exchange as an instrument of monetary policy is dictated by other factors such as stability in the foreign exchange market and the need to build foreign exchange reserves as guided by the design of the monetary programme[1].

Thus during the process of implementing monetary policy, on a daily basis, the RM outcomes are compared with the RM targets and decisions taken to align the outcomes with the target. Overtime, however, the CBK has been faced with a challenge of realigning RM outcomes to the set targets. There are periods of perpetual overshooting or undershooting of the targets despite monetary policy actions taken by the CBK (chart 1)[2]. According to the chart, and as expected from economic theory, there is a positive relationship between the deviations of RM and deviations of money supply, M3, from their respective targets (chart 1). This implies that the effects of the deviations of RM from target impacts on the money supply path.

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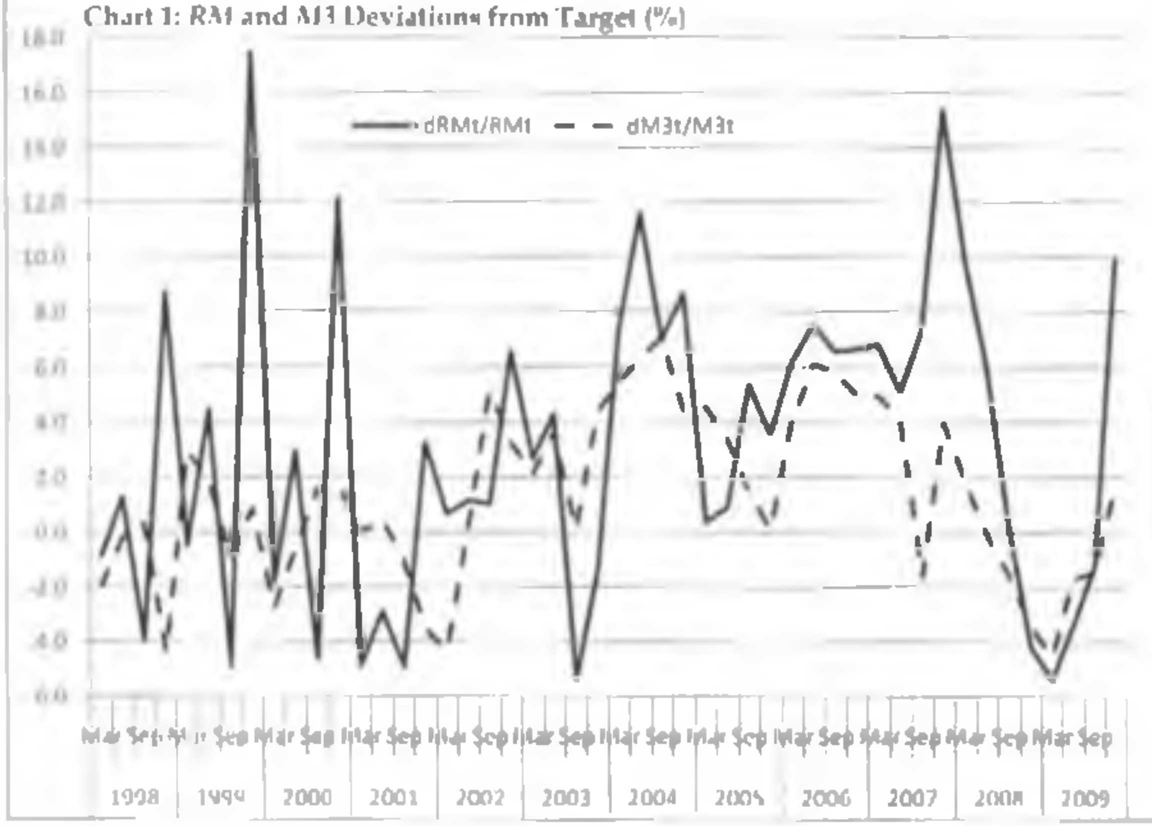
[1] While designing a monetary programme, the amount of foreign exchange build up or sale is factored in to mirror the developments in the balance of payments.

[2] Represented by percentage deviation of actual reserve money from target, zero and negative deviations means targets were met while positive deviations means targets were missed

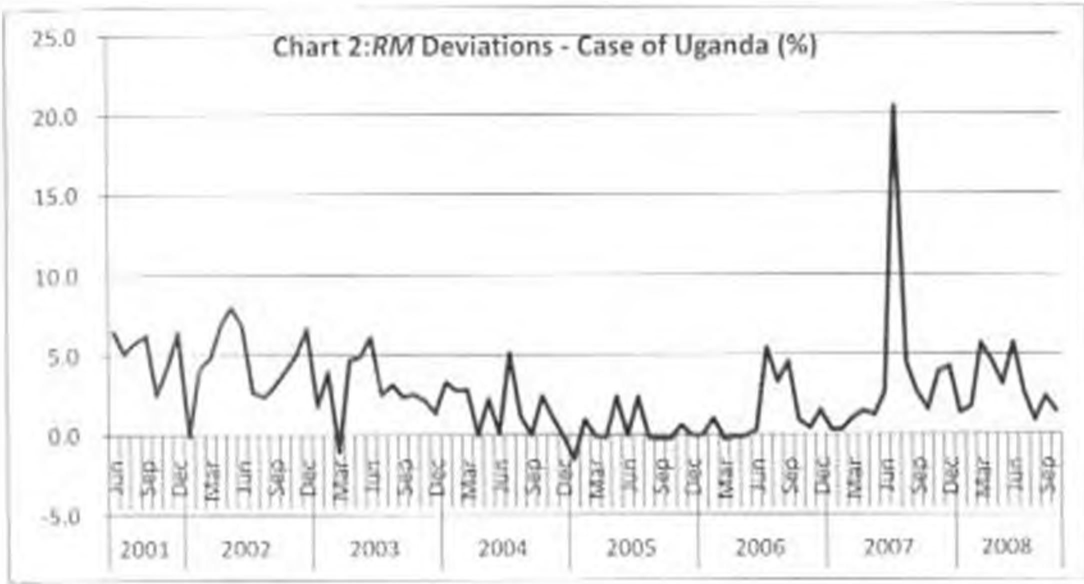
Chart 1: RM and M3 Deviations from Target (%)



Source: Author

Thus by virtue of the fact that the money supply is related to price changes, based on the quantity theory of money, and since inflation has been argued as 'always and everywhere a monetary phenomenon' there is a possibility that part of the inflation outcomes in Kenya could be associated with the missed RM targets. Though this paper is not aimed at establishing to what extent the missing of RM target has contributed to inflation, it however underscores the fact that the attainment of RM targets is critical to the success of monetary policy and by extension the attainment of the government's broad macroeconomic objectives.

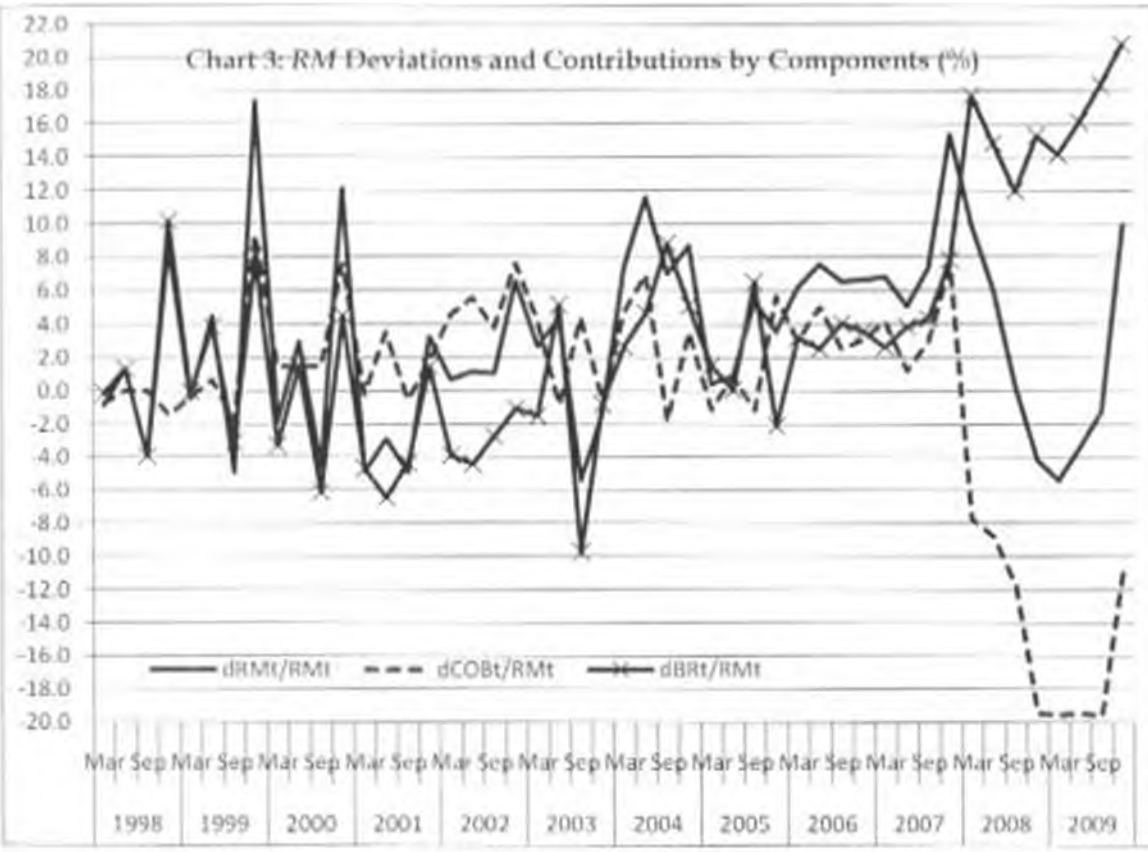
The problem of missing RM targets is not unique to Kenya as can be seen in the case of Uganda (chart 2 below). Even among developed countries, this phenomenon is common as confirmed when John Crow, the former Governor of the Bank of Canada, once remarked; we did not abandon monetary aggregates, they abandoned us



Source: Author

Based on the above, there is a need to understand what it is that causes RM to deviate from its target most of the time. Two approaches may be employed that of looking at the *sources* and *uses* side of RM. The *sources* side attempts to answer the question by looking at the changes on the assets of the CBK i.e. changes on the net foreign assets and net domestic assets. Whereas this approach is good it is limited in the sense that it does not answer to what cause the changes to take place.

Thus in this study we look at it from the *uses* side which comprises of the components of RM. Changes in these components (currency outside banks and bank reserves) depend on the demand for each of them. The contribution by each component to the deviation of RM from target is derived by looking at how each component deviate from the respective target (chart 3). The chart show COB was above target most of the time prior to 2008 but this got reversed thereafter leading to RM falling below target since then. However, bank reserves were largely on target most of the time except for some few periods. After 2008, this also reversed and bank reserves went above target.



Source: Author

1.1 The Statement of Problem

RM, which is the operating target for monetary policy in Kenya, has been off target. Whenever RM is off target, money supply outcomes are also off target and *ceteris paribus* inflation outcomes are mostly off target. This phenomenon beckons several questions which include

1) Have economic agents changed the levels of currency demanded from what had been targeted?
2) Have commercial banks, through their intermediation process; changed their demand for bank reserves from what had been programmed?
3) Is there a distortion on the programmed path for the velocity of money?
4) Was the targeted inflation far below or above what had been programmed given the prevailing economic conditions?
5) Was the targeted economic growth far below or above what had been programmed given the prevailing economic conditions?

Issues 3 to 5 are factors beyond CBK control and CBK monetary policy actions are only reactive or accommodative to them and so for purposes of this study they are taken as given (as programmed). However, though issue 1 and 2 are also beyond CBK control an understanding of them will give CBK a proactive role in the daily management and implementation of monetary policy. Thus this study seeks to explain the deviation of RM from target by looking at what drives the demand for RM components.

