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By

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UNIVERSITY ILE IFE OF NIGERIA

Women and community A dynamic specification of aggregate money demand function in Nigeria : 1960-1995credit in southwestern Nigeria

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JUNE, 1998

A DYNAMIC SPECIFICATION OF AGGREGATE MONEY DEMAND FUNCTION IN NIGERIA (1960 - 1995)

By

FOLORUNSO, BENJAMIN AYODELE
B.Sc. (Hons.) Econs., Ife.

Being

A RESEARCH THESIS SUBMITTED TO THE DEPARTMENT OF ECONOMICS, FACULTY OF SOCIAL SCIENCES, OBAFEMI AWOLOWO UNIVERSITY, ILE-IFE, NIGERIA, IN PARTIAL FULFILMENT OF THE CONDITIONS OF AWARD OF THE DEGREE OF MASTER OF SCIENCE IN ECONOMICS (M.SC. ECONOMICS)

JUNE, 1998

CERTIFICATION

This research study by Mr. Folorunso Benjamin Ayodele has been carried out under our supervision and being approved for the Department of Economics, Obafemi Awolowo University, Ile-Ife.

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AUTHORIZATION

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DEDICATION

This research study is deservedly dedicated to every member of my household, friends and to those whose dreams and aspirations are yet to come true.

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BENJAMIN AYODELE **FOLORUNSO**

JUNE, 1998.

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ABSTRACT

This study has attempted to determine the nature of the demand for money relationship by presenting an alternative statistical evidence consistent with the existence of a long run money demand function and find if there existed a stable long run money demand function for more than three and a half decades in Nigeria.

Data series employed were gathered from various sources such as CBN publications notably; Statistical Bulletin, Economic and Financial Review and Monthly and Annual Reports and Statement of Accounts for various years and the publication of International Monetary Fund such as International Financial Statistic Yearbook.

Models were developed through the adoption of Cointegration and Error-Correction Mechanism (ECM) techniques. The time series property of quarterly data employed were first of all investigated. This was then followed by testing for cointegrated variables which appear in the aggregate money demand models using the sample period from 1960 to 1995.

Based on the time series property of data used, the results clearly indicate that the tests failed to reject the null hypothesis that these variables are non-stationary except for inflation rate. It was found also that long run equilibrium relationship existed between nominal (or real) money stock and nominal (or real) income. However, it is difficult to establish cointegration among all the variables of money demand function over the sample period.

The evidence also shows that real M1 and M2 balances are cointegrated with real income. This implies that there exists a stable long run demand function for real M1 and

M2 balances as a function of real income and other explanatory variables. The maintained hypothesis is that money demand in Nigeria has remained stable, but the dynamic adjustment processes are more complex than those presented in most earlier studies.

As our results show that the discrepancy between the actual and desired real money holdings in the previous period is not fully corrected in the present period, we recommend that the disequilibrium in the money market can be exploited by the authority to influence real income. Also effective control of money holdings can only be achieved through the adoption of an appropriate income policy and not via domestic interest rate ceilings since this variable is less significant.

CHAPTER ONE

INTRODUCTION

1.1 Historical Background:

The demand for money concept has a long history. Several economists spanning several epochs have reflected on the demand for money. Indeed, the empirical relationship which has received most attention in the modelling of private sector financial behaviour is the demand for money function. Over the years, there has been a plethora of studies on the aggregate money demand functions in both developed and less-developed nations and it is arguably the most estimated relationship in the whole empirical macroeconomics (Thompson, 1993).

As a subject of study, the demand for money function has continued to attract considerable attention from theoreticians and practitioners alike in both the advanced and less-advanced nations of the world. Despite over two decades of substantial theoretical and empirical investigations into the money demand function in Nigeria, the interest of researchers has not waned at all. The sustained interest in this area of economic research derives from the central importance of money demand function to both economic theory and in the design and implementation of monetary policy (Oresotu and Mordi, 1992). Indeed, the considerable amount of research devoted to the demand for money is justified by its fundamental role in the monetary authority's formulation and implementation of monetary policy, and the potential impact of monetary policy on both economic activity and inflation.

Empirical studies on the demand for money functions commenced in the 1950s through 1990s in both developed and less-developed nations of the world while such studies began in Nigeria in the 1970s. In fact, empirical investigation into the nature of money demand function remains perhaps the most extensive studied area of economic research in Nigeria judging by the plethora of studies that have emerged since the seminal work of Tomori (1972) which opened the debate of the 1970s to the studies carried out in the 1980s.

Through these years, attention focused on whether a stable money demand function, in fact, exists as macroeconomic theory assumes and this alone has led to other major important issues like specification and estimation issues. The specific issues include: what explanatory variables should enter into money demand function; the appropriate measures to be used for variables of the model; what definition of money is proper (narrow or broad money); the correct specification of money demand equation either in nominal or real term; how sensitive is money demand to interest rate; and the complementary relationship between money and physical assets as well as financial assets in the process of economic development.

If monetary policy is to have a predictable effect on the ultimate objective of economic policy then the temporal stability of such specified money demand function is very crucial. Indeed a poorly specified money demand function could lead, for instance, to spurious inferences on the underlying stability of money demand. However, researchers had, for the most part, reached a consensus that money demand functions were stable in most countries of the world. Indeed, most studies carried out in the 1960s and early 1980s such as Meltzer (1963), Brunner and Meltzer (1963, 1964), Laidler (1966a, 1966b), and Goldfeld (1973) for the USA and Kavanagh and Walters (1966), Laidler and Parkin (1970) and Goodhart and Crockett (1970) for the UK, were able to find stable and well-determined money demand functions. Stability has also been confirmed in the case of the money demand function in Nigeria in these same periods.

In arriving at this conclusion, researchers drew heavily on a simple specification based on partial adjustment and/or adaptive expectation in which money depends on a scale variable (income or wealth), prices and interest rates series as a basis for their "standard" function and, even till today many researchers still use this specification. However, the consensus on the stability of money demand function began to falter in developed nations (especially in USA and UK) in the mid-1970s through 1980s as the conventional partial adjustment model began to lose its adequacy in explaining developments in money demand as major divergences emerged between the forecast and actual values.

The apparent breakdown since about 1973 of then well-established stable relationship between the variables in the money demand function led to the various attempts to explain the sources of shifts in the function. These include a rise in monetary policy uncertainty (Mascaro and Meltzer, 1983), strength in stock market and increase in financial transactions (Friedman, 1988), disinflation of the 1980s (Judd, 1983), financial deregulation and innovations (Simpson and Porter, 1984; Judd and Scadding, 1982) and institutional changes (Hacche, 1974; Goodhart, 1981). Recent findings of these studies in developed nations, however, point to the fact that the allegations of shifts in the demand for money functions were unfolded. They simply resulted from inadequate dynamic specification of the relationships between money and its determinants.

1.2 Statement of the Problem:

In Nigeria, the aggregate money demand function often revealed its stability (see Tomori, 1972; Ojo, 1974b; Iyoha, 1976) but in recent years the public's demand for money has grown significantly more strongly than predicted by existing money demand regression equations. Despite the efforts to rectify the instability, this phenomenon persists. Indeed, the actual money balances held by Nigerians in 1995 was almost thirty scores as much as money held in 1960. Why have Nigerians prepared to hold as thirty scores as much money in 1960 now? Answering this question introduces us to the factors that influence money demand in Nigeria (i.e., specification issue), which in turn sets the stage for understanding how monetary policy affects the whole economy.

Most earlier studies on money demand in Nigeria covered a period when monetary policy was carried out in an environment of underdeveloped financial markets, regulated interest rate regimes, limited international capital flight and pegged exchange rate systems. Even though the financial markets in Nigeria remain underdeveloped, with the adoption of Structural Adjustment Programme (SAP) in the mid-1980s, the trade and financial environments in Nigeria have changed significantly.

While the improvement in trade environment is as a result of the relaxation of capital controls and a shift towards a more flexible exchange rate regimes, the improvement recorded in financial sector follows the deregulation of the financial markets. Following these recent developments, a lot of changes has occurred in monetary policy formulation and implementation. Indeed, these innovations have altered the relationship between money demand and its determinants and these have prompted a reassessment of the appropriate instrument of monetary policy.

Moreover, since it is now widely recognized that money demand balances in any economy (including Nigeria) cannot be explained satisfactorily by standard or conventional equations apparently because of shifts which occurred in the mid-1980s and early 1990s, aggregate money demand functions in Nigeria has to be re-examined in the light of the events and discoveries of the 1980s and 1990s. Part of the problem can be traced to specific events like those mentioned in studies carried out by researchers in USA and UK. While the attempts by Central Bank of Nigeria to control growth in domestic stocks of money may have altered the responses of the demand for money to standard functional arguments, the problem may also be attributed to policy shift of government when SAP was introduced in 1986 but the possibility remains that a more general instability may be present going by the characteristics of time series analysis.

Before the global economic recession of the early 1970s, the macroeconomic environment of most countries, both developed and less-developed (including Nigeria), was taken as relatively stable (i.e., stationary). World inflation rate was low. Macroeconomic variables such as income, consumption, money, prices and other time series data did not fluctuate greatly. At that period, the costs of treating non-stationary series as if they are stationary were not great.

Today, the costs of inappropriate time series specification are apparent. It is now being widely discovered that economic world is not stationary after mid-1970s as economic time series aggregates fluctuate more widely (Adam, 1992). This trend also accounts for the breakdown of many well-established econometric models in the late 1970s. Apart from the failure of these models to predict future outcomes, it became increasingly obvious that this predictive failure was so marked among pure macroeconomic time series models. As put by Adam:

> ... as data samples get longer and the extent of non-stationarity has become more pronounced, the failure to appropriately deal with this non-stationarity has a progressively more serious implications (p.11).

It follows, therefore, that when the individual economic time series employed for modelling are non-stationary, correlation between them will be "spurious" except the residual term is white noise (i.e., stationary).

The debate on econometric methodology is far from being simply a matter of epistemological discourse, and according to Adam (1992):

> It is the immediate application of such techniques to the increasingly more demanding economic policy issues environment which attests to its relevance (p.1).

1.3 Justification of the Study:

It has been shown from empirical studies that there exists a strong, positive relationship between the existence of money and economic development of any country of the world. In fact, the study of money demand becomes pertinent in a developing nation like Nigeria in order to determine how it affects the functioning of the economy and how monetary authority conducts its monetary and fiscal policies to affect economic activities.

Since the issue of stability of the demand for money is crucial for our understanding of the underlying transmission mechanism of monetary policy, it is not only necessary to specify the appropriate form of money demand function but also to investigate the stability of this function. Also, proper management of monetary policy and its effectiveness in the real economy call for a stable relationship between money and macroeconomic variables such as income or wealth, prices, interest rates, rate of inflation and so on; that is, a stable money demand function. Moreover, a thorough understanding of the monetary sector of the economy is highly indispensable for formulating optimal policies for economic stabilization and growth.