1.5 The Objectives of the Study

The objectives of this study are

a) Estimate the demand for currency outside banks and compare it with the actual and program targets
b) Estimate the demand for bank reserves and compare it with the actual and program targets
c) Based on (a) and (b) compute the implied demand for RM levels and compare it with actual and program targets.

d) Draw conclusions from the above outcomes including policy recommendations on how to deal with the deviations of RM from target as a useful guide in the daily RM management by the CBK.

1.6 The Justification of the Study

Given the importance of RM as a monetary policy operating target, any monetary policy decision that affect the broad macroeconomic stability hinges on the attainment of RM targets. The success in the attainment of RM targets depends on the CBK understanding of how the demand for RM evolves. Thus the justifications of this study may be summarised as:

a) The need to develop a guide for CBK and the Monetary Policy Committee (MPC) in reviewing the success of the past and current RM programs and in shaping decisions for the future monetary programs

b) The need to understand the dynamics behind the market for bank reserves and how that can be used in the day to day implementation of monetary policy by the CBK

c) The need to understand the dynamics behind the holding of currency outside banks by the public and how that can be used in the day to day implementation of monetary policy by the CBK

CHAPTER 2: LITERATURE REVIEW

This section presents the literature review for both currency outside banks and commercial bank reserves. The literature covers the theoretical and empirical aspects of base money and its components. The overview of the literature contain value addition which this study contributes to the existing literature and future research work that can be undertaken to further research work in this area.

2.1 Theoretical Literature

2.1.1 Theoretical Literature on Currency outside Banks

The theory for the demand for currency outside banks follows that of the demand for money since it is a component of money. There are a number of theories that explain the demand for money, classical quantity theory, Keynes' liquidity preference and Friedman's modern quantity theory of money. The classical quantity theory of money, due to Fisher (1911), was based on the concept of "transaction velocity of circulation of money" which measures the average number of times a unit of money is employed in carrying out transactions in a given period.

According to Fisher the velocity was assumed to be fairly constant in the short-run thereby transforming the equation of exchange[1] into quantity theory of money, which states that nominal income is determined solely by movements in the quantity of money. Thus the quantity theory of money attributes the movements in the price level solely to the changes in money supply. Assuming the money market is in equilibrium

[1] The equation of exchange is expressed as $MV = PT$, where M is quantity of money in circulation, V is transactions velocity of money in circulation (average number of times a shilling is spent in purchasing goods and services), T is the quantity of transactions conducted per unit of time and P is the average price per transaction

so that money demand equal money supply and replacing Y for T, the quantity theory of money demand equation becomes $M^D = kPY$ where k represent the inverse of the velocity of money. Thus the Fisher's quantity theory of money demand implies the demand for money is purely a function of income and interest rates have no effect. This conclusion was based on the assumption that people hold money to conduct transactions and thus the demand for money was determined by the level of transactions generated by level of nominal income (PY) and the institutions in the economy that affect the way people conduct transactions that determine the constant velocity.

Another approach similar to that of Fisher is the Cambridge approach where individuals are allowed some flexibility in their decisions to hold money and are not completely bound by institutional constraints as suggested by Fisher. Thus the classical Cambridge approach allowed for the possibility that the velocity of money could fluctuate in the short run because decisions about using money to store wealth would depend on the yields and expected returns on other assets that also function as stores of value in addition to medium of exchange. Thus one key contribution of this approach was to allow effects of interest rates on the demand for money equation.

An improved demand for money analysis was however done by Keynes in 1936. He provided a more rigorous analysis than his predecessors and looked at money demand issue from a different analytical angle. He abandoned the classical view that velocity was constant and developed a theory of money demand that emphasized the importance of interest rates. Keynes in his "Liquidity Preference Theory" postulated that there are three motives behind the demand for money: transactions, precautionary and speculative motive. The transaction demand for money arises because of the non synchronization of payments and receipts. In the spirit of the classical thinking, Keynes believed that the transactions component of the demand for money was proportional to income. The precautionary motive emphasizes the fact that people hold money not only to carry out current transactions but also to cushion against unexpected need. Keynes considered the demand for precautionary money balances to be proportional to income.

Keynes developed a demand for money equation, known as the liquidity preference function, which says that the demand for real money balances is a function of real income and nominal interest rates. According to him the transactions motive and precautionary motive for demand for money is positively related with real income while the speculative motive for demand for money is negatively related to nominal interest rate. Keynes significant contribution to money demand theory came from the role the speculative motive plays. The speculative demand for money is what Keynes called 'Liquidity Preference'. Individuals could hold their money in money or bonds. The major implication of the Keynesian analysis is that when interest rate is very low, everyone in the economy will expect it to increase in the future, and hence, prefers to hold money whatever is supplied. At this point, the aggregate demand for money becomes perfectly elastic with respect to the interest rate. At low levels of interest rate, the economy gets into a liquidity trap in which interest elasticity of money can be infinite thus making the conduct of monetary policy impotent.

One key implication of Keynesian liquidity preference theory of the demand for money, which contrasts sharply with the classical quantity theory, is that the velocity is not constant but instead positively related to nominal interest rates, and positively related to real income. In contrast to the quantity theory of money's views of a constant velocity, the Keynesian liquidity preference theory implies that velocity is procyclical, since procyclical interest rate movement induces procyclical velocity movements.

There are further developments in the Keynesian approach where more precise theories have been developed to explain the three Keynesian motives for holding money. The first is the inventory theoretic approach where Baumol (1952) and Tobin (1956) (B-T analysis) applied inventory theoretic approach to develop a theory of money demand in which money was viewed as an inventory held for transactions purposes and this money was sensitive to the level of interest rates. The models assume the presence of two stores of value (money and interest bearing alternative assets), a fixed cost of making transfer between money and alternative assets and exogenous receipt and expenditure streams. All payments are made with money and all the relevant information is assumed to be known with certainty. In the simplest of these models, individuals are paid (in bonds) an amount Y at the beginning of a period and spend this amount uniformly over the period.

The basic idea in this B-T analysis is that there is an opportunity cost of holding money in terms of the interest that can be earned on other assets. There is also a benefit to holding money – the avoidance of transaction cost. When the interest rates increase, economic agents try to economize on their holdings of money for transactions purposes because the opportunity cost of holding money increased. The models led to a well-know square root formula law expressed as

$$\frac{M^d}{P} = \sqrt{\frac{bY}{2i}} \qquad \text{(1)}$$

Where i the nominal interest rate on bonds and b is is the brokerage charge or fixed transactions cost for converting bonds into cash. The precise form of the equation depends on the assumed means of payments mechanism.

The key conclusions from the Baumol-Tobin formulations in terms of elasticities of the transactions demand with respect to Y, and i are first the transactions demand for money is interest elastic. Specifically, the interest elasticity for the demand for real transactions money balances is -0.5, which means the higher the rate of interest, the higher the cost of holding funds in transactions balances and the lower the demand for such balances. This refutes the Keynesian postulation that the transactions demand for money is interest-inelastic. Second, the transactions demand for money rises less than proportionately with individual's income (elasticity of 0.5) due to economies of scale in the cost of cash withdrawals from bonds. This conclusion refutes the classical and neoclassical claims that transactions demand for money is proportionately related to income.

Friedman (1956) in restatement of the quantity theory approach looks at money under the consumer demand theory. Money is included in the assets that an individual can choose to hold and like any other capital good yields a flow of services to the agent who holds it over time. Friedman identifies three major factors that determine the demand for money: the total wealth which constraints the agents' budget; the price of return on money and alternative assets and tastes and preferences of the wealth holders.

Miller and Orr (1966,1968) applied the inventory theory to the transactions demand for money. His work is interpreted as a model of the Precautionary motive for money holding since there is minimum allowable money holding below which a penalty must be paid. As in the Baumol-Tobin (B-T) framework, Miller and Orr (M-O) consider two assets and transactions cost which are fixes per transaction. The difference is that M-O take cash flow to be stochastic. In their simplest version of their model, cash flows follow a random walk without drift in which in a given time interval (say 1/t of a day), there is an equal probability of a positive or negative cash flow of m dollars. Given a lower bound below which money balances cannot drop (normalized to zero), the optimal policy consists of an upper bound h, and a return level z. Whenever money balances reach the low bound z dollars of bonds are converted to cash; whenever the upper bound is reached, h-z dollars of cash are converted to bonds. Minimizing the sum of expected per day transactions and opportunity cost yields the optimal return level.

$Z=[(3b/4r)\sigma 2]1/3$ .... (n)

Where σ2 is the daily variance of changes in cash balances (σ2=M2t) M-O show that h=3z and that the optimal size of average cash balances is given by M=4z/3. Thus like the B-T approach, the M-O model yields constant interest elasticity, although the value is 1/3 rather than ½.

2.1.2 The Theoretical Literature for the Demand for Bank Reserves

Modeling commercial banks reserve management has a long history, tracing its early roots to Edgeworth (1888). The rising interest in the issue followed naturally the evolution in banking in the 19th century, which developed into fractional reserve system, where only a portion of overall claims was backed by commodity money. The rest of borrowed funds were invested at interest in illiquid assets, such as long-term loans to agriculture and manufacturing. Since that time banks reserve management problem has essentially been to balance the foregone interest of holding too large reserves against costly stock outs of holding too small an inventory of reserves.

With the triumph of the Keynesian economics since the 1930s, analysis of banks reserve needs became closely linked to the growing money demand literature. The Keynesian theory of money demand distinguished three motives for holding reserves the transaction motive, the precautionary motive and the speculative motive. The early models on the transaction demand for reserves, pioneered by Baumol (1952) and Tobin (1956), followed an inventory theoretic approach, where the transaction motive for holding reserves is modeled by means of costly stock adjustment. In those models reserves are used to pay a stream of transactions, which is perfectly foreseen. Holding reserves is costly, as there exists the alternative to invest in interest-bearing bonds. On the other hand, selling bonds for reserves induces transaction costs, which explain the positive demand for reserves. The demand for reserves in that framework is explained by the famous square-root rule, as described in equation (i) above but in this case the interest rate *i* is given as $r^B - r^R$ such that the demand for bank reserves is expressed as

$$R^d = \sqrt{\frac{2cY}{r^B - r^R}} \quad \text{(iii)}$$

Where Y is the volume of transactions, c is the fixed cost per adjustment, r^B is the interest rate on bonds and r^R is the remuneration on reserve holdings, which is usually assumed to be zero. The demand for reserves is positively related to the transaction volume Y and to the reserve adjustment cost c, and negatively to the interest rate on bonds r^B.

The simple inventory model is useful in explaining several long-run trends in banks payment and reserve arrangements. As the transaction demand for reserves is ultimately due to their use in clearing and settling payments, the need for clearing reserves by banks is naturally closely linked to the evolution of payment technology and payment systems, as emphasized by Pauli (2000). As holding reserves is costly, the main driving force in the endogenous development of payment arrangements has always been banks need to economize on the cost of liquidity.

The inventory model predicts three structural factors, which in the course of years have had a major (negative) impact on banks reserve needs. First, the model suggests that there exist major economies of scale in reserve management. A strong tendency towards centralized reserve management within banks and banking groups is supportive for that conclusion. Second, as reserve needs depend on the volume of transactions, there is a strong incentive for netting payments between banks, whose customers are commercially linked with each other. The efficiency gain of netting can be achieved by using interbank credit in place of immediate settlement in currency. A third prediction of the model is that lower costs of reserve adjustment will reduce the need for non-remunerated reserves. That links the need for clearing reserves closely to the development of the financial market, in particular the money market.