Recent findings on the stability of money demand function in the leading capitalist nations and some less-developed nations have shown that Error Correction Model (ECM) is the best suited for model estimation when economic variables that function individually as non-stationary demonstrate similar pattern of movement over the long term; that is, when these variables are cointegrated. Studies and application of ECM have grown tremendously. For instance, application of ECM to the consumption function (Davidson et al., 1978) and some researchers recently have incorporated ECM and Cointegration in the demand for money function for countries such as USA (see Hendry and Ericsson, 1991; Baba et al., 1992), UK (see Hall, 1990; Adam, 1991), Japan (see Yoshida, 1990) and Kenya (see Adam, 1992).

The time series property of Nigeria's macroeconomic variables seems to justify ECM-type money demand function. Most Nigeria's macroeconomic variables seem to be non-stationary yet, no such estimation has been undertaken. A coherent framework of economic policy is lacking hence the need to determine how monetary authority should go about designing and conducting its monetary policy. We therefore, undertake this study in order to seek for a more dynamic aggregate money demand function so that the monetary authority's control of money stock can be a useful instrument of economic policy in Nigeria.

1.4 Objectives of the Study:

This study focuses on the estimation of money demand function in the wake of financial and trade liberalization in Nigeria. The broad objective of this study is, therefore, to re-estimate the money demand function in Nigeria by presenting alternative statistical evidence consistent with the existence of a long run money demand function during 1960 and 1995.

The broad objective has been broken down into the following specific objectives:

(i) To examine and analyze the nature of long run money demand in the wake of financial and trade liberalization in Nigeria;

(ii) To find if there existed a stable long run money demand function for more than three and a half decades in Nigeria;

(iii) To make policy recommendations that will assist the monetary authorities in future policy formulations and implementation.

1.5 Research Hypotheses:

Given the research objectives, hypotheses to be tested are:

(i) Macroeconomic variables of money demand model in Nigeria are non-stationary but cointegrated;

(ii) There existed a stable money demand function in Nigeria between 1960 and 1995.

1.6 Expected Contribution to Knowledge:

The knowledge of the existence of stable and form of money demand relationship will enable the monetary authority to predict accurately the effect of a given increase in the stock of money upon its regressors thereby allowing monetary authority to control money stock via the manipulation of interest rates. Also, these findings will put some weight on the argument whether there is a significant difference between the actual and desired money demand balances and that spurious regressions are largely due to dynamic specification errors.

1.7 Scope of the Study:

As recent studies on money demand function have identified major defects in the conventional approach to modelling with time series data, a new estimation method (ECM and Cointegration) has rapidly gained support of researchers. Indeed, research on testing for stationarity and cointegration has burgeoned in recent years. As a complement to these research studies, this study draws attention to some recent developments in the econometric approach to the modelling of money demand in Nigeria.

Against this background, we focus on the re-estimation of Nigeria's money demand function and show whether money balances are cointegrated with data on income, interest rates, exchange rate, inflation rate and prices from the Nigerian economy in an attempt to derive a dynamic model of aggregate money demand for the economy over the period spanning thirty-six years (1960-1995). The confirmation of cointegration will then support the existence of a stable long run demand for money function.

1.8 Sources of Data:

The models developed in this study will be estimated by using quarterly time series data for the period 1960-1995. These series are gathered from various sources, viz:

(a) the publication of the CBN notably; Statistical Bulletin, Economic and Financial Review and Monthly and Annual Reports and Statement of Accounts for various years;

(b) the publication of Federal Office of Statistics (FOS);

(c) the publication of International Monetary Fund (IMF) such as the International Financial Statistic Yearbook.

1.9 Plan of the Study:

The plan of this research study is as follows:

Chapter One introduces the demand for money in general while Chapter Two runs a comprehensive review of the existing literature and the theoretical issue on the demand for money. This review will cover most previous studies (which we are aware of) which had been carried out on money demand both in Nigeria and other nations of the world. Such review will focus on the issue of specification, estimation and stability of the money demand function in conjunction with the recent development in time series analysis. Also, some theoretical propositions put forward by various monetary economists concerning the demand for money hypotheses will be thoroughly investigated and discussed. The modelling requirements (i.e., research methods and techniques) as well as the institutional factors in the Nigeria economy that have practical implication for modelling money demand are discussed in Chapter Three. While Chapter Four employs Cointegration and ECM techniques to the empirical estimation and analysis of money demand using Nigeria's quarterly data between 1960 and 1995, Chapter Five concludes.

CHAPTER TWO

LITERATURE REVIEW AND THEORETICAL FRAMEWORK

2.1 Introduction:

The nature of the demand for money has been an area of greatest interest in macroeconomics and has had important implications for the conduct of monetary policy. The main issue involved in the estimation of the demand for money is whether or not the function is stable over time and this issue alone has given rise to two other issues; specification and estimation issues. For many years there was wide agreement among economists about the nature of the demand for money function, but in recent years the demand for money has once again become controversial as evidence from several countries points to instability in "conventional" demand for money equations. This instability issue will be discussed in Section 2.2 of this chapter by reviewing the existing literature on the demand for money (concentrating on the issue of stability) both for the developed and less-developed nations, including Nigeria.

Also, the discussion of what money is, what it is used for and the way the stock of money is measured leads naturally to the developments of theories that can explain the quantity of money balances that public wants to hold i.e., the demand for money balances. Hence, the discussion of the various theories of money demand is provided in section 2.3 of this chapter.

2.2 LITERATURE REVIEW

2.2.1 Introduction:

The major issue focused by many empirical investigations of money demand in both the advanced and less-advanced nations, including Nigeria, is whether money demand functions are stable over time. Put differently, has there been any evidence of instability in the demand for money function? In order to capture the views of researchers concerning stability and other related issues, this section is divided into three subsections: the section showing evidence from developed nations; the section showing evidence from less-developed nations; and finally, the section showing evidence from Nigeria.

2.2.2 Evidence From Developed Countries:

Over the years, there has been a plethora of studies on the aggregate demand for money functions in developed nations notably United States of America, United Kingdom and Japan. The wealth of empirical studies generated by researchers in these nations suggests that the demand for money function is remarkably stable. Knowledge of the form and existence of a stable aggregate money demand function makes it easier for the monetary authorities to control money stock via the manipulation of interest rates. If instability exists, it can have a profound influence on monetary policy by rendering its effects uncertain. The monetary authorities will, therefore, no longer be able to predict accurately the impact of a change in the money supply unless they can depend on the predictability of the money demand function.

The concept of stability requires the demand for money relation to be highly predictable in a statistical sense, as measured by the overall goodness of fit statistics, the precision of the estimated coefficients and the ability of the equation to forecast accurately out of the sample period. In relation to this stability issue we shall first of all concentrate on US studies before discussing studies in UK and other developed countries.

Latane (1954) attempted to test the Keynesian Liquidity Preference theory and postulated that total money balances rather than idle balances were interest rate elastic. Using Ordinary Least Square technique of estimation, he found, in his regression analysis, a coefficient of correlation of 0.871. In a later study, **Latane (1960)** estimated a log-linear demand for money function, employing long-term interest rate and was able to find that a stable long run demand relationship really existed for money narrowly defined (M1).

Meltzer (1963) runs a regression analysis of money demand and his results strongly indicates that the demand deposits is at least as stable as other alternative demand functions. Therefore, there seems no compelling reason for broadening the definition of money to include time deposits as argued by Friedman. His findings also suggest that a relatively stable long run demand function for money can be isolated and its principal determinants are to be interest rate and non-human wealth. To him, money demand function is more stable when wealth rather than income constraint is adopted.

Brunner and Meltzer (1963, 1964) compared a number of different demand for money hypothesis, using identical tests and time periods and the same measurement procedures where possible. The tests applied greatly distinguished between the effects of income and wealth on the demand for money. Although, the theory and empirical results assigned a role to income as an argument in the wealth model, income appears to play a much smaller role than wealth as a determinant of desired money balances. As a concluding remarks for monetary authority, as regards monetary policy, they assert that:

> ... a comparatively stable demand function for money has been obtained from wealth model (p.282).

However, **Bailey (1963)** discussed on Brunner and Meltzer's study and made the following remark that:

> ... the concluding claim to have developed a stable demand function for money is premature. Their work shares several defects with previous studies and it fall short of presenting a definitive analysis of the demand for money (p.358).

This comment, without doubt stimulates the improvement of subsequent research studies in this area.

Laidler (1966, 1969) pointed out that the hypothesis that the demand for money is proportional to the level of income would be challenged by those who regard wealth as a more appropriate argument of nominal and real money balances. He suggested that a stable money demand function was consistent with more than a single definition of money balances. Also, he could not find any evidence that the function was any less stable at low rate of interest. However, permanent income and interest rate were found to be the best explanatory variables for both definitions of money, with the broader definition of money providing the more satisfactory results.

Goldfeld (1973) examined the demand for money function using quarterly data. Although Goldfeld's result differed in several important ways from those of the previous studies, which were based strongly on annual data, his preferred model specification which is of the form:

$$\ln m1_t = \alpha_0 + \alpha_1 \ln y_t + \alpha_2 \ln r_t^{ms} + \alpha_3 \ln r_t^{s} + \alpha_4 \ln m1_{t-1} + \mu_t \quad \ldots\ldots\ldots\ldots \quad (2\text{-}2\text{-}1)$$

became the standard formulation (where **m1** = real narrow money i.e., currency plus demand deposits deflated by the aggregate price level or GNP deflator; **y** = real gross national product, $\mathbf{r}^{ms}$ = short run market interest rate; $\mathbf{r}_s$ = rate of interest on saving deposits). His empirical estimates of equation (2-2-1) from pre-1974 sample period revealed that the quarterly money demand function was most stable. It then follows that the demand for money function is most stable when narrow transaction definition of money, short term market rate interest such as treasury bill or commercial paper, interest rate on saving deposits, measured income rather than permanent income or wealth and lagged money are employed. Indeed, Goldfeld tested for the stability of equation (2-2-1) by examining the ability of the equation to forecast outside the sample period. The stability test showed no systematic tendency to drift off such forecast up to 1973 which was the year of his study.

Laumas and Mehra (1976) examined the stability of the money demand function for the US over the post war period by employing varying parameter regression approach developed by Cooley and Prescott (1973). Under this approach, the basic notion is that the parameter vector in an econometric relationship may be subject to sequential variation over time because of the problem of structural change, mis-specification and aggregation.

Therefore, an econometric relationship is said to be stable if and only if the parameters in such a relation are not subject to permanent changes over time.

Using this econometric technique to the demand for money formulated as a function of income and interest rate in a log-linear form, they confirmed the stability of the money demand function which according to them are properly specified. Put in their own words:

> The evidence presented shows that all those quarterly demand for money functions that assume complete adjustment of actual to desired money holdings within a given quarter yield unstable econometric relationships. For quarterly demand for money functions that do allow lags in adjustment, it seems that stable demand for money functions include short and intermediate interest rate (p.467).

Similarly, most studies for UK such as **Kavanagh and Walters (1966)**, **Laidler and Parkin (1970)**, **Goodhart and Crockett (1970)** were able to find stable and well-determined money demand functions. The precise form and type of the equations as well as the period of data employed varied between studies. Static long run equations of the form:

$$m_t^* = \alpha_0 + \alpha_1 r_t + \alpha_2 y_t + e_t \quad \ldots\ldots\ldots\ldots\ldots\ldots \quad (2\text{-}2\text{-}2)$$

(where $\mathbf{m}^*$ = real money demand; $\mathbf{r}$ = interest rate; and $\mathbf{y}$ = real income) were commonly adopted for annual data while studies using quarterly data generally estimated short run equations which allowed for adjustment (partial) and expectation lags.

The review of these studies as well as Bailey's remark indicates that the standard earlier empirical findings contain two problems. The first is that, the issue of money demand equations being subject to serial correlation is often overlooked in empirical research study. It is widely recognised that equations that are subject to serial correlation may provide a misleading results (see Courakis, 1978 and Lieberman, 1980 for examples) but too little effort has been expended on the money demand area in an attempt to avoid the possible problems that may result. The second problem is lack of stability in estimated coefficient which has been suggested by several studies.

Studies such as **Goldfeld (1976)** and **Enzler et al. (1976)** found that, starting from 1974, forecasts from equation (2-2-1) began to falter as the equation strongly overpredicted real money balances in United States of America. Similar studies by **Hacche (1974)** and **Artis and Lewis (1974, 1976)** were carried out in the United Kingdom in order to highlight the instability problem. They found that the conventional short-run partial adjustment equations as well as adaptive expectation models, which had explained the data well in the 1960s, were unable to forecast the quantity of money accurately in the early 1970s, with the estimated equations systematically underpredicting the actual UK money stock.

The evidence of systematic overprediction and underprediction of real money balances in both USA and UK respectively by the standard or conventional money function suggests the possibility that the demand for money had become "unstable" in the real sense that it had become more difficult to predict accurately the impact of a change in money supply. Indeed, this problem is not solely confined to the UK and US. Studies by other researchers showed that instability also appeared to be present in the money demand equations of several other countries in this period (see Boughton, 1979 and Fair, 1987). The breakdown in the relationship was particularly apparent in the equation for broad money for UK. For the USA the overprediction of the actual money stock by the conventional short-run equations led to the concept of "missing money" in the 1970s and in contrast to the U.K. experience, it was the narrow money equation which was particularly problematic.

Also, difficulties were encountered in the 1980s, when there was a noticeable decline in the velocity of circulation of most forms of money demand in both the UK and US, in consequence, the standard money demand equations were often found to underpredict the actual money stock in both countries.

As recent evidence has shown that the stability assertion is no longer valid, studies undertaken since mid-1970s and 1980s, in both the UK and US have, therefore, been largely concerned with explaining these apparent shifts in the demand for money function; this has led investigators to look for "new" relationships which can explain money holdings over a longer data period than that used in the early short-run studies. In some cases, this search has involved the consideration of institutional factors specific to the different economies. We shall, therefore, concentrate on analysing the recent USA studies first of all before turning to UK studies later.

In order to empirically explain money demand as their own contribution to the temporary instability of money discussion, **Hafer and Hein (1980)** investigated two alternative stock adjustment mechanisms. The result of their study indicated that both stock adjustment relationships were statistically stable when first difference form were employed. Put in their own words:

> It does not appear that the relationship between money demand, real income and interest rates has changed significantly over recent periods. The surprisingly accurate predictions of money demand over the post-1973 period using first difference approach buttress the conclusion that the

money demand relationship has not suffered from any drastic shifts that would invalidate monetary policy (p.34).

Arango and Nadiri (1981) in their study of four major industrialized nations, viz; Canada, Germany, United Kingdom and United State of America found no evidence of instability in the demand for money function, except in Canada, which they attributed to developments in the foreign exchange market. Their results seemed to support an earlier study in two of the nations considered by Hamburger (1977) whose analysis was on Germany and the UK, who asserted from his study that the quantity of money appeared to be relatively stable as a function of income and interest rates and confirming that the monetary aggregate narrowly defined is appropriate for a moderately large open economy. They agreed that despite variation in the institutional setting and openness of the economies examined, the demand functions for the narrowly defined money stock appeared quite robust.

Judd and Scadding (1982) have suggested that the most likely cause of the observed instability in the demand for money after 1973 is the innovation in financial arrangements and institutional change. The innovation in financial arrangement allowed the private sector to economise on its holdings of transaction balances. This change appears to have been induced by high interest rate and inflation rate, and the existence of legal impediments to the payment of a market rate of return on transactions balances. Banks were consequently encouraged to provide their customers with new accounts for their transactions balances, which evaded the regulations on interest payments. Because these accounts fell outside the traditional definition of narrow money, their introduction had the effect of introducing instability into the M1 function. The institutional change, on the other hand, involved a greater emphasis on monetary aggregates targeting by the Federal Reserve.

The important implication of Judd and Scadding's study is that, more progress in explaining shifts has been made than it has in producing formulation that will be able to predict future shifts. Also, it can be inferred from Judd and Scadding's survey that none of the traditional alternative empirical specifications of money demand seemed to be superior to the conventional Goldfeld's specification in the sense of reducing materially the latter's post-1973 over-predictions.

Financial innovations as explained by Judd and Scadding might be the proximate cause of money demand instability but **Mascaro and Meltzer (1983)** as well as **Hall and Noble (1987)** on US money demand explained that such instability was caused by the rise in monetary policy uncertainty. Their main argument was that increased volatility of money growth induced by policy raised the degree of perceived uncertainty, thereby increasing the demand for money. They alleged that an increase in the degree of monetary instability was caused by the Federal Reserve's new monetary control procedures. They reasoned that an unstable and unpredictable environment, people choose to hold more money and less of other assets such that there is a positive association between variability and the demand for money. They assumed further that an increase in the demand for money raises short-term nominal interest rates. It, therefore, follows that there is also a positive association between monetary variability and the level of the nominal rate of interest. The implication of these assertions is that any money demand regression should include the volatility of money growth (measured as quarterly or annual moving average of standard deviation of quarterly or annual M1 growth rate) as one of the regressors in order to achieve structural stability.

According to **Judd (1983)**, the instability observed in money demand was as a result of disinflation in the 1980s. He explained that since actual (or expected) rate of inflation had fallen over the 1980s, and considering the a-priori inverse relationship between money demand and the rate of inflation, it was therefore expected that money demand regression including expected rate of inflation should exhibit parameter stability.

Simpson and Porter (1984) related the source of instability in money demand function to the deregulation of the financial market. The contention was that money demand had become more interest sensitive. So, when interest-bearing chequeable deposits were introduced in US in 1981, it became part of M1 thereby explaining the observed strength in M1 during the 1980s. It follows, therefore, that M1-A (where A is interest-bearing chequeable deposits) should be structurally stable over the 1980s.

Explaining the reason for such instability, **Friedman (1988)** instead stressed that instability in money demand function is caused by strength in stock market and increase in the financial transactions. According to him, using the real income to capture all financial transactions was grossly inadequate. Also, the rise in stock prices increases the financial wealth of the individual households. These two arguments presented could have contributed immensely to instability in money demand. Hence, for money demand to be stable over time, the regressors must include two additional variables that will explain the impacts of financial transactions and wealth on money demand.

Mehra (1989), however, investigated the authenticity of the previous hypotheses concerning instability in money demand functions. In addition to the previous explanations, he specified a money demand equation that included a financial deregulation variable which captured the introduction of an instrument for savings as well as for effecting transactions. His study showed that none of these earlier hypotheses could satisfactorily explain the instability in M1 in US. According to him:

> The econometric evidence presented here does not support explanations that assign a key role to the behaviour of the volatility of M1 growth, the rate of inflation, the real value of stock, the volume of financial transactions, or the financial wealth of household (p.9).

However, the most probable cause of such instability in M1 demand, according to him, is the introduction of M1 chequeable deposits that pay interest. Indeed, Mehra's analysis showed that one needed a broader monetary aggregate (i.e., M2) in order to identify a stable money demand function. He was able to confirm this by presenting alternative statistical evidence consistent with the existent of a long run M2 demand function during 1952(1) to 1984(4) using US time series data. The study showed that real M2 balances are cointegrated with the real income and market interest rate, implying that a stable long run demand function for real M2 as function of real income and market interest rate exists.

Several other studies have also found a significant role for measures of the volatility of interest rates. For instance, **Baba et al. (1992)** considered a variable based upon the standard deviation of the bond yield and found that it has a significant positive effect upon the demand for narrow money. Using a general distributed lag error-correction approach, it is claimed that the incorporation of such a variable can help explain the "missing money" period of the 1970s as well as the decline in the velocity in the early 1980s. These studies also linked the large increase in the M1 aggregate in the 1980s to the introduction of interest-bearing cheque accounts, which followed interest rate deregulation in 1981. The growth of such deposits, which combined elements of both savings and transactions balances, had a considerable effect upon the demand for M1 in the 1980s as funds were switched out of existing retail savings deposits, which comprised part of the non-M1 component of M2, into these new interest bearing accounts.

Hamburger (1987) focused upon the importance of including a broad spectrum of asset yields in the money demand function. Such an approach conforms to Friedman's demand for money function, being based upon the monetarist view that money is a substitute for a wide range of assets, both financial and real, and not merely for short-term financial assets. According to the monetarist hypothesis, the high rates of inflation after 1973 increased the nominal return to goods and induced a shift out of money towards real expenditure. Hamburger specified a function for M1, in which the real money demand depended upon real income, the lagged money stock and three rates of return, representing the rate on time deposits, the long-term bond rates and the dividend-price ratio ruling in the stock market. Hamburger argued that the later variable is a proxy for rate of return on equities, and therefore the yield on physical capital which could be used to explain the apparent shifts in the demand for money function over the past two decades. The value of the ratio certainly changed considerably in the period 1972-74 when the stock market prices fell dramatically and dividend levels were maintained. Similarly, Hamburger maintained that the increase in money holdings that occurred in the 1980s was associated with a marked fall in the dividend-price ratio.

In an attempt to obtain more satisfactory money demand functions, many UK studies have looked at alternative specifications of the traditionally estimated short-run relationships. Different functional forms, more flexible lag structures and additional explanatory variables have all been considered and have been particularly successful in improving the demand equations for narrow money. **Mills (1978)** estimated different functional forms and found that the demand for narrow money is adequately explained by the conventional independent variables, regardless of which functional form is adopted.