Apart from specific terms of lender of last resort support, the early literature did not pay much attention to central bank operating procedures, i.e. to the modalities of the supply function of reserves. Monetary policy was implemented via control of the monetary base, which was linked to monetary aggregates through the money multiplier. Alternatively, the central bank could affect the money multiplier and money supply by adjusting the required reserve ratio. However, money supply considerations were not the only motivation for high reserve ratios that were generally applied in those days. There was also a persistent fear that banks voluntary reserve holdings will stay too low to stand large deposit withdrawals. Equilibrium in the money market is then given by the equality of the interplay of demand and supply of money, where money demand is a function of the income and the interest rate and money supply is an exogenous constant fixed by the central bank. Equating money demand and supply for each income level then produces an upward-sloping portfolio balance schedule (LM curve), which can be affected by changes in nominal money supply.

In later contributions, the simple inventory model was extended to incorporate elements of uncertainty. For example, Tobin (1958) used portfolio approach to show that the demand for reserves is not only a (negative) function on the interest rate on bonds but also a (positive) function on the uncertainty of returns for alternative investments. If a bank has two assets, non-interest bearing reserves, R, and earning assets, A, yielding r_A, higher volatility of r_A induces greater demand for reserves. Olivera (1971), Miller and Orr (1966) as well as Frenkel and Jovanovic (1980) continued to model the demand for reserves in the same tradition but assumed that net disbursements are governed by a stochastic process that leads to a need for precautionary reserves. Some of those models suggested that an increase in payment uncertainty might result in higher demand for reserves.

The growth of an efficient market for trading banks reserve balances induced a major reformulation in modeling banks reserve management. Given that central banks normally paid no interest on reserves and charged high penalties in the case of reserve deficiency, banks had a strong incentive to balance daily interbank positions between themselves. However, another prerequisite for the birth of efficient reserve trading was the development of the payment infrastructure to the stage, where banks could forecast their daily balances with some accuracy. Given that option, banks were no more willing to hold non-interest bearing reserves for the settlement of anticipated transactions, if the yield on overnight funds or short-term Treasury bills was high enough to cover the transaction costs of interbank trading. Instead of transactions demand, the precautionary demand due to uncertainty about the size of future deposit withdrawals became crucial for the existence of excess reserves. Furthermore, as overnight funds began to trade at a market rate that was determined by supply and demand, it became evident that the discount rate affects the funds rate through its influence on the demand for reserves.

Poole (1968) was the pioneer to extend the inventory model of reserve demand in order to take into account the role of an efficient money market. He examined the significance of excess reserves, commercial bank borrowing from the central bank, and the central bank lending rate (the discount rate) as a problem of bank reserve management optimization under stochastic demand. The model assumes that the representative bank's day-to-day adjustment of its reserve position takes place in the interbank overnight market and through borrowing from the central bank. The model considers the optimal amount of reserves that a bank is willing to hold as a consequence of uncertain deposit levels. Holding reserves yields a return to the bank by preventing costs from unexpected deposit drains, but the other side of the bargain is the opportunity cost of reduced interbank lending. The problem the bank faces is to allocate its liquid funds optimally between reserves and interbank lending on the basis of costs and returns related to different assets.

Most central banks implement monetary policy through market-oriented instruments geared to influencing closely short-term interest rates as operating objectives or for some the quantity of bank reserves. They do so largely by determining the conditions that equilibrate supply and demand in the market for bank reserves. The market for bank reserves is a special one since the central bank is a monopolist supplier which can also directly affect demand by way of setting of reserve requirements and operating key interbank settlement systems.

On the balances for reserve requirements it must meet two preconditions to be the binding factor in determining the demand for reserves (Borio (1997)). One is that it should be possible to use them to meet settlement needs and the other is that the amount of reserves banks needed to hold to comply with the reserve requirement should exceed their working balances. This condition can only be met if some averaging provisions exists, allowing banks to offset deficiencies with surpluses over a given period. This provisions acts as a buffer over the overnight rate.

According to Ulrich (2004), excess reserves are defined as reserves which does not contribute to the fulfillment of reserve requirements but useful for liquidity forecasting. They may not be easy to see in a case where the maintenance of the requirements is averaged over a maintenance period and therefore reserve holdings in a system without required reserves are excess reserves. It is frequently observed that for those countries with averaged reserve requirements, the trend is such that the excess is low at the beginning of the cycle and high at the end of the cycle as banks try to make up for the non-observance at the beginning. Thus the demand for bank reserves is therefore the demand for both reserve requirements and settlement balances.

In a case where the reserve requirements can sometimes, within the maintenance period, be used to meet settlement needs, then that provision declines during the maintenance period as there is less time for banks to manoeuvre and meet the monthly target on average. This implies that reserve requirements with averaging provisions call for less active day-to-day management of liquidity by the central bank. In the absence of binding bank reserves, the demand for bank reserves would be the demand for settlement balances. They argue that the settlement balances have a high cost since they bear no interest and a positive balance means incurring an opportunity cost equivalent to the overnight day rate. Only for precautionary reasons could a bank strive to hold such positive balances to avoid the risk of having to incur a penalty over the market rate owing to the inability to meet its settlement obligations with its existing balances at the central bank. Such precautionary balances could be minimized if the settlement system provides for a period of borrowing/lending among participants after the positions become known. Thus the demand for working balances depends largely on institutional and operational characteristics of payments and settlements and by the terms and conditions of central bank late-day assistance.

Again the demand for settlement balances is likely to be insensitive to changes in the overnight rate and can be unstable if there is uneven distribution of reserves in the system. This then calls for an active management of the supply of liquidity by the central bank to avoid large fluctuations in the overnight rate.

The model of excess reserve demand assumes that the uncertainty in the amount of excess reserves increases proportionately with the level of transactions deposits. The role of excess reserves in monetary policy depends on the particular operational strategy adopted by the central bank. For most monetary targeters, the demand for excess reserves is believed to be relatively inelastic, and little attention is given to its response to changes in the monetary policy signaling rate in line with Sellon and Seibert 1982. However, since excess reserves pay no interest, banks are likely to economize on them when market interest rates increase, which might provide the necessary elasticity. Given a downward-sloping demand for reserves, setting the supply of reserves each day would fix that day's interest rate in the interbank market. This downward-sloping demand for excess reserves is the conceptual basis of interest rate targeting in the absence of reserve requirements (e.g., Longworth 1989, Sellon and Weiner 1996).

2.2 Empirical Literature

2.2.1 Empirical Literature on the Demand for Currency outside Banks

Whereas there is a lot of literature in the demand and supply of money there is relatively little on the demand and supply of base money. However, there is a lot of literature based on the components of base money i.e. currency outside banks and bank reserves. Economic theory presents a standard currency demand equation based on the theory of transaction and portfolio demand for money. Such an equation could be estimated in isolation (Jadhav, 1994) or could be a part of a bigger macroeconomic model (Palanivel and Klein, 1999). The explanatory variables traditionally used in the equation are income or its proxy (Y), price level (∏) and the opportunity cost of holding cash (r).

Cabrero et al. (2002) modeled the daily series of banknotes in circulation in the context of the liquidity management in the Euro system and confirmed the importance of interest rates as a determinant of COB. This is because interest rates represent the opportunity cost of holding currency. Thus the higher the interest rates the lower the levels of currency outside banks. In his study of currency in circulation in Macedonia, Stavreski (1998) also pointed out that the low opportunity cost of holding wealth in form of cash, which is a result of low nominal interest rates on demand deposits is one cause of the high level of currency outside bank. He reports that "... due to inflation in the past in Macedonia, savers are used to the high interest rates, so that currency demand deposits are considered unattractive and non-worthwhile form of holding money in commercial banks ..." (page 10).

Nenovsky and Hristov (2000) also hypothesized real sector development (GDP growth) among other factors such as interest rates as another determinant of COB. As peoples' income increase in nominal terms, COB is expected to rise. Their study also revealed that one motive of demand for COB is economic agents' willingness to save or hoard in cash. They distinguished two forms of hoarding, one associated with official economy and the other underground economy. Under the official economy, the public decides to voluntarily hoard a portion of their cash when income on alternative assets is smaller than transaction costs on portfolio transformation. Both Nenovsky and Hristov (2000) and Stavreski (1998) also agree on hoarding cash for servicing economic activity in the underground economy. Cash is the most suitable means of payment that leads to no trace when economic agents are trying to hide part of their activities in order to reduce tax base, and cash offers maximum degree of anonymity, which makes it an attractive form of financing illegal transaction

The underdeveloped nature of the banking system and the insufficient development of non-cash payment such as credit cards, debit cards and ATM cards have also been cited as causes of high cash utilization in some countries [Cassino et al (1997); Stavreski (1998)]. Electronic means of payment such as smart cards are stored value cards, which record an amount of credit and the amount spent using that credit. These are, therefore, designed to replace small transactions, and therefore, are expected to reduce COB.

In Kenya few studies have been done on the money demand function but none on currency outside banks. The earliest one was Darrat (1985), estimated an autoregressive model for the demand for money function where real money balances were explained by foreign interest rate, inflation effects proxied by the expected rate of inflation reflecting the opportunity cost of holding money and real GNP as a scale variable reflecting economic activity. The definition of money stock was both the narrow (M1) and the broad (M2) money. In Mwega (1990) a broader definition of money is used which includes deposits of the Non Bank Financial Institutions (NBFI). The argument in the paper was that the rapid growth of NBFIs in the 1980s was likely to have affected the elasticity of the money demand function with respect to its principal determinants, which could be considered as a form of financial innovation.

Following Darrat (1985), Mwega (1990) used a less volatile scale variable, which is the expected real income. Treasury bill rate was used to reflect the opportunity cost of holding money, the argument here was that this rate has fluctuated relatively freely in accordance to the conditions in the money market, having been determined in an auction on market

The results for the period 1973 to 1988 showed that the elasticities were significantly below unity. The results were computed for all definitions of money Stock M1, M2, M3, where deposits of NBFIs are included). Treasury bill rate was found to be significant in M1 and M2 formulations but insignificant in M3. Stability was further tested using dummies to test for structural break, results were however sensitive to the definition of money stock used. Perhaps why TBR did not respond to M3 is subject to debate and perhaps further research. It would therefore be interesting to enlarge the sample and show how Mwega (1990) conclusions might change.

A further extension of the same model is by Adams (1992). In Adam (1992), the demand for narrow money in Kenya is estimated using quarterly data from 1974(3) to 1989(2). But uses GNP scale variable adjusted for changes in international terms of trade and total final expenditure. The justification was that for an open economy, GDP would fail to accurately reflect transactions demand for money due to the volatility in terms of trade. The nominal exchange rate was included in the model to capture currency substitution. An error correction dynamic model is specified.

Ndungu (1994) uses the inverted demand approach on Kenyan data and finds that monetary base in the inflation model provides relatively stable results compared to the broad money aggregate. However, he used a cointegrated VAR approach. Dynamic models approach. This approach uses the equilibrium error correction, which provides a flexible dynamic specification for the money demand function. This entails an explicit and separate modelling of the short-run dynamic specification and the long-run cointegrating relationship for money supply. This specification allows distinguishing between shocks which cause temporary effects on money holdings and shocks with persistent long-run effects. Ndungu (1994) uses this dynamic model within an inverted money demand equation framework.

Ndungu (1997), studied the ability of the central bank to control money supply growth, which was measured by the volatility of money multiplier. The increase in variability would reflect a potential for temporary loss of monetary control. He found out that the money multiplier for Kenya was not stable especially in the 1990s and this is the period when the country was liberalizing the financial system.

2.2.2 Empirical Literature on the Demand for Bank Reserves

(2001) paper estimated the demand for excess reserves in the United States and found that excess reserves are negatively related to the Federal funds rate and positively related to transactions deposits. It also finds that clearing needs significantly affect the demand for reserves with increases in excess reserves coming in response to lower required reserve balances and higher clearing volume. Poole (1968) developed a general model for the precautionary demand for reserves based on two basic propositions. The first is that the quantity of excess reserves demanded should vary inversely with short-term interest rates, which are the opportunity cost of holding reserves, assuming that excess reserves pay no interest. The second proposition is that since excess reserves are providing a buffer against uncertainty about reserve balances, demand should increase with uncertainty.