Coghlan (1978) used a model, allowing for a freely-estimated lagged structure, to isolate a transactions demand function based upon quarterly UK data for M1 over the period 1964-74. The preferred specification for nominal money balances takes the form:

$$\begin{aligned} M_t = \; & \underset{(3.80)}{0.379Y_t} - \underset{(2.17)}{0.216Y_{t-3}} + \underset{(6.05)}{1.326P_{t-1}} - \underset{(5.73)}{2.069P_{t-2}} + \underset{(4.57)}{1.675P_{t-3}} \\ & - \underset{(3.53)}{0.816P_{t-4}} - \underset{(5.16)}{0.048R_t} + \underset{(18.62)}{0.838M_{t-1}} \qquad (R^2 = .99) \qquad \ldots\ldots\ldots \; (2\text{-}2\text{-}3) \end{aligned}$$

where all variables are written in logarithmic form and the figures in parentheses refer to t-statistics. The lag structure implied by the results is complex and obviously different for each explanatory variable; adjustment to real income and price level changes is complete in less than a year, while adjustment to changes in the rate of interest is slower. A long-run income elasticity of unity is implied by the results. Coghlan concluded that there was no evidence of a breakdown in the demand function for narrow money in the

1970s.

Artis and Lewis (1981, 1984) extended Coghlan's data period and find that, although the estimated equation yields long-run coefficients similar to those obtained by Coghlan, the short-run properties of the equation are unstable and the equation fails to predict subsequent movements in M1 holdings.

All the models outlined in the previous studies above lead to short-run demand for money equations which include lagged dependent variables. However, the task in empirical work on the demand for money function is of two fold: testing for the existence of long-run equilibrium relationships proposed by theory; and deriving an adequate short-run dynamic model. Emphasis on long-run equilibrium relationships in recent time suggests that a useful specification search (i.e, "general to specific" approach) is to see if the levels of the variables that enter the function are cointegrated. If they are, then not only is the notion of the underlying long-run equilibrium relationships between them accepted as valid, but the short run dynamic specification search is also narrowed to a class of models known as the error correction models.

The requirement in modelling the demand for money is, therefore an approach that captures the long run relationship between the variables while avoiding spurious inferences. **Engle and Granger (1987)** have shown that short run models are difficult to interprete and also mis-specified if there are equilibrium relationships among the variables in the long run. This is why the cointegration and error correction technique have been found useful in modelling the demand for money in several recent studies.

Hendry (1979, 1985), using "first-difference" econometric technique, also found that the demand for M1 exhibited greater parameter stability when a more flexible lag response was allowed in a model in which the long run real money demand depends upon real income, the rate of interest and the expected rate of inflation. In addition to price homogeneity, an income elasticity of unity was assumed in steady state, implying that agents wish to hold money in proportion to their nominal income in the long run. Hendry in his study applied reparameterization approach which allows the unrestricted lagged model to be interpreted as an error-correction equation, so that while the growth in real balances depends upon the growth in prices and income, there is also a correction for any divergence from the long-run equilibrium demand relation. In this way, the approach allows the investigator to model the short run dynamics around the long run equilibrium demand for money function.

Hendry's (1985) preferred short-run equation, obtained from quarterly data for the period 1961-82, takes the form:

$$\Delta m_t = \underset{(0.01)}{0.04} + \underset{(0.13)}{0.37}\Delta y_{t-1} - \underset{(0.07)}{0.58}\Delta R_t - \underset{(0.12)}{0.80}\Delta P_t - \underset{(0.01)}{0.10}(m-y)_{t-2} - \underset{(0.07)}{0.28}\Delta m_{t-1}$$

$$(R^2 = 0.71) \quad \ldots\ldots \quad (2\text{-}2\text{-}4)$$

where all variables, except the rate of interest, are expressed in logarithms and the figures in parenthesis are the standard errors of the estimates. The symbol Δ is used to denote the first difference of the variable, so that the dependent variable represents the quarterly growth in real money balances, while Δ**P** can be interpreted as a proxy for the expected rate of inflation. Income enters with a lag, while only the current interest rate is significant. The term $\mathbf{(m\text{-}y)_{t-2}}$ represents the error-correction mechanism; previous disequilibria, in the relationship between the level of real money balance and real income, affect the rate of change in real demand through this variable, which represents the ratio of lagged real balances to lagged real income.

The hypothesis of unitary long-run income elasticity is accepted by the data, while the coefficient on the error-correction variable indicates a feedback of 10% from previous disequilibria between money and income. This is relatively slow adjustment, possibly reflecting minimal costs of being out of equilibrium. In contrast, the results imply large immediate responses to changes in inflation and the interest rate. Given the high values frequently attained by both nominal interest rates and the rate of inflation over the second part of the data period used in the study, such findings indicate the importance of these variables to any explanation of money holdings post-1970.

Lucas (1988), however, updated the long-run relationship estimated by Meltzer (1963), using a narrow definition of money and by extending the data period to 1985. Although evidence of stability remains and the estimated elasticity values were in line with those obtained by Meltzer, the results appeared to be dependent upon the restrictions imposed upon the estimated equation.

Hendry and Ericsson (1991) found that the coefficient estimates of earlier Hendry studies change very little when the data period is extended to 1985, but that the model massively underpredicted money holdings over the remainder of the 1980s. Holdings of M1, in real terms, increased considerably over this period, leading the two to hypothesize that the advent of high-interest cheque accounts in the 1980s had the effect of increasing the demand for narrow money, once individuals had learnt of the availability of such accounts. A net opportunity cost variable, defined as the difference between the three-month local authority deposit rate and a measure of the retail sight deposit rate, was included in the estimated equations in order to measure this effect. The preferred equation for the period 1964-89 takes the form:

$$\underset{}{\triangle m_t} = \underset{(0.004)}{0.02} - \underset{(0.05)}{0.63RC_t} - \underset{(0.14)}{0.69\triangle P_t} - \underset{(0.06)}{0.17\triangle(m-y)_{t-1}} - \underset{(0.01)}{0.09(m-y)_{t-1}}$$

$$(R^2 = 0.76) \qquad \qquad (2\text{-}2\text{-}5)$$

where **RC** represents the net opportunity cost variable. The figures in parentheses are standard errors indicating that the coefficient estimates are all highly significant. The authors feel this equation represents an improvement over the previous Hendry's specifications.

Cointegration techniques were also applied to the analysis of the US demand for money function by **Miller (1990, 1991)** and **Hafer and Jasen (1991)**. Both studies found that a long-run cointegrating relationship existed between the broad M2 aggregate, real income, prices and interest rate variable, but that the existence of an equilibrium relationship for narrow money is more doubtful. Miller's results were based upon quarterly data for the period 1959-87, while Hafer and Jasen also used quarterly data, but for a longer period encompassing the year 1915-88.

Baba et al. (1992) were more optimistic about the ability of investigators to isolate a stable long-run cointegrating equation for narrow money, arguing that such a relationship can be obtained for M1, using quarterly data over the period 1960-88, if adequate consideration is given to factors such as the rate of inflation, the long-term bond yield, the own return on money and the "riskiness" attached to bond holding.

In Japan, **Yoshida (1990)** re-estimated Japan's money demand function both with the conventional partial adjustment (PA) model and with the error correction model. His results showed that the conventional money demand function exhibited a strong residual correlation, pointing to the unreliability of estimated results. A comparison with standard error of the two regressions shows that the ECM-money demand function has a far better fit than that of a conventional function. An out-of-sample simulation for three years produced satisfactory results. Moreover, a sequential Chow test revealed that the ECM-money demand function has remained stable since 1976 in contrary to the prevailing insistence on shifts in the money demand function or "missing money". These findings seem to put some weight on the argument that "missing money" phenomena are largely due to specification error.

2.2.3 Evidence From Less-Developed Countries:

As money plays a crucial role in transmission mechanism of both monetary and fiscal policies and in virtually all the theories of income determination, considerable effort has been expended in order to specify the demand for money for different less-developed countries. Indeed, as one of the keystones of econometric modelling, numerous attempts have been made to investigate the various theory of money demand in these less-developed countries. Thus, much of the literature of the 1970s focused on whether the evidence favoured the transactions or asset (or utility) or the Keynesian liquidity preference theory in these less-developed nations of the world.

Much has been said about the empirical inapplicability of the keynesian liquidity preference theory in developing nations. The main argument against this theory is that observable interest rates in these nations do not generally reflect money market conditions, and in most cases, they are institutionally fixed. Also, as there are few alternative financial assets available for the wealth holders, the so-called speculative demand for money is negligible. The corollary of this is that money is considered being held mainly for transactions purposes (Wong, 1977).

One aspect of recent studies in the demand for money function in developing nations is its specification. Many writers consider that money is being held for transactions motive hence, the quantity theory of money is taken to be more realistic or applicable to these nations. Some other writers have considered the expected rate of inflation to be a significant explanatory variable in the money demand equation (see Crockett and Evans, 1980; Driscoll and Lahiri, 1983). The argument is that asset choices of wealth owners in these countries are often restricted to holding either money or real goods such as land, consumer durables, houses etc, and under these situations, the expected rate of inflation becomes a more approximate proxy for the opportunity cost of holding money.

Many other writers like Wai (1956), Ogiogio (1989) and Hetzer and Mehra (1989) still conceive that interest rates are relevant in the demand for money function in less-developed nations as there exists a certain link between the non-organised and organised money markets and borrowing is still a means of financing economic activity. The interest rate in the unorganised market although unobservable would reflect the degree of credit restraint in the demand for money function.

Needless to say that much of the sophistication regarding statistical and economic tests and procedures are absent in most studies conducted in less-developed nations, however, this does not imply that considerable work has not been done. Indeed, 1970s and 1980s witnessed an upsurge of evidence in these countries, especially since the influential work of Wong (1977).

Prominent among these works is that of **Adekunle (1968)**. The results of his study suggest that the propositions of the theoretical relationships of the standard money demand function have a fair amount of generality, and in less-developing nations, desired real money balances are related to interest rates, expected rate of change in prices and current income, rather than expected income. However, he argues that while there is wide room for generalization about desired money holdings, there are differences in the form of the demand for money function that can be appropriately applied to each economic environment.

Adekunle's findings also point to the fact that in less-developed economies desired money balances are related to current income rather than expected income which, he argues, makes the work of monetary management in these countries more difficult. He explains that in situation where instruments of monetary policy are not fully developed and where there is substantial lags in acquiring information about and interpreting developments in the level of economic activity, the added flexibility required of monetary management may be difficult to achieve especially because of static income expectations.

Park (1970) observes in his study that income velocity of money is more subject to short-run variations in developing nations than in industrial ones. For this reason, there arises the need to seek for alternative form of demand for money functions for developing countries. In most cases, the expected rate of inflation has either been considered or found to be a powerful explanatory candidate in the money demand function.

Suveira (1973) in his study on the Brazilian economy estimates the demand for money function for the economy for the period 1948-1967 in terms of wealth constraint and expected yield on non-money assets (i.e., expected return on its substitution). He estimates a demand for money function from annual, quarterly and monthly observation. He adopts Cagan's proxy for the expected rate of return on non-perishable goods (i.e., expected rate of return of a change in prices) as an index of the rate of return on non-money assets. Income is taken as a constraint on real balances in the estimation obtained from annual observations and sales is employed as a proxy for wealth in the estimates from quarterly and monthly observations.

Suveira's findings suggest that the demand for money function is inelastic with respect to income and expected rate of increases in prices. The coefficient of determination is 0.87 implying the 87 per cent of the real balance variance is explained. The coefficient of expectation and the price-expectation elasticity were found to increase as the rate of inflation increases and vice versa. He also found that the response of the economy to monetary policy and the speed and magnitude of adjustment to changes in the money stock increases with the rate of monetary expansion.

Some peculiar features of less-developed economies have led some theorists to proposed a modified formulation of money demand function. The narrowness of capital markets as considered would not permit effective use of interest rate as a monetary policy variable. This led **Wong (1977)** to suggest an index of the degree on credit restraint (CR) instead of the interest rate. Covering five less-developed nations; Korea, Sri Lanka, Taiwan, Thailand and Philippines, Wong's aim is to construct a money demand function which is theoretically tenable and empirically more applicable to the less-developed nations in general. Applying a simultaneous equations model, he makes the following conclusions that: in developing nations where interest rates are inoperative, some proxy variables could be employed to reflect the degree of credit constraint. Wong, therefore, suggests that the degree of credit restraint itself, if appropriately measured, can be treated as a proxy variable for the rate of interest variable in the demand for money function. Employing first order partial adjustment model, he shows that inflation variable is more significant than interest rate. However nothing was said about the stability of such estimation and this issue is one of the limitations of this particular study and most previous studies on money demand functions in the less-developed countries.

However, **Pathak (1981)** in his study examines the stability of Kenyan money demand function for 1969-1978 within her institutional structure. Both narrow and broad monetary aggregates (i.e. M1 and M2) were used separately so as to find out their relevance in the Kenyan economy. Annual treasury bill rate, which was the only relatively free market rate in Kenya was employed as a proxy for interest variable. His results show that demand for money is positively and negatively related to money income and interest rate respectively while these variables are also significant statistically. Also, income elasticity of money demand is confirmed to be unity thereby supporting the monetarists argument that the quantity theory is the demand for money. He also finds a stable money demand function for Kenya which provides suitable basis for the monetary analysis in Kenyan economy.

Deadman and Ghatak (1981) investigate the stability of India's money demand function. Having defined stability as the constancy over time of the estimated coefficients of the explanatory variables the authors use the test proposed by Brown, Durbin and Evan (1975) and concluded that there is a strong indication of structural instability for any narrowly defined monetary aggregate over the period 1948-1976. Their results also suggest that the use of the most broadly monetary aggregate (M3) indicates much greater stability over the same period. In all cases, the usual finding of the greater importance of income over interest rates as explanatory candidates in the money demand function was confirmed by this study.

Darat (1986) in his study of the demand for money functions for three OPEC nations including Nigeria employed the distributed lag framework (Modified Almon Polynomial Procedure) for his model specification for currency, narrow and broad monetary aggregates. A major departure from earlier studies was the consideration given to the international monetary influences on the domestic money holdings, through the inclusion of foreign interest rate, along with income and expected rate of inflation in his specification. Employing Cochrane-Orcutt procedure to correct for serial correlation problem detected, and employing quarterly time series data, a battery of diagnostic tests were conducted particularly for testing temporal stability of the estimated equations. He concludes that the expected real income (permanent real income) and inflationary expectation play significant roles in determining real balances in these countries, while foreign interest rate exerts a significant negative impact on real money demand and exerts a stronger effect on real money balances in terms of long-run elasticities than expected inflation rate. In the light of these findings, he states that money demand functions in open economies that do not include foreign interest rate among their explanatory candidates may be seriously mis-specified to the extent of potentially rendering the whole demand for money relationship structurally unstable.

Adam (1992) in his study applies recent econometric methods of cointegration and error correction model to the demand for money in Kenya. According to him:

> The purpose of this paper is therefore two fold. The first objective is to survey the main developments in econometric thinking ... The second, ... considers the practical application of this methodological approach to the particular environment encountered in Africa (pp.1-2).

Indeed, Adam's study is to establish an empirically robust and theoretically consistent model for the demand for narrow money in Kenya for the period 1973-1990. Having established the explanatory variables of real money balance as real income, the domestic rate of interest, rate of return on holdings of foreign currency and the rate of inflation, he considered the order of integration of each series using Dickey-Fuller (DF) Augmented Dickey-Fuller (ADF) and the Sargan-Bargava Durbin Watson tests. He reports that with the exception of inflation which is clearly stationary [I(0)], other variables clearly indicate non-stationary series [I(1)]. It is also confirmed that money demand series cointegrates with other variables of the model and then develops a parsimonious error correction model.

Examination of the coefficients of his parsimonious equation confirms that the error correction model tracks the data well over the sample period. The array of further diagnostic tests indicates that the model is consistent with the data. There is no evidence of first or higher-order autocorrelation in the equation errors while the other statistics support the view that the distribution of the error term is independently and homoscedastiscally normal. In Adam's words:

> Evidence of within-sample forecast accuracy further supports this hypothesis with the model estimated to 1985 tracking the actual data from 1985 to 1989 with a high degree of accuracy... We can conclude, therefore, that for the full sample the model adequately capture the salient features of the data and is consistent with the main implications of economic theory (p.35).

2.2.4 Evidence From Nigeria:

In Nigeria, the empirical investigation into the nature of demand for money function remains perhaps the most extensively studied area of economic research judging by the plethora of studies that have emerged since the seminal work of Tomori in 1972. These studies have attempted to examine the issue of specification, estimation and stability highlighted in the preceding subsections. Even though most of them followed the conventional specification found in the economic literature, there has been a lot of disagreements as regards method and testing.

Tomori (1972) in his pioneering work employed a very simple linear model which expresses nominal (or real) GDP as a proxy for income or both income and interest rate (official discount rate) representing the opportunity cost of holding money. His aim was to examine if a stable money demand function existed for Nigeria. Applying the OLS technique of estimation, he confirmed the proposition that there is a stable demand for money in the period of 1960-1970.

Ojo (1974a), however, disagreed with the methodology and most of the assertions reached by Tomori in his study. He specified a model in which interest rate was excluded and concluded that adjustment would probably take place not by way of purchase of financial assets but rather by way of purchase of physical assets. **Odama (1974)** also criticized the econometric technique employed by Tomori by emphasising error in approaches. Indeed, they warned, for the purpose of relevant policy action, that the results in Tomori's study should be interpreted with utmost caution.

Teriba (1974) also faulted Tomori's model specification as inadequate, including serious methodological pitfalls and interpretational defects. He argued that estimating an aggregate money demand function, as did by Tomori, was not sufficient but the demand for its components. On the basis of his specification he found out that the result of the disaggregated equations for currency and demand deposits differed substantially from those for the aggregate equation and indeed, he was able to find stable functions for the various components of money in Nigeria.

Ajayi (1974) on his part addressed the shortcomings inherent in Tomori's results by specifically providing solution to the stability question raised. Applying the partial adjustment framework, and using OLS to estimate money demand equations expressed as a function of current income, short term interest rate and lagged money balances (for both real and nominal), he found that money demand functions are stable over time in Nigeria.

Ojo (1974b), in a bid to establish the correct money demand function in a developing economy characterised by under-developed money market, specified and estimated (employing OLS technique) two kinds of relationship between money and its determinants. He found that income and price change expectation (i.e., inflation rate) were the two significant variables explaining money demand in Nigeria. However, he warned that this findings may not be validated if there is improvement in the money market as the role of interest rate may become significant in money demand functions in Nigeria.

Iyoha (1976) in his study sought to test the applicability of the permanent income hypothesis to Nigeria and to establish that interest rate plays little or no role in the demand for money. His major findings are that there is no evidence that the current income specification is superior to that of permanent income and that interest rate has little or no influence on the money demand function in Nigeria. Also, his study confirmed stability in the demand for money for the period 1950-68.

Approaching the specification and estimation of money demand function from a simultaneous equation framework, **Akinnifesi and Phillips (1978)** conclude that the demand for real money balances in Nigeria can be described as a function of its own lag value, expected real income and expected rate of interest. As for policy recommendation they suggest that the monetary authority could focus on some crucial interest rates such as minimum rediscount rate and treasury bill.

Unlike the preceding studies, **Fakiyesi (1980a, 1980b)** approached the issue of an appropriate money demand function for Nigeria from an entirely different perspective and sought to examine the structural stability of money demand function in Nigeria for the period 1960-1976. Adopting the adaptive expectations framework, he concluded that irrespective of the definition of money used, the demand for money function was generally stable during the period covered by the study.

Adejuyigbe (1988) and **Audu (1988)** in their studies of money demand functions in Nigeria similarly adopted the partial adjustment mechanism in obtaining a specification for the demand for both real and narrow money balances. Adejugbe concluded that measured income, rate of interest and lagged variables constituted effective determinants of the demand for money. His estimated equation for M2 was confirmed stable while the test revealed instability in the case of M1. Audu on his part concluded that the demand for money function in Nigeria has shifted in terms of the significant of the coefficients of the predictor variables and the intercept term.

Oresotu and Mordi (1992) reported that for both real and nominal adjustment mechanisms, the coefficient for income variable (measured as a current real income) has a positive effect on demand for M1 and is statistically significant. It follows, therefore, that the real income is a significant factor explaining the demand for real money balances narrowly defined. Their results also show that the coefficients of the expected inflation and nominal interest rate (using deposit rate as a proxy) variables have the expected negative signs in the real adjustment specification. However, while the coefficient for inflation is statistically significant, that of nominal interest rate is not. In the nominal adjustment specification, while the coefficient of the expected rate of inflation, though statistically significant, possesses the wrong sign, the coefficient of the interest rate has the appropriate sign but statistically insignificant as in the real adjustment specification.

2.2.5 Conclusion:

The reputation of the aggregate money demand function has plummeted since the mid-1970s. Once viewed as a pillar of macroeconomic models, it is now widely regarded as one of the weakest stones in the foundation. The origins of this fall from grace are not hard to find: The past two decades have witnessed a large number of financial innovations and deregulatory measures in many countries which have dismembered traditional payments patterns and have rendered the identification of the line between money and other liquid assets all but impossible.

In Nigeria, very little is known about contemporary relationship between money and the other key macroeconomic variables. Indeed, the far-reaching and wide ranging reforms measures adopted since 1986 must have altered many of the known relationships between money and other macroeconomic variables. It appears that a coherent framework for monetary policy is lacking hence the need for determining how monetary authority should go about designing and conducting its monetary policy. The basic problems to be addressed involve the identification, estimation and the selection of the most appropriate aggregate money demand model for Nigeria which will go a long way in helping the CBN in its monetary policy formulation and implementation.

2.3 THEORETICAL FRAMEWORK

2.3.1 Introduction:

Since econometric modelling deals with the interaction of economic theory and empirical analysis, it will be useful to discuss some economic theories relevant to the formulation of models of aggregate money demand. Several empirical studies on the money demand in many countries are based on a variety of a number of approaches to the demand for money. The emphasis is on the variables which the various theories identify as influencing the money holding and the extent to which they predict the stability of money functions.