Ho and Saunders (1985) develop a micromodel of the interbank deposit market, including major institutional characteristics. Nautz (1998) studies bank reserve demand under the conditions of uncertainty of future monetary policy of Deutsche Bundesbank. Based on results obtained by using ARCH-M model, the Nautz concludes that the central bank can influence money market, announcing its monetary policy explicitly or implicitly. This impacts the expected variance in bank reserve demand. Jahnsen (1998) analyzes RM demand in Great Britain using quarterly data which covers a 20-year period. The author uses in his study a cointegration model with error adjustment. Bartolini, Bertola and Prati (1999) analyze the effect of Federal Reserve behavior on bank reserve demand. In accordance with this econometric model interbank market rates volatility reflects market participants.

Money demand in transition economies has been thoroughly studied. In contrast to developed countries where money demand is relatively stable and its behavior predictable, in transition economies it is characterized by a number of specific features. For example, Nenovsky (1998) points out the high degree of foreign currency substitution and lack of confidence in monetary authorities as major factors behind the disturbed stability of the function of money demand. However, bank reserves are a relatively narrow segment of money in the economy. Therefore, bank reserves are characterized by a certain behavioral stability provided by the transaction and institutional specificity of payment and reserve systems.

Existence of minimum required reserves distorts the information generated by the money market about motives for bank reserve demand. For example, in case of an attack against the fixed exchange rate in absence of minimum required reserves, enhanced demand for bank reserves will prompt a faster increase in interest rates than in a situation when banks are required to maintain minimum reserves.

A liquidity crisis with a certain lag may also occur if a system of averaging minimum required reserves is employed. On the other hand, minimum required reserves ensure less interest rate volatility in the interbank market which may occur as a result of significant deviations in banks' payment activity within the maintenance period. This thesis is well grounded and studied by Clouse and Elmendorf (1997). Since the interbank market rate reflects the opportunity cost of maintained reserves on a particular day of the maintenance period, the banks' ability to average their positions allows, in the event of liquidity squeeze, to avoid borrowing from the interbank market. This step should be initiated provided banks fail to fulfill their reserve positions. In the absence of an averaging system and insufficient liquidity, enhanced demand for bank reserves will prompt an increase in interbank market rates.

Another argument in favor of maintaining minimum required reserves ensure high commercial bank liquidity. High liquidity can be provided by introducing liquidity requirements. In Argentina, for instance, minimum required reserves were gradually replaced in 1995 by a requirement to maintain a portfolio of high-liquid and low-risk forex assets, with the amount of these assets dependent on the deposit base of an individual commercial bank. Consequently, employment of minimum required reserves as an argument for maintaining bank liquidity is not well grounded. Moreover, Argentina's experience during the Asian crisis and later in the Russian and Brazilian forex crises evidenced that this technique works well.

2.3 Overview of the Literature

Most of the available literature has covered the demand for money in details. However, literature on the demand for COB and BR are limited particularly for Kenya. For those studies that have modeled COB, annual GDP was used as a proxy for economic activity, short term interest rates as the opportunity cost of holding money and the use of ATMs and credit/debit cards used as a measure of financial innovation. The little literature on the modeling of BR is based on the factors which affect the separate components of BR. This study contributes to empirical literature by attempting to model demand for RM for Kenya indirectly by modeling the key components of RM – COB and BR separately. From observation, the seasonality factors and recent financial innovation affects the demand for COB in Kenya and this study will incorporate them in the model. Factors affecting the various components of BR will also be used together in the BR model in this study.

CHAPTER 3: METHODOLOGY

3.1 Empirical Framework for the Demand for COB

Literature recognises that under a fractional-reserve banking system, a withdrawal of deposits into currency reduces bank reserves and, unless reserves were previously in excess of the desired level or are otherwise replenished, forces a multiple contraction of earning assets and deposits. Thus a deposit of currency into a bank augments bank reserves and allows a multiple expansion of earning assets and deposits and if not offset by other factors, alters the aggregate amount of the money supply as well as its composition. It is therefore important to understand the drivers of currency demand in an economy

The management of cash by economic agents (companies and individuals) generally follow the Baumol model approach which enables them to find out their desirable level of cash balance under certainty This model assumes cash management has two costs the holding cost and the transaction cost These two costs are identified in other studies among the factors that underlie the demand for currency as follows:

(i) The Cost of Holding Currency

Cagan (1958) observed that the rise in the cost of holding currency leads people to substitute deposits for currency and conversely. The foregone cost of holding currency is measured by the current rate of return on deposits since currency typically yields no nominal return

(ii) The Volume of Transaction

One advantage of currency over deposits is its wide acceptability. Where wide acceptability is important, as in cash-and-carry transactions between strangers, the use of currency predominates. If we suppose that a constant fraction of retail transactions involves the use of currency and that this fraction is substantially higher than for other types of transactions, then the currency ratio would vary directly with long-run movements in the fraction of total transactions made through retail stores. Such a relation explains the seasonal variations in the currency ratio with the ratio typically reaching its high point for a given year mainly during the Christmas periods. Bowsher (1980) in studying the significance of currency in underground transactions observed that the increase in economic activities, both formal and informal, cause an increase in currency holdings by the public

(iii) The Degree of Financial Innovation and Financial Deepening

Financial innovation expresses the degree to which currency can be exchanged for other financial assets or payment modes without the loss of benefits derived from holding cash. For example the introduction of automated teller machines reduces the need for holding large amounts of currency as it becomes available as and when you need. The use of check books to make payments have reduced the need to transact solely in cash as this is a simple and safe mode of payment. Other financial innovations include the use of MPESA payment systems which have drastically reduced the holdings of cash by economic agents for the case of Kenya.

Related to this is the aspect of financial deepening which captures the broadening of financial markets with the supply of more financial instruments and expansion of financial access all of which reduces the levels of currency held by the public

Helsinki (1990) in studying the importance of currency substitution and financial innovations for money demand for Finland noted that the conventional demand for money specifications which do not take these factors into account are clearly misspecified and produced unreasonable results and that the problem is particularly acute for narrow concepts of money.

3.1.1 Empirical Model for the Demand for Currency Outside Banks

In this study we seek to model the demand for currency outside banks by taking into account variables that are relevant to the Kenyan situation. The volume of transaction is an indicator of economic activity and is proxied by the quarterly gross domestic product (GDP). The average deposit rate is used as a representative opportunity cost for holding cash while the consumer price index (CPIR) is the opportunity cost of holding money in the bank instead of at hand. The ratio of M1 to M3 is used as a proxy for financial innovations and financial deepening within the Kenyan economy.

A linear long run equation is to be estimated using ordinary least squares (OLS) regression as.

$$COB^{D} = a0 + a1RGDP + a2DEP + a3CPIR + a4m \quad \text{.................................}(iv)$$

Where

COB	-	Currency outside banks in nominal terms
RGDP	-	Quarterly real GDP (as measure of economic activity)
DEP	-	Deposit rate (as the return on money)
CPIR	-	Annual average consumer price index
m	-	Ratio of M1 to M3 (capture financial innovation)

In case there exist serial correlation of errors terms in the long run equation above, an error correction model (ECM) is estimated using Engel Granger procedure. The equation will be re-estimated using a vector autoregression (VAR) approach and number of cointegrating equations determined using Johansen cointegration test.

The data transformations and diagnostic tests are detailed in sections 3.4, 3.5 and 3.6 below

3.2 Empirical Framework for the Demand for BR

Bank reserves are a relatively narrow segment of money in the economy and are characterized by a certain behavioral stability provided by the transaction and institutional specificity of payment and reserve systems (Petrov2000) Hamilton (1997b) while studying the factors affecting bank reserve demand and supply used a vector autoregressive (VAR) model, imposed a number of constraints on individual variables and applied impulse analysis of individual variables to determine the effect of shock duration on bank reserve demand and supply. However, Furfine (1998) summed up the function of bank reserve demand as consisting of two separate components: required reserve demand and settlement demand and the total bank reserve demand in the monetary system is a sum total of individual functions of commercial bank demand

On the minimum required reserves, employment or absence of minimum required reserves is part of the institutional specificity of bank reserve demand. Commercial banks hold their reserves for two major reasons. First, commercial banks need adequate balances on their current accounts at any time in order to be able to effect payments on their own account or on the client's account due to the banks specific role of payment mediators in the economy, or the so-called liquidity buffer role of bank reserves. Secondly, the maintenance of commercial bank reserves is required by the central bank since employment of minimum required reserves helps stabilize demand for reserves within a particular period and thus contribute to highly efficient monetary policy.

Accordingly, the demand for bank reserves can be modelled by taking into account the factors that affect the motives for bank reserve demand.

(i) Determinants of transactions demand for bank reserves

Transactions demand for bank reserves results from economic agents' preference for making non-cash payments (Petrov2000). With a view to better security of claims, financial mediators prefer the central bank as a clearing centre between commercial banks. This is also in line with the recommendation of the Payments and Settlement System Committee at the Bank for International Settlements (BIS Report, 2000). In technical aspect, the mediation function of commercial banks in payments is effected in a manner allowing any agent who has initiated payment through its bank to generate demand for bank reserves (on condition that the final recipient's account is outside the payer bank).

Therefore, the increase in commercial bank demands for bank reserves is quite normal in periods of concentrated payments, and vice versa: transactions demand decreases with reduced payment activity. Transactions demand is measured by the volume of effected non-cash payments and are an accidental quantity dependent on bank customers' behaviour. Thus the bank reserve demand, R^{td}, (in this case the clearing account balances of commercial banks at the central bank) is in direct proportion to the monetary equivalent of transactions, QM, (cheques cleared):

$R^{td} = f(QM)$,.. *(v)*

Another transactional demand for reserves stems from the customer demand for cash withdrawals over the counters of commercial banks. This demand is proportional to a bank's level of deposits at any given day and mirrored by the ratio of cash in till to total deposits, CT.

$$R^{td} = f(CT), \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \quad (vi)$$

(ii) Demand for Precautionary Bank Reserve Balances

Unlike the transaction demand for reserves which is captured by the value of cheques to be cleared, the precautionary balances (over and above the normal level of clearing balances) creates demand for bank reserves which should be proportional to the requirement for a particular balance of minimum required reserves at the end of each maintenance period to be covered by any individual commercial bank. However, bank reserve demand for covering minimum required reserves is a function of compliance with required reserves from the previous day and the opportunity cost for maintaining these reserves i.e.

$$R^{pd} = f(RR_{t-1}, i), \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \quad (vii)$$

(iii) Speculative Demand for Bank Reserves

Literature also observes the possibility of speculative demand for bank reserves which reflects banks' ability to generate income from arbitrage transactions. This depends on the opportunity of placing abroad funds borrowed in the interbank market and vice versa. However, there is no evidence that Kenyan banks invest funds borrowed in the local inter bank market in foreign inter-bank markets and hence this factor does not account to the demand of bank reserves in the Kenyan context.

3.2.1 Empirical Model on Demand for Bank Reserves

Stemming from the empirical framework above, we model the demand for bank reserves by Kenyan Banks taking into account the demand for two components of bank reserves namely transaction reserves and precautionary reserves. Since it is not possible to segregate them at any one time for all the banks, this study models an aggregated demand for bank reserves taking into account the determinants of the separate components of bank reserves.