Two special characteristics of money that provide the starting points for a number of theories are its use as universally acceptable means of exchange and its role as a store of value. The former leads to the transactions model of money demand while the latter leads to portfolio model. Several economists spanning several epochs have reflected on the demand for money applying either the former or the latter theory. Here, we start with the classical school analysis of the demand for money, then we proceed to the Keynesian approach as well as its extensions before we go into the modern versions of the demand for money models (notably, the general portfolio or asset theory, risk avertory, buffer stock) and the development of the Neo-Quantity approach (Neo-classical).

2.3.2 The Classical Analysis of Money Demand:

Modern monetary theory has its origins in the classical writings. The original and lasting contribution of the classical school to monetary theory lies in its formulation of what is called the "Quantity Theory" of money. Simply stated, the Quantity Theory is an hypothesis about the relationship of the stock of money to the general level of commodity prices, according to which changes in the price level are explained by prior changes in the money stock.

The influence of money on prices was deduced from analysis of historical experience of price revolution which occurred as a result of the introduction of greater quantities of gold in Europe in the 16th century. This theory, however, provides the analytical framework for explaining the functioning of an economy. Interestingly enough, the Quantity Theory can alternatively be viewed as a theory of aggregate demand and as a theory of the demand for money. As a theory of money demand, it represents two approaches; the Fisherian and Cambridge approach to the money demand. In what follows, we discuss the development of these two approaches.

A. Fisherian Approach:

When explaining the demand for money in relation with the Quantity Theory, it is more direct to use the approach formulated by Irving Fisher called Income-Velocity which leads to the inventory theory of money demand. The basis of Fisher's theory is an identity linking the value of sales with the amount of money which changes hand. If **Y** equals the number of transactions and **P**, the average price level, the **PY** is the value of transactions undertaken. Each transaction involves an exchange of money and the number of times money changes hand (that is, the velocity of circulation), **V**, multiply by the fixed stock of money, **M**, must be equal to the value of transactions. We, therefore, have an identity as below:

$$MV \equiv PY \quad \ldots \quad (2\text{-}3\text{-}1)$$

This identity, often referred to as the "Equation of Exchange" is used to formulate the quantity theory of money as well as the demand for money theory. Fisher (1911) inquired into the demand for money using this identity and his inquiry was fundamentally based on the concept of money as a means of transactions. For this reason, he analyzed the institutional details of the payments mechanism and, therefore, concentrated on the velocity circulation of money. Nevertheless, Fisher's theory emphasized a proportionate relationship between the amount of money in circulation, the level of transactions and the price level. At this juncture, we need to ask ourselves: how does the Equation of Exchange become a money demand function?

According to Fisher, the demand for money depends upon the value of transactions to be undertaken and this is equal to a constant fraction of these transactions. Within this framework, we know that the stock of money, **M**, is exogenous (that is, it is determined by the monetary authority). Indeed, and mathematically speaking, it is a constant. We also know in macroeconomic theory that equilibrium requires that supply equals demand ($\mathbf{M^s = M^d}$). So, in Fisher's term,

$$M^d = M^s = PY/V \quad \text{or} \quad M^d = kPY \quad \ldots \quad (2\text{-}3\text{-}2)$$

where **k** is the reciprocal of **V** (i.e., $\mathbf{k = 1/V}$). The main implication of this approach is that it links the demand for money to the volume of trade(i.e., value of transactions) in the whole economy. Equation (2-3-2) above, being a behavioural relationship can be directly estimated and some interesting .results can be derived from the Equation of Exchange.

B. The Cambridge Approach:

The Cambridge approach to the Quantity Theory was primarily the work of five men: Alfred Marshall, A.C. Pigou, Frederick Lavington, Denis Robertson and John Maynard Keynes, who were all of Cambridge school in England. The approach of this school, in fact, is much pleasing to economists, for it involves the application of general demand analysis to the special case of money:- inquiring into the utility of money, the nature of budget constraint facing the individual, and the opportunity cost of holding money as opposed to other assets (both financial and physical).

These Cambridge economists recognized that individuals may desire to hold money for the same general reasons as they desire to hold goods, because both money and goods yield utility. These scholars believed that money yields utility for two reasons: first, because money holding provides a degree of security against future uncertainties; second, because it is generally acceptable in exchange for goods and services, thereby avoiding the inconveniences of barter transactions. For this reason, the transactions motive is the major determinant of money holding. Pigou (1917) provided a more general explanation:

> Hence, everybody is anxious to hold enough of his resources in the form of titles to legal tender (currency) both to enable him to effect the ordinary

> transactions of life without trouble, and to secure him against unexpected demands... For these two objects; the provision of convenience and provision of security, people in general... elect to hold money (p.164).

However, the Cambridge scholars excluded interest bearing deposits, from their definition of money and the yield on money is purely psychological, and its magnitude at the margin depends, as for all goods, upon its quantity in relation to the urgency with which these needs are held. The larger the supply of money, other things being equal, the lower its marginal yield. Therefore, money was treated just like any other goods and its possession was subject to diminishing marginal utility.

Given that money has utility, the Cambridge scholars believed that the nature of the budget constraint facing the individual and the opportunity cost of holding money as opposed to other assets determine the amount of money the average individual would be willing to hold. Even though their statements and reasoning tend to be unclear, as regard the nature of the budget constraint, the scholars recognized both property (wealth) and current income as being the relevant variables. Marshall (1923) wrote:

> ... Suppose that the inhabitants of a country ... find it just worth their while to keep by them on the average ready purchasing of power to the extent of a tenth part of their annual income, together with a fiftieth part of their property; then the aggregate value of the currency of the country will tend to be equal to the sum of these amount (p.44).

However, they failed to discuss the composition of wealth as well as distinguishing a stock variable (wealth) from a flow variable (income).

The opportunity cost of holding money, according to Cambridge scholars, consists of the rate of interest (**i**), the yield on real capital ($\mathbf{r_c}$), and the expected rate of inflation (π). Keynes (1924) wrote that money holding habit of the community:

> ... are fixed by its estimation of the extra convenience of having more cash in hand as compared with advantages to be got from spending the cash or investing it (p.85).

Lavington (1921) wrote that:

> ... Thus, the quantity of resources which he holds in form of money ... yields him a return of convenience and security equal to the yield of satisfaction derived from the marginal unit spent on consumables and equal to the net rate of interest (p.30).

Pigou (1917) stated that movements in the general level of prices were expected to influence money demand. According to him:

> ... If it is expected that the quantity of commodities for which, say, a note of one pound can be exchanged will be greater a year hence, than it is now, the inducement to hold pounds is now increased, and conversely, if it is expected that a pound will buy fewer commodities a year hence, it is diminished (p.169).

These three yields give a clue to the nature of the composition of individual wealth. Therefore, wealth must have consisted of money, bond, real capital goods, including consumer durables, and inventory of commodities. Indeed, no one of the Cambridge scholars brought together all the relevant assets and their respective yields in one coherent theory of portfolio choice. This task was done by other scholars especially Milton Friedman.

Apart from all these factors exerting an influence on money demand function as discussed by the Cambridge scholars, they also mentioned the list of variables discussed by Fisher, namely: habits of the individual, the system of payments in the community, the availability of money substitutes, the density of the population, the system of communication and so forth. They also mentioned the general level of confidence, or mood of the public and the business world, as important factors determining the demand for money, especially that portion held to meet the uncertainties of the future.

Reading through the various works and combining the analyses of the various Cambridge scholars, it is possible to write a general demand function for money in the following manner:

$$M^d = f(W, PY, i, r_k, r_c, U, X) \quad \ldots \quad (2\text{-}3\text{-}3)$$

where; **W** = wealth; **PY** = money income; **i** = nominal interest rate; $\mathbf{r_k}$ = yield on real capital including consumer durables $\mathbf{r_c}$ = yield on commodities; **U** = utility of money; and **X** = all those institutional factors mentioned by Fisher.

It was known a priori that the demand for money was expected to be positively related to **W** and **PY** and negatively related to **i**, $\mathbf{r_k}$ and $\mathbf{r_c}$. Regarding equation (2-3-3) above, as to which of the variables in the function are most significant in explaining the demand for money, little evidence can be provided as to the relative importance of the variables for the scholars did not test their formulation empirically. However, limited work was done and the principal factors explaining the changes in the demand for money was changes in the price level even though, significant changes had occurred in both long term and short term interest rates.

Therefore, it follows that apart from Keynes (1936) in his General Theory, it appears that the Cambridge scholars failed to integrate (even though there is possibility of integration) their money demand function into the classical model. It should be noted that once the demand for money or velocity is made a function of interest rate, a change in either saving or investment, which changes the interest rate, will also change velocity,

V, and money spending, **MV**. Thus, making the demand for money as a function of interest rate serves to integrate the real and monetary sector. However, such an integration and subsequent analysis was not performed.

Pigou, one of the Cambridge scholars, rather made a number of simplified assumptions to show that this version of Cambridge approach to the money demand and that formulated by Fisher achieved the same result. Pigou's reconciliation was to show that the Cambridge "**k**" was the reciprocal of Fisher's **V**. For him to do this, he first assumed that his budget constraint termed "Resources" **(R)** bore some constant relationship to Fisher's volume of transactions" **(PY)**. Thus, the demand function for money in which resources, **R**, the yield on capital, $\mathbf{r_k}$, and the yield on commodities (or the expected rate of inflation), $\mathbf{r_c}$, appear as arguments, could be transformed from:

$$M^d = f(R, r_k, r_c)$$

to $$M^d = f(PY, r_k, r_c) \qquad (2\text{-}3\text{-}4)$$

Taking the expectation about $\mathbf{r_k}$ and $\mathbf{r_c}$ as constant, and assuming that no economies were present in money holding, Pigou specified the demand for money as a constant proportion of money income **(PY)**, that is, constant proportion of volume of transactions:

$$M^d = kPY \qquad (2\text{-}3\text{-}5)$$

where the value of **k** depends upon those variables whose values are assumed constant ($\mathbf{r_k}$ and $\mathbf{r_c}$). Any change in these variables could cause changes in the magnitude of **k** and hence in the proportion of money income the individual desires to hold in a money form. These assumptions, indeed, render the demand for money relationship a more or less short-run construct.

Contrasting the Fisherian and Cambridge approaches to the demand for money theory, it is found that both tend to lead to different definition of money. While Fisherians define money in terms of anything that serves as a medium of exchange in effecting transactions on one hand, the Cambridge scholars stressed the store of value function of money thereby argued for more comprehensive list of assets to be included in the definition of money. Also, Fisherian approach is a flow analysis as it links money holding to the flow of income, while the Cambridge school presents a stock analysis as it links money holdings to the stock of wealth held by the community.

Moreover, Cambridge school emphasized economic variables (wealth) whereas Fisher concentrated on the institutional practices and technological changes which facilitate or impede exchange. Finally, both Fisher and Cambridge school provide the origin for two quite different approaches to monetary theory which have been developed by contemporary scholars. Stressing on the non-synchronization of in-payments and out-payments, Fisher's approach has led to an inventory theory of money holding largely for transactions purposes (i.e., transaction approach). On the other hand, the Cambridge approach has been developed into the portfolio or capital theoretic approach to money demand.

2.3.3 The Keynesian Analysis of Money Demand:

Keynes (1936) analyzes the determinants of the demand for money. In doing this, he explained that the function of the monetary sector is to determine the rate of interest which results from a balancing of the demand for money with the available supply. To him, the rate of interest is purely monetary phenomenon, and its role is to induce people to give up the liquidity of money for the illiquidity of other available assets for wealth holding (in this case, long term bonds). For this reason, Keynes' approach to the money demand is often called the "Liquidity Preference Theory".

According to Keynes, Liquidity Preference or the demand for money, is said to arise from three motives. The first is the long familiar desire for money to make transactions, since in daily life, individual or business income and expenditures are never perfectly synchronized. Therefore, money will be desired to perform the basic function of a medium of exchange. Given society's basic institutional and technical arrangements as discussed by Fisher in his analysis of velocity, the higher the level of money income, the greater the demand for money to make transactions. Under such circumstances, the demand for money may be written as:

$$M_T = k(PY) \quad \text{(2-3-6)}$$

where, $\mathbf{M_T}$ is the transaction demand for money and **k** expresses the fraction of money income, **PY**, society desires to hold as money because society's incomes and expenditures are not perfectly synchronized.

The second general reason for preferring the liquidity of money, Keynes called it the precautionary motive which arises to provide, according to him:

> ... for contingencies requiring sudden expenditure and for unforseen opportunities of advantageous purchases and to hold an asset of which the value is fixed in terms of money to meet a subsequent liability fixed in terms of money...(p.196)

This desire to hold money will be substantially weakened if a highly organized financial exchange exists, for in that case, bonds can be quickly converted into money to meet unforseen contingencies. Keynes argues that since the precautionary demand for money is unrelated to any economic variable in the system, it will be subsumed under the transactions demand.

The third motive considered by Keynes was the speculative motive. This represents the unique contribution of Keynes because Keynes at last provided the reason why a rational man would prefer to hold money rather than interest-bearing assets, especially bonds. On a more theoretical level, Keynes' speculative demand for money finally enable economists to integrate the monetary sector of the economic model with the real sector in a general equilibrium model. In addition, the speculative demand for money has important implications for effectiveness of monetary policy. Within this framework, money is no more neutral or a veil as argued by the classicals. Also, Keynesian framework permits changes in the stock of money to changes in the equilibrium values of real variables.

Keynes, in his discussion of speculative demand for money, explained that individual compares the current rate of interest, $\mathbf{i}_c$, with the rate of interest expected to prevail in the near future, $\mathbf{i}_e$, when deciding whether to hold wealth in money or a bond form. The difference between these two rates will result to a capital gain or loss if the bond (consols) is held. For this reason, it is argued that, in deciding whether to hold bond or money, the wealth owner must not only be concerned with the present interest rate, but with the rate expected to prevail in the near future, for that rate will govern whether a capital gain or loss will accrue as a result of holding bonds. As long as the net yield which consists of the interest rate paid on the bond in addition or subtraction of capital gain or loss, is greater than zero only bonds will be held. If the net yields is less than zero, only money will be held, whereas if it is exactly zero, the individual will be indifferent between bonds and money.

From the analysis above, a demand schedule for speculative balances can be derived for all individuals which will relate money holdings to the current rate of interest. This, according to Keynes, can be done in several steps. First, a maximum critical value of the current rate is selected which will produce only bond holders for the society. This implies that at that value of the current rate and above, everyone in the society will hold only bonds. This current rate of interest is designated as $\mathbf{i}_A$ in Figure 1 below. As this current rate is lowered, individuals will then diversify their portfolio by holding money and bonds in order to avoid net loss. So, at the current interest rates $\mathbf{i}_B$ and $\mathbf{i}_C$, these individuals will hold $\mathbf{M}_0$ and $\mathbf{M}_1$ amount of speculative balances respectively.

As a part of the deviation of the speculative demand schedule, Keynes supposed some minimum value of the critical interest rate to exist above which everyone's critical rate would lie and this is represented by $\mathbf{i}_D$. At this rate everyone becomes a money holder, for holding bonds means a net loss. So, at $\mathbf{i}_D$ the demand for speculative balances become absolute-infinitely elastic. This portion of the demand schedule is the

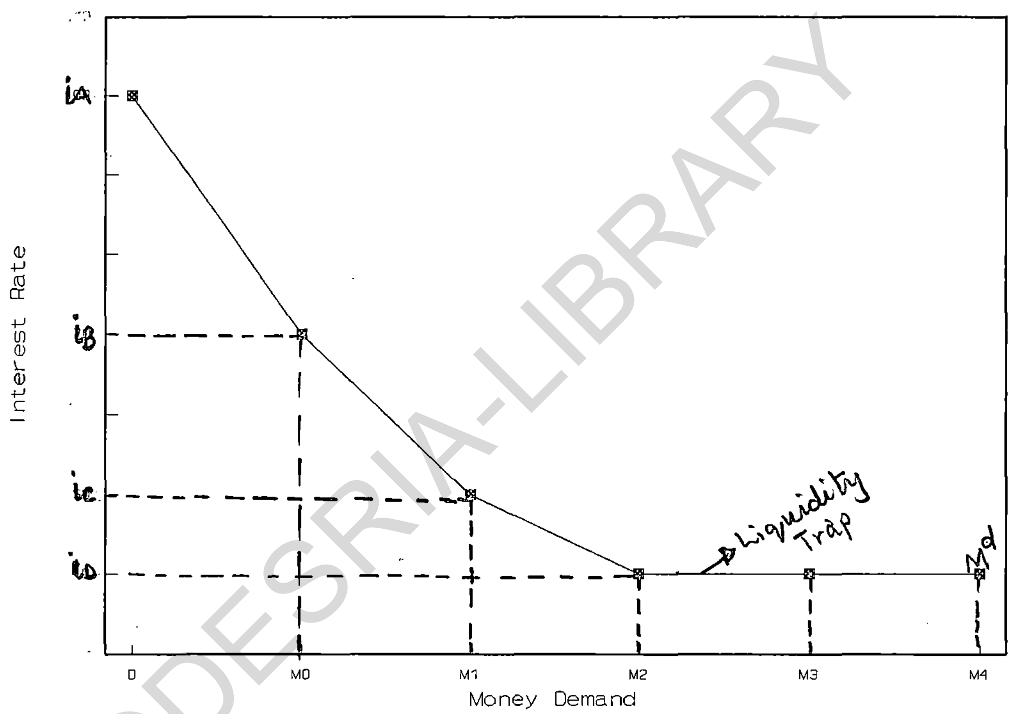

Fig.1: The Demand Schedule For Speculative Balances

familiar liquidity trap and has played a rather prominent role in the early monetary policy implications drawn from the General Theory. Linking all the various points we obtain the speculative demand for money curve which is depicted in the Fig.1 above.

Combining the transactionary, precautionary and speculative demand for money, Keynes' demand for money can be written in linear form:

$$M^d = L_1(Y) + L_2(i)$$

or $$M^d = f(r_B, PY) \quad \text{(2-3-7)}$$

or $$M^d = f(r_B, r_e, PY)$$

Therefore,

$$M^d = f(Y, i) \quad \text{(2-3-8)}$$

where **Y** is the level of income and **i** is the nominal interest rate.

The a-priori expectation is that the demand for money is positively related to the current level of income while it is inversely related to the nominal rate of interest.

At this juncture two additional aspects of the speculative demand schedule should be considered; first, what determines its overall elasticity and second, is the function stable? Even though elasticity depends upon the divergent opinion among wealth holders as to their critical rate in current period, the ultimate resolution of the elasticity question must rest upon empirical studies. In general, however, empirical works' results suggest that the interest elasticity of money demand is low. According to Makinen (1977):

> Available information suggests an elastic range of -0.12 to -0.17, when short term rates are used and a range of -0.12 to -0.80, when long term rates are used (p.143).

The stability of the schedule is seldom discussed and its importance is not fully recognized by many Keynesians. Notwithstanding, when the speculative demand schedule was derived, it was assumed that each wealth holder had in mind an expected future rate towards which the current rate would move in the near future, but expectations about future rates are far from static. Depending upon how they are formed, they may be in a constant state of revision upward or downward. Keynes' theory implies that they are in a state of change and can even be influenced by announced policies of the monetary authority. The $\mathbf{L_2(i)}$ above which represents speculative demand for money explicitly introduces some uncertainty specifically about one particular variable (i.e., the future yield on bonds). Thus, volatile expectations might cause parameter instability. Also, expectation formations may be such as to cause a highly elastic response of money holdings to a small change in interest rate.

A. Extensions of Keynesian Analysis: Capital Theory Applied to the Transactions Demand:

As presented by Keynes, the aggregate money demand rested upon two primary determinants: a transactions motive and a speculative, or asset, motive. These combination of motives, however, represented an unfortunate and inconsistent union of two quite different approaches to monetary theory. The transactions demand was made to depend upon the technical and institutional customs and practices in a community which governs its receipt of income and subsequent flow of expenditures. For convenience, it was assumed that these customs and practices would change gradually over time so that the relationship of money holding to income could be assumed to be constant and linear. Keynes, thus, assimilated into his monetary theory the classical tradition normally associated with the work of Fisher.

On the other hand, in developing the speculative or asset demand for money, Keynes used the portfolio or capital theoretic approach which is built upon an analysis of utility, budget constraint and opportunity cost. Combining these two quite different approaches to monetary theory under the general label of liquidity preference created an unsettled state of affairs for many monetary economists who preferred a more uniform application of methodology to the demand for money. Also, speculative theory of money demand rests on unrealistic composition of the portfolio of assets held by the individuals. Individual's portfolio would consist of combination of various assets including money and not two-asset portfolio (i.e., not a plunger).

Several attempts have been made to rectify this inconsistency. First, there is a tendency to blur the sharp distinction between motives for holding money balances emphasizing instead that money is held for many purposes and that the amount held is sensitive to various economic variables notably; income, vector of interest rates, expectation of commodity price changes and so on. Second, Baumol (1952) and Tobin (1956) applied the capital theoretic or portfolio analysis to the transactions demand, thereby making consistent the methodology applied to the total demand for money.

Following the general outlines of the Baumol-Tobin approach, in applying capital theory to the transactions demand for money, money balances held to make expenditures are considered a sort of inventory and the goal of the individual is to minimize the costs associated with money holdings. The first cost is the one associated with both monetary and non-monetary, that is, the fee necessary to sell bond on an organized financial market and physical exertion and inconvenience involved in making the conversion. Both expenses are called the brokerage fee. The second cost is applicable to the loss of interest which the individual could have earned by holding his wealth in bond form rather than liquid money.