The non-cash transaction payment is proxied by the total quarter values of cheques cleared in the clearing house (QM) while the cash transaction payment is proxied by the ratio of cash in till to total deposits, *CT*. The precautionary balances are proxied by the rate of cash reserve ratio (*RR*) and the opportunity cost of maintaining these minimum balances is the interbank rate i

A linear equation is to be estimated using ordinary least squares (OLS) regression as

$$BR^{D} = b0 + b1(QM) + b2(CT) + b3(RR) + b4(i_{I}) \ldots\ldots\ldots\ldots (viii)$$

Where

CT	-	Ratio of CIT to total deposits (ratio of cash payment)
RR		Rates of cash reserve requirements
QM	-	Actual value of cheques cleared (non-cash payment)
i_I	-	Interbank rate

In case there exist serial correlation of errors terms in the long run equation above, an error correction model (ECM) is estimated using Engel Granger procedure. The equation will be re-estimated using a vector autoregression (VAR) approach and number of cointegrating equations determined using Johansen cointegration test

The data transformations and diagnostic tests are detailed in sections 3.4, 3.5 and 3.6 below.

3.3 The Analytical Framework

3.3.1 Analyses of COB Actual and COB Forecasted Demand

In order to compare the actual COB with the demand for COB, COB^D, at any given time, a ratio (COB_{AD}), is computed at that point in time is as below

$$COB_{AD} = \left(\frac{COB - COB^D}{COB^D}\right) * 100$$

In periods when COB_{AD} is greater than zero, the implication is the public had more currency than was demanded.

3.3.2 Analyses of COB Targets and COB Forecasted Demand

Ideally these ought to be the same to the extent that the targets set by CBK were based on the demand for COB. The demand for COB, COB^D, and the COB targets (COB^T) used for the daily monetary policy implementation are compared by computing the ratio, COB_{TD}, as below

$$COB_{TD} = \left(\frac{COB^T - COB^D}{COB^T}\right) * 100$$

When COB_{TD} is more than zero, it means the set targets were higher than the demand for COB and vice versa

3.3.3 Analyses of BR Actual and BR Forecasted Demand

In order to compare the actual BR with the demand for BR, BR^D, at any given time, a ratio (BR_{AD}), is computed as

$$BR_{AD} = \left(\frac{BR - BR^D}{BR}\right) * 100$$

In periods when BR_{AD} is greater than zero, the implication is the bank reserve levels was greater than what banks actually demanded and vice versa.

3.3.4 Analyses of BR Targets and BR Forecasted Demand

The demand for BR, BR^D, and the BR targets (RM^T) used for the daily monetary policy implementation are compared by computing a ratio, R_{TD} ;

$$BR_{TD} = \left(\frac{BR^T - BR^D}{BR^T}\right) * 100$$

When BR_{TD} is more than zero, it means the set targets were higher than the demand for BR and vice versa.

3.3.5 Analyses of RM Targets and RM Forecasted Demand

3.3.5.1 Deriving Forecasted Implied Demand for RM

Based in equations (iv) and (viii) an implied demand for RM, RM^D is be computed as

$RM^D = BR^D + COB^D$ ....(ix)

Where BR^D and COB^D are the estimated equations for the demand for bank reserves and currency outside banks at any given time based on the models (vi) and (v) above respectively

3.3.5.2 Analyses of RM Actual and RM Forecasted Demand

In order to compare the actual RM with the implied demand for RM, RM^D, at any given time, a ratio (R_{AD}) at that point in time is computed as

$$R_{AD} = \left(\frac{RM - RM^D}{RM}\right) * 100$$

In periods when R_{AD} is greater than zero, the implication is CBK provided more RM than was in demanded. When R_{AD} was less than zero, monetary policy was tight and constraint monetary expansion

3.3.5.3 Analyses of RM Targets and RM Forecasted Demand

The implied demand for RM, RM^D, and the RM targets (RM^T) used for the daily monetary policy implementation are compared by computing a ratio, R_{TD}

$$R_{TD} = \left(\frac{RM^T - RM^D}{RM^T}\right) * 100$$

When R_{TD} is more than zero, it means the set targets were higher than the demand for RM implying the targets were loose. When R_{TD} is less than zero, it means monetary policy targets were tighter than expected

3.4 Data Sources, Variable Description and Transformation

The analysis will be based on quarterly data from March 1998 to Dec 2009 which are sourced from the CBK and the Kenya National Bureau of Statistics (KNBS) publications. COB data used for each quarter is the last working day's position as published in the CBK Monthly Economic Reviews while the quarterly GDP data used is as published by KNBS. The nominal deposit rates used are the weighted average deposit rate for the last period of each quarter as published by CBK. The inflation rate used is the annual average overall inflation rate for Kenya as published by the KNBS. Similarly the data for monetary aggregates M1 and M3 used in the computation of financial innovation measure, m= M1/M3, is computed based on end of quarter monetary aggregates data.

The variables CT, *RR* and QM are taken based on end of quarter positions. The interbank rate is the rate which prevailed at the end of each quarter. Since the CPIR data is based on February 2009 as the base year and the real GDP is reported with October 2001 base year, the study rebases the CPI index to be in line with the real GDP series.

The interbank and deposit rates are transformed as in equation (x) to facilitate interpretation as elasticities.

$$i_t = Log\left(\frac{i_t}{100}+1\right) \quad \text{..............................} \quad (x)$$

3.4.1 Deseasonalization of Data

The quarterly data series, Yt, to be used in the COB and BR models are to be deseasonalised to remove the impact of seasonal variations on the estimation of the model. Deseasonalization will be carried out through the following steps/processes.

(i) Compute the centered moving average of Y_t as

$$X_t = Sum(Y_{t-1}, Y_{t-2}, Y_{t-3}, Y_{t-4})/4$$

(ii) Compute the ratio $I_t = Y_t/X_t$

(iii) Compute the seasonal indices such that quarter *j* index, I_j is the average of observations of I_t only for quarter j j= 1, 2, 3,4

(iv) Adjust the seasonal indices so that they multiply to one. This is done by computing the seasonal factors, SF, as the ratio of the seasonal index to the geometric mean of the indices i.e

i. $SFQj = I_j/(GEOMEAN(I_1, I_2, I_3, I_4))$; j= 1, 2, 3,4

ii. The interpretation of the scaling factors is that the series is percent higher in period relative to the adjusted series.

(v) The seasonally adjusted series is obtained by dividing Y_t by the seasonal factors

Since this process has been automated in EVIEWS software, the software will be used to generate the deseasonalised series for each variable and the respective seasonal factors shown as an appendix. The model will be run through seasonalised data series and as such the estimated COB and BR series which will be on a deseasonalised form will have to be reseasonalised by multiplying the series at each point in time with the corresponding quarter seasonal factors.

3.5. Diagnostic Tests

Diagnostic tests are conducted on the long run equation model in order to determine if any of the assumptions of the classical normal linear regression model are violated. The following econometric diagnostic tests will be carried out using E views statistical software:

3.5.1 Testing for Stationarity of variables

It is important to test for stationarity of variables to be used in the models because classical regression analysis is based on asymptotic theory, which implies the convergence of sample moments to constants. This is obviously not the case when variables are non-stationary as sample moments converge to Brownian motion or Weiner Processes which has serious consequences for the using ordinary least squares (OLS) methods. The test of stationarity is equivalent to testing for unit roots and this is done in this study using the Augmented Dickey-Fuller Test (ADF) and Phillips-Perron Test (PP). The null hypothesis, *H0*, is a variable is non-stationary and has a unit root is rejected if p-value ≤ level of significance

3.5.2 Jarque-Bera (JB) Test for Normality of Residuals

The residuals from the models need to be normal so that the OLS estimators will also be normally distributed and in that case, inference is possible using standard statistical distributions: t – distribution, F – distribution and χ - distribution. In this study we shall apply the JB test which measures the difference in kurtosis and skewness of a variable compared to those from the normal distribution to determine whether a variable is normally distributed. The null hypothesis, *H0,* is a variable is normally distributed and is rejected if p-value < level of significance

3.5.3 Engle's ARCH LM Test of Heteroscedasticity

In this study we test if the variance of the residual term is not constant over different values of the explanatory variables. If this is the case, using OLS the residual variance, is a biased estimator of the true variance and as a consequence, the estimated variance of the parameter estimates are biased and may overestimate or underestimate and thus misleading the inference using the standard distributions. The test is done using the Engle's ARCH LM Test and the null hypothesis *H0* is no autoregressive conditional heteroscedasticity up to order *q* which is rejected if *p* value < level of significance

3.5.4 Test for Serial Correlation

To rule out the possibility of residuals being related over differing time periods, we test for serial correlation of residuals using Breusch-Godfrey LM Test. If serial correlation exists then using OLS the residual variance, is likely to underestimate the true σ which can mislead inference using standard distributions. The null hypothesis is no autocorrelation up to order *p and is* rejected if the *p*-value < level of significance

3.5.5 Ramsey's Regression Specification Error Test (RESET)

In order to establish whether the model has well specified i.e. no incorrect functional form or inclusion of irrelevant variables or exclusion of relevant variables which may lead to non- normal distribution of residuals, serial correlation, inconsistency of regression with actual workings of the economy, we use Ramsey's Reset Test.

CHAPTER 4: ESTIMATIONS AND ANALYSIS OF RESULTS

4.1 Results of Modelling the Demand for COB

The variables used in the model were deseasonalised and the test for stationarity revealed all the variables are of order one (Appendix I). The long run equation was estimated using ordinary least squares regression with log of real GDP, log of consumer price index, log of deposit rate and log of *m* as independent variable as in equation (v). The variable *m* for financial innovation became insignificant and had to be dropped during the model estimation. The result yielded the long run equation below

LNCOBSA = -5.7 + 1.47*LNRGDPSA + 0.36*LNCPIRSA – 1*LNDEPSA

t statistics (-6.39) (5.33) (5.71) (-3.5)

Adjusted R^2 =0.98 DW = 0.76

The t statistics shows all variables are significant with expected signs according to economic theory. The results showed real GDP to be positively related to the demand for currency in line with expectation from economic theory. A one percent increase in real GDP result in 1.47 percent increase in amount of currency demanded. As expected also the currency demand increases with increase in inflation and a one percent increase in consumer price index will lead to 0.36 percent increase in currency demanded. Currency demand is negatively related to deposit rate of interest with a one percent decline in the rate causing a one percent rise in currency held outside the banks.

The tests on residuals for the long run equation were found to be stationary and normally distributed according to the ADF and Jarque Bera Tests respectively. The test for serial corelation based on the Breusch Godrey LM Test was rejected implying the errors were serially correlated. Tests for the presences of autogressive conditional heterodescasticity among the residuals were rejected implying that the variance was constant (Appendix II)

Since the long run equation indicates the existence of serial correlation in the error terms as shown by the low Durbin Watson (DW) statistic, an error correction model (ECM) is estimated using Engel Granger approach and the results are as below :-

Dependent Variable: **DLNCOBSA**

Variable	Coefficient(t-statistic)
C	0.038(5.1)
DLNRGDPSA	-0.49(2.3)
DLNDEPSA(-1)	1.28(1.8)
DLNCPIRSA(-2)	-0.48(-2.9)
DLNCOBSA(-3)	0.42(3.0)
DLNRGDPSA(-4)	0.53(-2.0)
DLNCPIRSA(-4)	-0.28(-1.7)
*RESCOBSA1(-1)	-0.25(-2.4)
Adjusted R^2	0.30

The ECM for COB shows an error correction mechanism of 25 percent in the first quarter

The same estimation was carried out using vector autoregression approach (VAR) and testing for existence of cointegrating equations using Johansen cointegration test techniques. The results showed the existence of one cointegrating equation which when normalised is expressed as:

* RESCOBSA(-1) = LNCOBSA - LNCOBSA(-1) - LNCOBSA - (-5.7 + 1.4*LNCOBSA(-1) [illegible] 0.36LNCPIRSA(-1) - [illegible]LNDEPSA(-1))

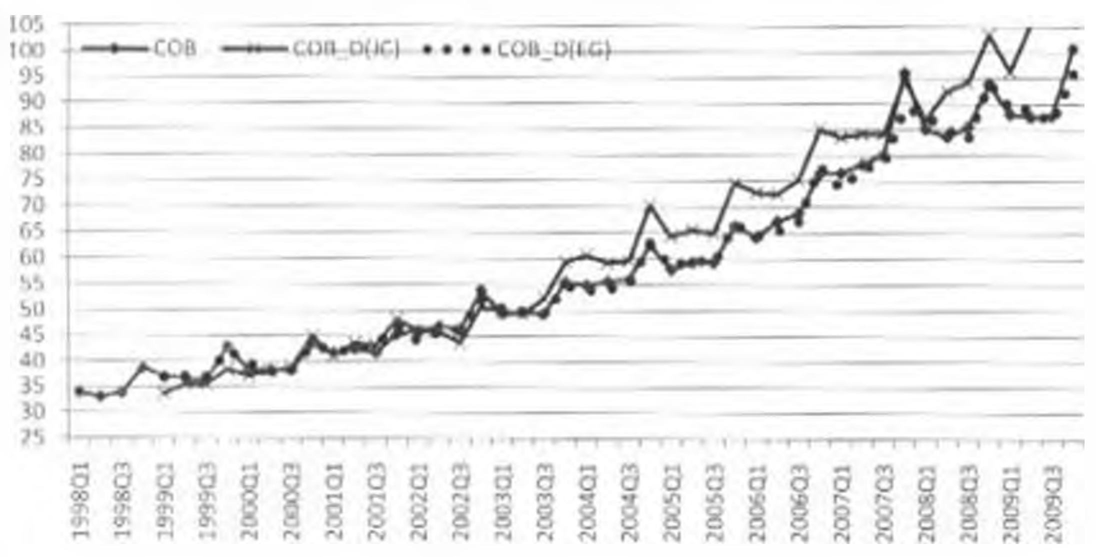
LNCOBSA = – 6.6 + 1.58*LNRGDPSA + 0.44*LNCPIRSA – 3.05*LNDEPSA

t-statistics (6.58) (3.14) (6.9)

4.1.1 Comparing Actual COB and Within Sample Forecast for Demand for COB

In order to compare the results of the model with the actual COB data, we work back to recover the equivalent seasonalized COB demand, (COB D), from the modeled deseasonalised COB. This is done by multiplying the estimated COB demand value (COBSAF) for every quarter by the seasonal factors (Appendix II) which had earlier been derived when deseasonalizing the COB data. In the model, this process is done manually using an excel template and the comparison between actual, demand for currency outside banks estimates based on Engel Granger approach, COB_D(EG), and the Johansen approach, COB D(JC) is as shown by the chart 3 below

Chart 3: Actual and Modeled Demand for COB (Ksh Bn)



4.2 Results of Modelling the Demand for BR

The variables used in the model were deseasonalised first. The unit root tests for the stationarity of variables revealed all variables are of order one, except the cash in till to deposit ratio (CT) (Appendix II), and were differenced once to make them stationary before using in the ECM model. The long run equation was estimated using OLS with log of the value of cheques cleared within a quarter, log of interbank rates and log of rates of cash reserve requirements as independent variables as in equation (vi). The results showed the interbank rate as insignificant and was dropped from the model. The results of the long run OLS estimation is

LNBRSA = 2.07 + 0.98*LNQMSA + 5.71*LNRR

t statistics (-4.2) (12.5) (5.9)

Adjusted R^2 =0.83 DW = 1.22

The t statistics show all variables as significant with expected signs from economic theory. The residuals for the long run equation were found to be stationary under the unit root tests (Appendix I) and normally distributed under ADF and JB diagnostic test respectively. Test for serial corelation and presences of autogressive conditional heterodescasticity were rejected (Appendix II).

As expected also the value of cheques cleared increases with the increase in bank reserves such that a one percent increase in the value of cheques cleared leads to 0.98 percent increase in the demand for bank reserves. Changes in cash reserve requirements also affect the bank reserves positively with 5.7 percent increase in the bank reserves for a one percent increase in the rate of cash reserve requirements.

The low DW statistic indicates the existence of serial correlation in the error terms and all I(1) variables were differenced once to make them stationary before using them in the error correction model (ECM) which was estimated using the Engel Granger approach. The results are:

Dependent Variable: DLNBRSA

Variable	Coefficient(t-statistic)
C	0.19(-2.8)
DLNQMSA	-0.31(2.3)
LNCISA(-2)	0.22(2.3)
LNCISA(-4)	-0.15(-2.3)
[3]RESBRSA(-1)	-0.38(-3.0)
Adjusted R^2	0.21

The model has an error correction mechanism of 38 percent in the first quarter and the cash in till to depsoit ratio is positively related to bank reserves as expected.

The same estimation was carried out using vector autoregression approach (VAR) and Johansen cointegration techniques used to identify the number of cointegrating equations. The results showed the existence of one cointegrating equation which when normalised is expressed as:

LNBRSA = -2.76 + 1.00*LNQMSA + 7.14*LNRR

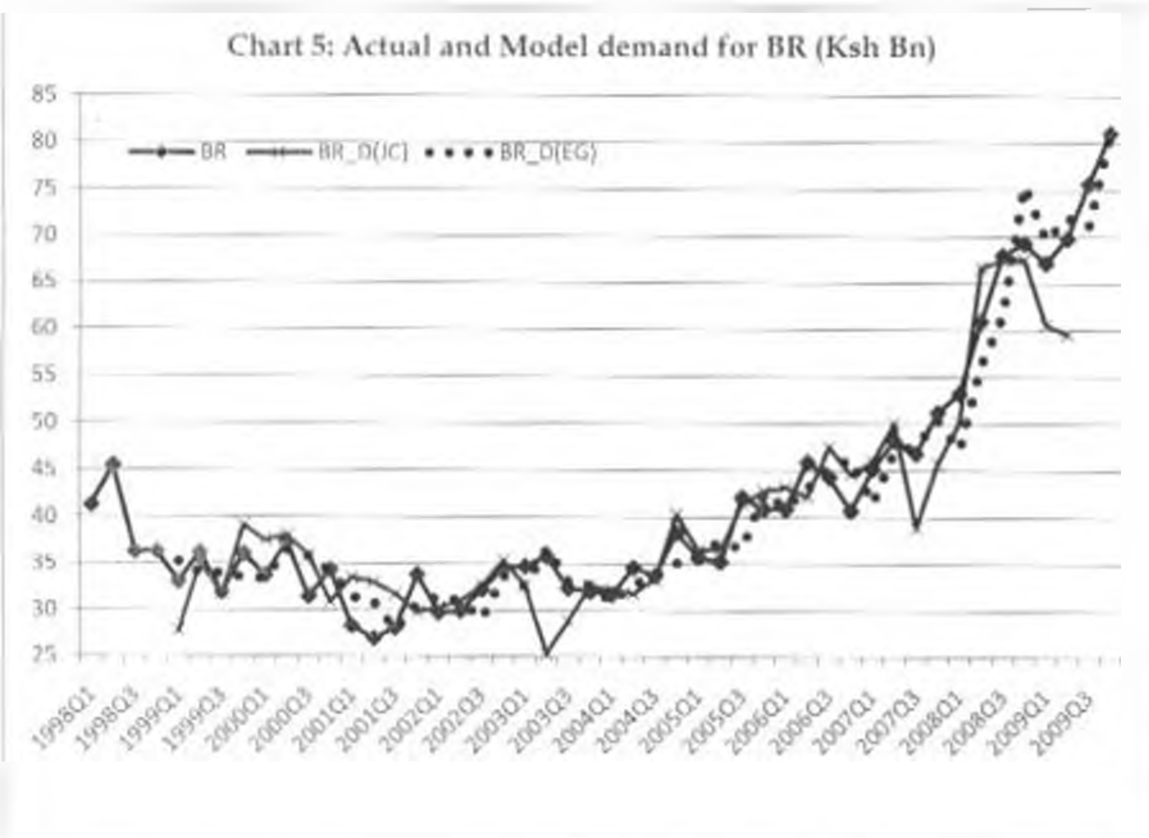
t-statistics (15.1) (9.4)

[3] RESBRSA(-1) = LNBRSA – LNBRSA(-1) = LNBRSA – (-2.07 + 0.98LNQMSA(-1)+5.7LNRR(-1))

4.2.1 Comparing Actual BR and Within Sample Forecast for Demand for BR

In order to compare the results of the model with the actual BR data, we work back to recover the equivalent seasonalized BRdemand from the modeled deseasonalised BR. This is done by multiplying the estimated BR demand value (BRSAF) for every quarter by the seasonal factors (Appendix II).

The comparison between the actual bank reserves (BR) and the demand for bank reserves estimates based on Engel Granger approach, BR_D(EG), and the Johansen approach, BR_D(JC) is as shown by the chart below



4.3 Deriving Implied Demand for RM

Based on the recovered seasonalised demand estimates for COB and BR, as shown in sections 4.1 and 4.2 above, an implied demand for RM, RM^D, was computed as

$$RM^D = BR^D + COB^D \text{ .... (xi)}$$

Where BR^D and COB^D are the estimated equations for the demand for bank reserves and currency outside banks at any given time respectively

Chart 6: Actual and Modeled Demand for RM (Ksh Bn)

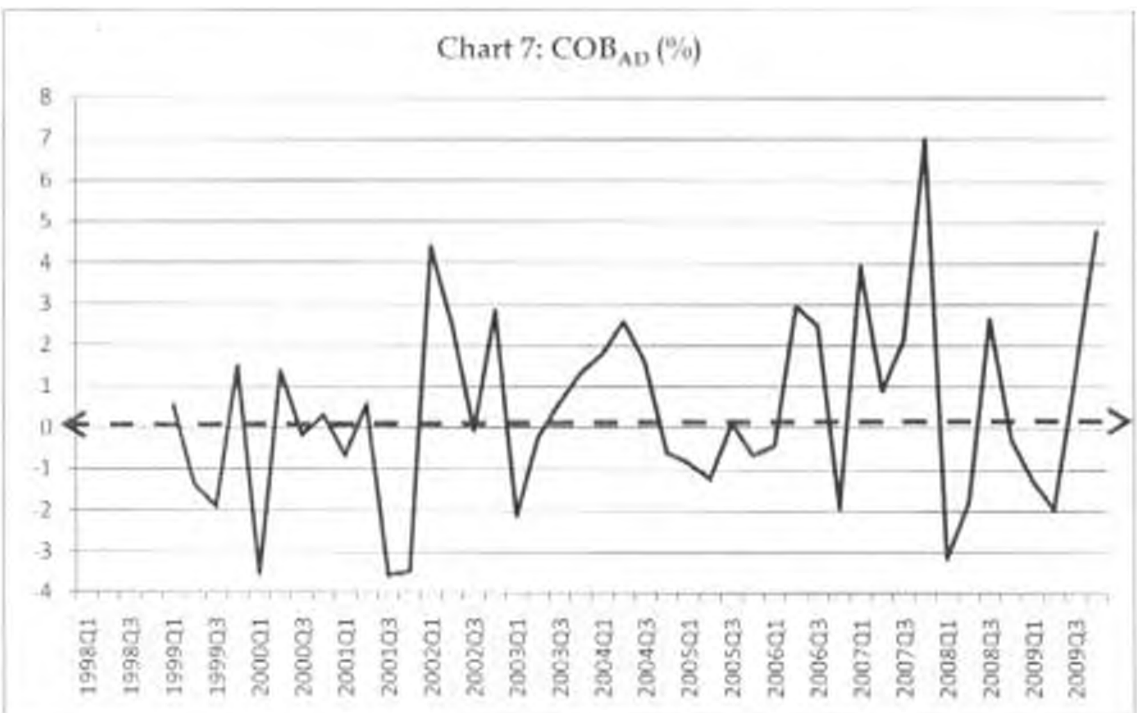
4.4. Analysis of Results

Since the Engel Granger models track the actual outcomes for both currency and bank reserves, it is used it in this analysis to determine the extent of the deviations of the actual and target for COB, BR and RM from the empirically determined levels of demand for each of them

4.4.1 Analyses of COB Actual and COB Forecasted Demand

The deviation of demand for COB from actual level is computed and graphed as below

$$COB_{AD} = \left(\frac{COB - COB^{D}}{COB}\right) \cdot 100$$



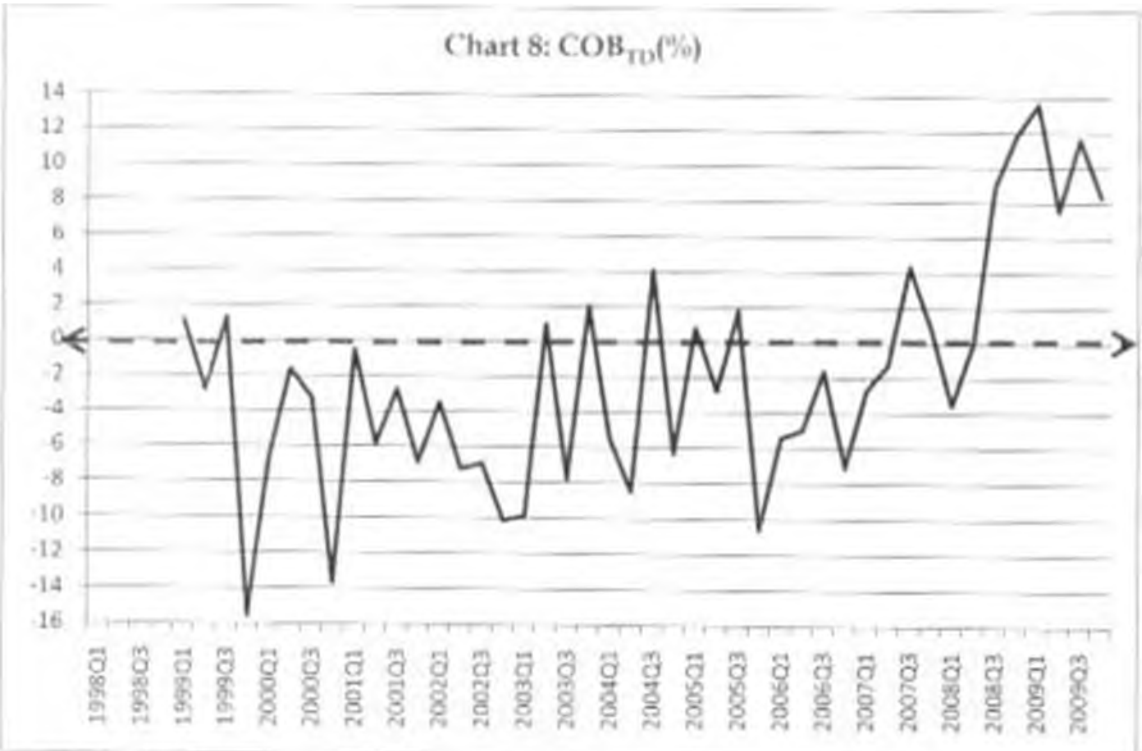
Source: Author

This result implies that the currency supply (actual) by the CBK in most cases exceeded that which was demanded by economic agents.

4.4.2 Analyses of COB Targets and COB Forecasted Demand

The deviation of demand of COB from the target level is computed and graphed as below

$$COB_{TD} = \left(\frac{COB^T - COB^D}{COB^T}\right) * 100$$



Source: Author

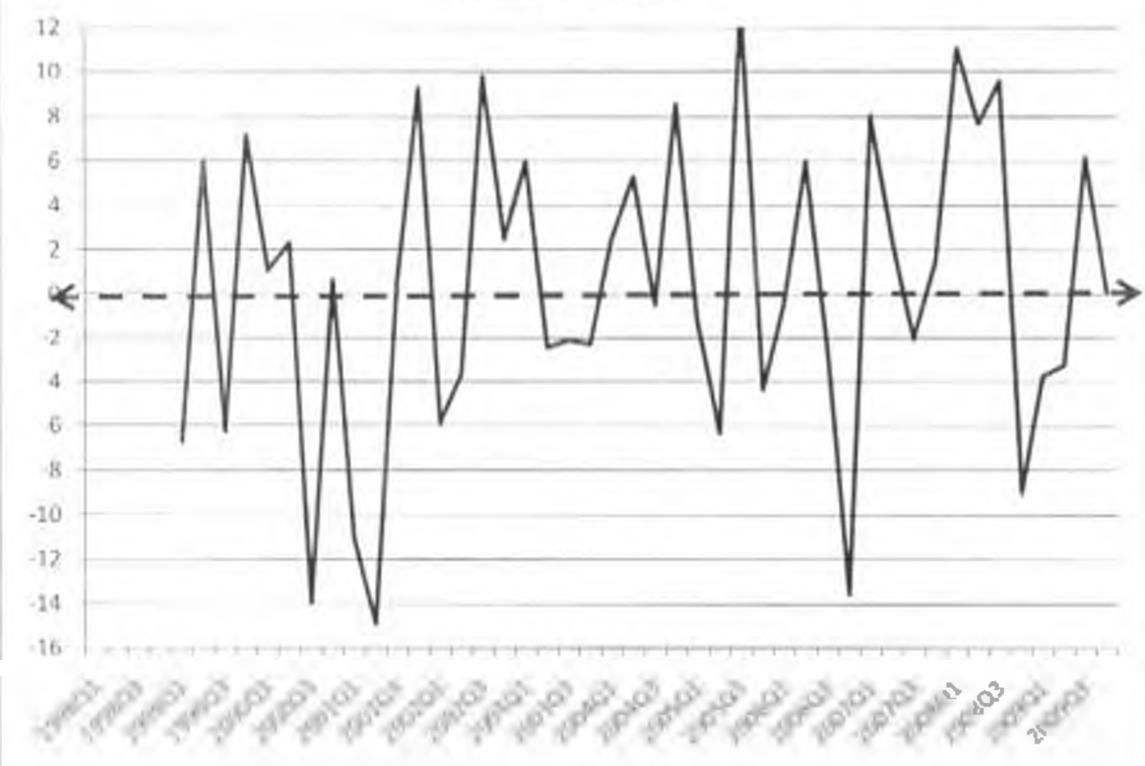
This result implies that the target for the amount of COB to be supplied by the CBK in most cases was below that which was actually demanded by economic agents. This therefore partly explains the missing of RM targets by CBK since the CBK was targeting to supply less than demand.

4.4.3. Analyses of BR Actual and BR Forecasted Demand

The deviation of actual BR from demand level is computed and graphed as below

$$BR_{AD} = \left(\frac{BR - BR^{D}}{BR}\right) * 100$$

Chart 9: BR_{AD}(%)



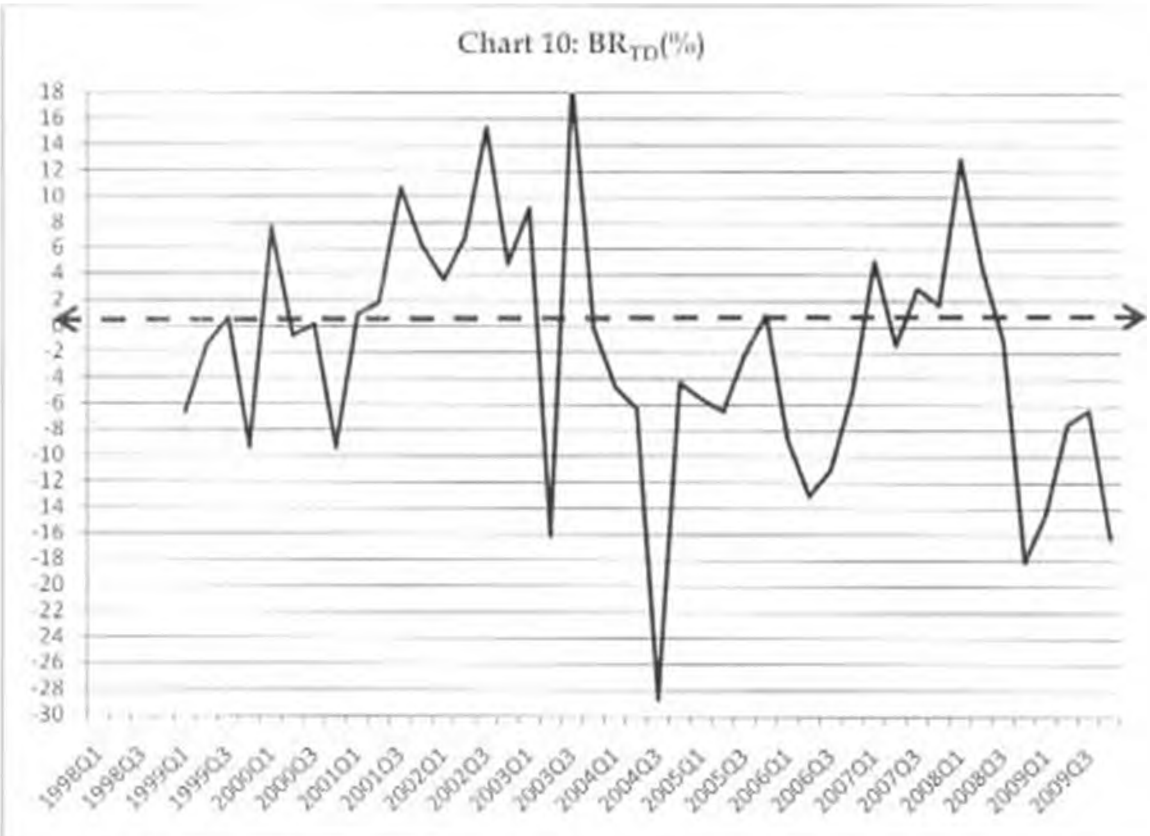
Source: Author

The result implies the actual bank reserve of commercial banks in most cases tracked the demand for it by commercial banks except in the latter years when actual started to exceed demand level.

4.4.4 Analyses of BR Targets and BR Forecasted Demand

The deviation of demand for BR from target level is computed and graphed as below

$$BR_{TD} = \left(\frac{BR^T - BR^D}{BR^T}\right) * 100$$



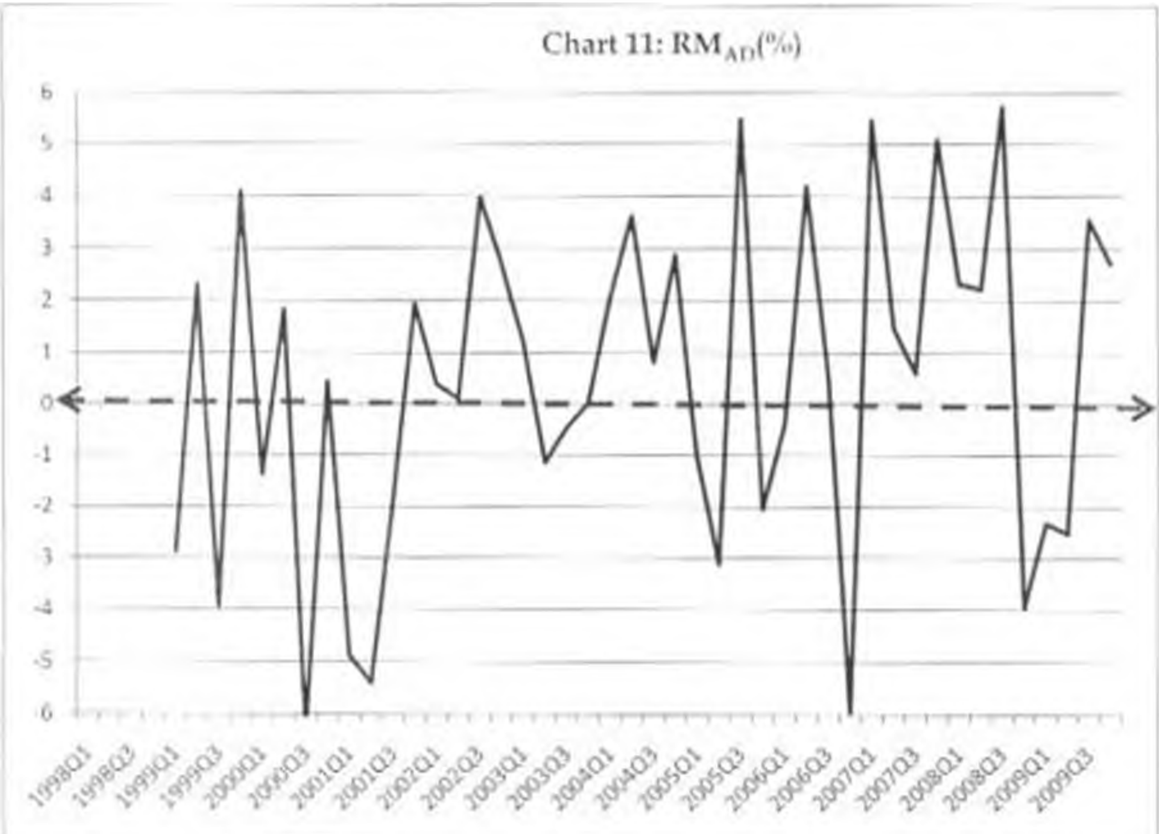
Source: Author

This result implies that the target for the amount of BR was mostly below that which banks actually demanded. This therefore partly explains the missing of RM targets by CBK.

4.4.5 Analyses of RM Actual and RM Forecasted Demand

The deviation of actual RM from demand level is computed and graphed as below

$$R_{AD} = \left(\frac{RM - RM^{D}}{RM}\right) * 100$$



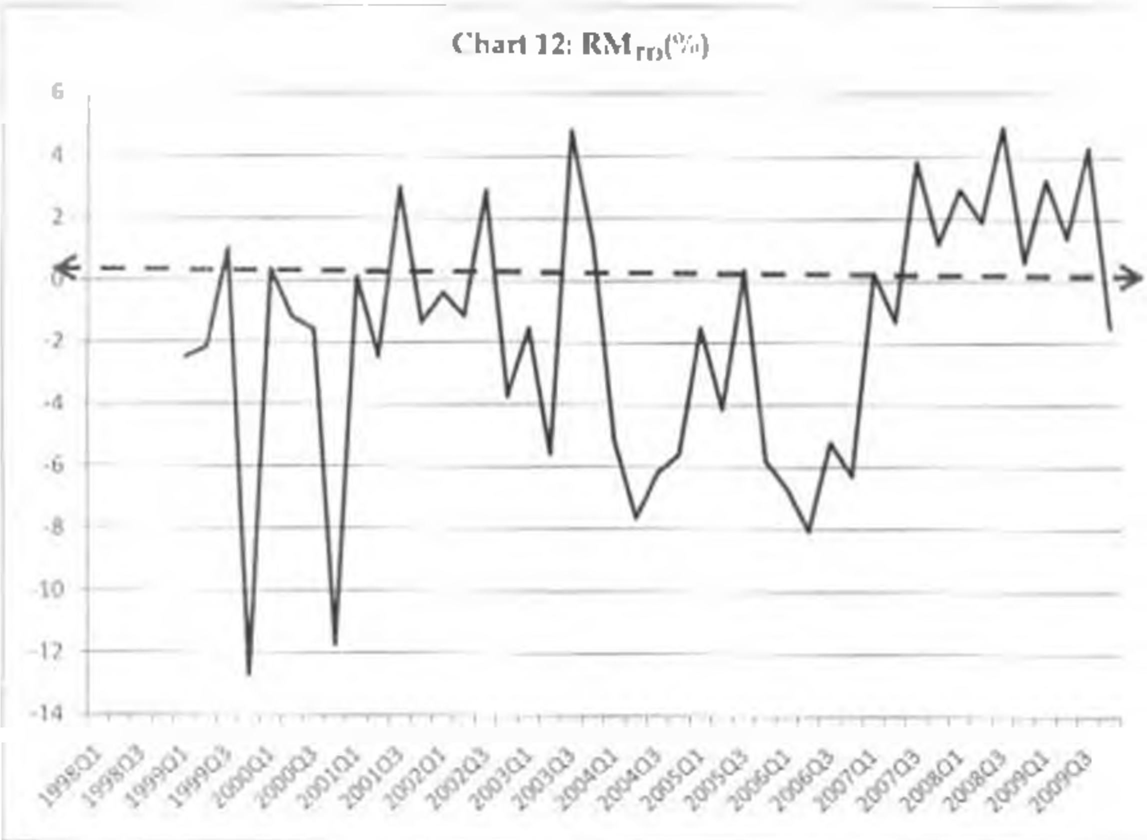
Source: Author

The results (Chart 2) shows the actual RM levels have in most cases been very close to the demanded amount on average except in Decembers when the demand has always been above the actual. In periods when R_{AD} is greater than zero, the implication was monetary policy was loose and provided more RM than was demanded which may have been inflationary. When R_{AD} was less than zero, monetary policy was unnessarily tight and constraint monetary expansion

4.4.6 Analyses of RM Targets and RM Forecasted Demand

The deviation of demand RM from target level is computed and graphed as below

$$R_{TD} = \left(\frac{RM^T - RM^D}{RM^T}\right) * 100$$



Source: Author

When R_{TD} was more than zero, it means the set targets were higher than the demand for RM implying the targets were loose. When R_{TD} is less than zero, it monetary policy targets are tighter than expected. The results of the study shows the amount demanded has been above what is targeted 63 percent of the time and thus explains the missing of RM targets

CHAPTER 5: CONCLUSION

In summary this study shows that the targets for RM have been tighter than expected resulting in the frequent overshooting of set monetary programme targets relating to RM. However, the overshooting has largely been within the 5 percent range over and above the expected demand. This implies that the excess supply of RM may not have contributed in fuelling inflation. There is therefore a need for the CBK to improve the forecast for the demand for RM as a first step to setting of RM targets and addressing the deviation of actual RM and targets.

There is a strong positive correlation between currency held by the public and the levels of economic activity. This confirms the role that CBK plays in stimulating the economy towards the realization of key economic objectives. Economic agents are also wary of inflation and tend to keep more currency for spending during periods of high inflation. The public is also sensitive to levels of deposit rates while holding currency since the deposit rates are opportunity costs of holding currency. Thus any increase in this rate is met with the public demand for less currency held and vice versa. The extent of financial innovation became insignificant factor in determining the levels of currency held by the public but this may largely have been due to lack of data on a proper proxy for this indicator.

In managing bank reserves, banks keep a watch on their transactional balances both at CBK (for clearing balances), over the counter (cash in till) and maintaining reserve requirement. Interbank rates much as they are investment opportunities in the short run do not influence banks' decisions to hold more or less reserves according to this study.

This study may further be extended in future research to explain the deviations in the intermediate target, M, from its programmed path. Also it is worth studying the impact of the deviations from targets of both RM and M3 on the other macroeconomic variables such as inflation, exchange rate and economic growth.

APPENDICIES

APPENDIX I: UNIT ROOT TESTS FOR MODEL VARIABLES

		Augmented Dickey Fuller Test			Philips-Perron Test			
		Intercept	Intercept+trend	None	Intercept	Intercept+trend	None	Or
Br	Levels	-0.226	-2.072	0.795	0.176	-1.695	1.036	I(1
	1st Difference	-9.264	-10.634	-9.223	-9.159	-18.308	9.012	
RR	Levels	1.778	-2.404	-2.624	-1.821	-2.404	-3.120	I(1
	1st Difference	6.620	6.707	-6.075	-6.625	-6.750	-6.075	
CI	Levels	-4.828	6.544	-0.390	5.778	-7.247	0	I(0
	1st Difference	8.326	-8.247	8.416	-22.157	-8.247	-22.15	
RINTER	Levels	-3.561	3.450	2.719	-3.877	-3.458	-2.753	I(1
	1st Difference	-4.789	4.762	-4.746	5.308	-5.783	4.492	
QM	Levels	-0.283	-3.025	1.593	0.880	-2.908	4.484	I(1
	1st Difference	-8.890	8.968	-8.331	10.766	-25.150	8.370	
RGDP	Levels	1.080	-1.814	2.424	-0.615	4.768	4.090	I(1
	1st Difference	2.809	-3.265	1.422	-12.792	13.142	-7.128	
COB	Levels	0.091	2.459	2.544	-0.373	-5.289	6.270	I(1
	1st Difference	3.027	-3.004	1.521	-18.724	17.855	-9.299	
CPIR	Levels	3.040	0.340	4.411	7.358	-0.800	5.110	I(1
	1st Difference	6.415	-7.665	0.846	-6.749	-15.177	4.953	
RDEP	Levels	5.229	2.314	-3.003	6.459	-2.836	3.097	I(1'
	1st Difference	3.956	-2.145	-4.391	-4.736	-5.652	4.545	
Critical Values	1% level	**-3.601**	**-4.199**	**-2.623**	**-3.585**	**-4.176**	**-2.617**	
	5% level	**-2.935**	**-3.524**	**-1.949**	**-2.928**	**-3.513**	**-1.948**	
	10% level	**-2.606**	**-3.193**	**-1.612**	**-2.602**	**-3.187**	**-1.612**	

APPENDIX II: DIAGONISTIC TESTS AND ANALYSIS TABLES

TABLE 3: SEASONAL FACTORS

Quarters	SEASONAL FACTORS						
	COBSA	RGDPSA	CPIRSA	DEPSA	QMSA	CTSA	BRSA
1	0.992314	0.983092	0.988571	0.983894	1.003449	0.950262	0.973798
2	0.980677	0.958213	1.010222	1.005744	1.035277	0.899769	1.012301
3	0.962148	1.022729	1.003347	0.990647	0.964636	0.936520	0.985870
4	1.068028	1.037966	0.997985	1.020105	0.997895	1.218845	1.028966

Source: Author

Table 4: Diagnostic Test Results for COB Model

Test	Test name	Test results
Stationarity	ADF unit root	The t-statistic (-5.44) < critical value(-3.595) - *Model residuals are stationary*
Normality	Jarque-Bera	P-value (0.26) > 0.01(level of significant) - *Model residuals are normally distributed*
Serial correlation	Breusch-Godfrey LM	P value (0.52) > 0.1(level of significant) - *Model residuals are serially correlated*
ARCH	ARCH LM test	P-value (0.13) > 0.1(level of significant) *Model residuals have no ARCH*
Specification	Ramsey RESET	P-value (0.82) > 0.01(level of significant) *Model is well specified*

Source: Author

Table 5: Diagnostic Test Results for BR Model

Test	Test name	BR residual
Stationarity	ADF unit root	The t-statistic (-3.81) > critical value(-3.595) - *Model residuals are stationary*
Normality	Jarque-Bera	P value (0.49) > 0.01(level of significant) *Model residuals are normally distributed*
Serial correlation	Breusch-Godfrey LM	P-value (0.24)> 0.01(level of significant) *Model residuals are serially correlated*
ARCH	ARCH LM test	P-value (0.87) > 0.01(level of significant) *Model residuals have no ARCH*
Specification	Ramsey RESET	P-value (0.03) > 0.01(level of significant) *Model is not well specified, hence the need to introduced error correction model*

Source: Author

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