It is generally assumed that in order to compute his optimum inventory of money, the individual has given uniform expenditure to make over a given time period, denoted as **Y**. As we know, each conversion of bond to cash will involve a brokerage fee, as explained above, and the total brokerage fee will be equal to the number of conversion in money **(Y/M)** multiplied by the brokerage fee **(b)** where **M** symbolizes the amount of bonds converted into money and **b** is the brokerage fee per conversion. Also, every time bonds are converted into money, the individual foregoes interest income and the total interest income foregone over the expenditure period is equal to the average money holding per conversion **(M/2)** times the interest rate applicable to the expenditure period **(i)**.

From this analysis above, it follows then that the problem posed to the individual is to minimize the sum of these two costs, denoted as **C**, associated with his money holding over the expenditure period.

$$\text{Min } C = (Y/M)b + (M/2)i \quad \ldots\ldots\ldots\ldots \quad (2\text{-}3\text{-}9)$$

Differentiating **C** with respect to **M**, and setting the result to zero we have;

$$\frac{dC}{dM} = -\frac{Yb}{M^2} + \frac{i}{2} = 0$$

$$Yb/M^2 = i/2$$

$$M^2 = 2Yb/i$$

$$M = \sqrt{2Yb/i} \qquad \text{(2-3-10)}$$

Equation (2-3-10), therefore, implies that the nominal money holdings for the cost minimising individual will vary directly with the square root of planned nominal expenditures and inversely with the square root of the market rate of interest.

The implications of the Baumol-Tobin model are several. First, the demand for real cash balances **(M/P)**, will rise by less than the rise in real income (or real expenditures), implying both that substantial scale economies exist in holding money balances, and that in the terminology of micro theory, money is necessity. Second, the demand for real balances is invariant with respect to changes in the price level and, therefore, inflation can only affect the demand for money by altering the rate of interest. Finally, no doubt should exist that the transactions demand has been formally recognized on a methodological level with the speculative demand, for now the individual, in deciding whether to hold wealth in a money or bond form for transactions purposes, must consider (among other variables) the market rate of interest. This permits the demand for real money balances to be written in one general functional form as:

$$M^d/P = f(Y/P, i) \qquad \text{(2-3-11)}$$

2.3.4 Modern Theories of Money Demand:

The specific theory addressed here is the portfolio approach to money demand. This theory has earlier been discussed as the Cambridge or Cash-balance formulation of the quantity theory of money and consists of the application of micro-demand analysis to the specific commodity called money. As developed by the Cambridge scholars, the cash-balance approach explains the factors determining the optimum portfolio of assets. The unsatisfactory affairs found in Keynes' approach; the highly aggregated state of assets (only money and bonds), the result that individual hold either all money or all bonds in their portfolios, and the combination of two quite different approaches to monetary theory was corrected by Tobin.

Hicks (1935, 1939) presented a specific application of general demand analysis, or asset theory, to money. As such, he sets forth the marginal productivity of money, the nature of the opportunity cost, the budget constraints, and how changes in each ought to affect the demand for money. An extensive list of assets, is set forth by Hicks which includes consumption goods (both durable and non-durable), money; bank deposits, short term and long term debts; stocks and shares; and productive capital.

The other contributions to the portfolio approach are also noteworthy here. The first is Makower and Marschak (1938) who applied such concepts as time, imperfect competition and uncertainty to explain the holding of the stock of money in a general equilibrium framework which includes other assets. The second is an attempt by Markowitz (1952) who applied the concept of risk, as represented by the variance and the expected rate of return from an asset to explain the holding of a diversified portfolio.

The notion that wealth holder must consider both the expected rate of return from an asset and the variance in that rate of return, if diversified portfolios are to be explained, represents a major theoretical contribution which was later considered by Tobin using curves and budget lines.

2.3.5 The Neo-Quantity Theory of Money Demand:

The modern quantity theory has its origin in the work of Friedman who introduced an elegant elaboration of the portfolio approach which, like Tobin, intended to amend the shortcomings found in Keynes' theory. Friedman (1956) does not ask what motives for holding money are but rather, given the fact that money yields utility, he asks what factors determine how much money people desire to hold. However, in contrast to utility theory as usually applied to the demand for goods in economic theory, Friedman applies utility theory to the demand for money in a rather loose version. Here, no explicit function is posited and other variables in the utility function are not analyzed. He also discusses the utility function and budget constraint in a very general terms. He merely notes that there will be diminishing marginal utility for money and that a whole host of financial assets, liabilities and real assets may provide alternatives to holding money and thus will appear as arguments in the utility function.

As regards the budget constraint, the maximum amount an individual can convert into money consists of his net financial asset or wealth (that is, gross financial wealth less his financial liabilities) and his physical wealth held in the stock of housing and consumer durables. In addition, the individual has human wealth in the form of discounted value of his future labour income. So in principle, wealth should include human wealth but social convention and the existence of uncertainty concerning the future limit the extent to which the individual may exchange future labour income for increased money holdings.

Some substitution is possible as the individual may use some of his non-human wealth to purchase education and thereby increase his future human wealth. Friedman is able to circumvent the problem of the illiquidity of human wealth by accepting that the demand for money should depend on total wealth (that is, non-human wealth plus human wealth) but because of the illiquidity of human wealth, he also includes the ratio of human to non-human wealth as a determinant of demand for money.

Having established wealth as the variable in the budget constraint, Friedman then considers the yields on alternative assets to money. In general term, the alternative to holding money consists of holding near money such as building society deposits, long term bonds (perpetuities or consols), stocks, equities, shares, real assets such as consumer durables and housing, and in the case of firms, capital equipment. To Friedman, the rate of inflation will influence the demand for all financial assets. A higher rate of inflation encourages a substitution into real assets. So, a higher rate of inflation increases the return to be obtained from holding real assets and decreases the money holding.

In Friedman's formulation of the demand for money, he expresses the demand for money in real term as:

$$M^d/P = f(r_i, Y^p, h, \pi^e) \quad \ldots\ldots (2\text{-}3\text{-}12)$$

where **h** is the ratio of human to non-human wealth; $\mathbf{r}_i$ is the vector of interest rate (that is, yields on alternative assets to money holding); $\mathbf{Y}^p$ is a measure of total wealth usually referred to as permanent income; while π^e is the expected rate of inflation. We expect that:

$f'Y^p$, $f'h > 0$ and $f'\pi^e$, $f'r_i < 0$ . . . . (2-3-13)

2.3.6 Conclusion:

Considering our discussion above, the theory of demand for money can be categorized into two, viz; transactions or inventory theoretical and portfolio or asset theories. Empirically, money demand function often employed is of the form:

$(M/P) = f(y, r)$ . . . . 2-3-14)

Considering linear semi-log specification, equation (2-3-14) becomes, in explicit form:

$\ln(M/P)_t = a_0 + a_1 \ln y_t - a_2 r_t + \mu_t$ . . . . (2-3-15)

where **M** is the nominal stock of money; **P**, the price level or GNP deflator; **y**, the real income; **r**, a market rate of interest, μ, the stochastic term; **t**, time period; and **ln**, natural logarithm.

In equations (2-3-14) and (2-3-15) above, if **y** represents the transaction volume and **r** is the opportunity cost or alternative forgone of holding money, then the model in equation (2-3-15) becomes transaction model or inventory theoretical money demand function. Baumol-Tobin inventory theory of money demand function is prominent in the theory of money demand function since their model centres on transaction demand for money.

According to the transactions theory, money is regarded as a medium of exchange which is held as inventory for transactions purposes. The justification for holding money comes from non-synchronization of expenditures and incomes flows and uncertainties concerning business world. Indeed, income is being received in less frequent intervals than expenditure. Even though, other liquid assets pay higher yield than money, the transaction costs involved in converting them into money (cash) whenever expenditure is necessary or required justifies money rather than asset holding. The money demand function is, therefore, expressed as:

$$M1 = f(PY, i) \quad \ldots\ldots\ldots\ldots\ldots \quad (2\text{-}3\text{-}16)$$

where value of transactions and yields are the appropriate scale variables.

Thus, under this transactions theory, the aggregate money holding is said to be an increasing function of the level of total transactions in the economy while it would be a decreasing function of the return on alternative assets, (here, time or savings deposits, government securities or stocks etc). The real or opportunity cost of holding liquid cash (money) is interest forgone by not holding these alternative assets. Under this theory, therefore, money balances would refer to the amount of the transaction media (i.e., narrow money which is defined in Nigeria as currency plus demand deposits or M1 for short).

If **y**, on the other hand, is the measure of permanent income and **r** is the vector of multiple interest rates on money and other financial assets, then equation (2-3-15) becomes a portfolio-selection money demand function. Friedman (1956) focuses on the portfolio demand for money but also includes expected rate of inflation and the ratio of human to non-human assets as an explanatory variables.

Indeed, asset or portfolio money demand treats money as a store of value i.e., money demand is regarded as one of the alternative forms of holding wealth or asset given that each of the various alternative assets yields a mix of income (such as interest and capital gains), and service flows (such as liquidity and convenience of making transactions in case of money). Money is, therefore, treated as one of the various assets in economic agent's portfolio. In this case, the demand for money function becomes a portfolio optimization problem, where economic agents decide or choose the composition of their portfolios to maximise the returns on them. For this reason, a more detailed specification of the yields on the alternative assets than the transactions model to money demand is required. Indeed, total wealth and not transactions, is the appropriate scale variable in such models while a broader definition or measure of money, which includes less-liquid deposits is required (i.e., M2 in the case of Nigeria).

From the above discussion, it is obvious that sufficient distinctions exist between transactions and portfolio demand for money to justify their separation in empirical modelling of money demand. However, this study is concerned with the portfolio demand for money in Nigeria.

CHAPTER THREE

RESEARCH METHODS AND TECHNIQUES

3.1 Introduction:

Traditionally, a number of issues are distinguished in macroeconomic modelling: specification, data collection, estimation and validation of model. Paying maximum attention to this set up, economic theorists had deduced how optimising agents would behave in all aspect of economic life and hence what interdependencies should exist between observable variables. Economic statisticians had designed and implemented measurement systems for national accounts so that the appropriate data series had been collected and collated. Econometricians had also estimated and tested empirical counterparts of the economists's theories on these data by using econometric techniques.

While various attempts at empirical macroeconometrics were based on the view of the "conventional" approach to econometrics, progress in econometric theory and computing had led to the development of more powerful estimators (like those we are going to employ in this study), the application of which to the already known economic structure would produce more efficient estimates of the parameters of interest and hence, better forecast and policies. Therefore, in this chapter, the theory of estimation method which gives rise to a selection of estimation technique adopted is greatly considered. Indeed, we shall discuss the traditional techniques applied to most demand for money in general and some modern methodological approaches to econometric model buildings.

3.2 Traditional Approach to Money Demand Function:

It has become common for economists to express or discuss a theory in terms of an equation or a set of an equations. Tinbergen (1951) explains that:

> The first thing to be done in any particular application is to give a correct economic analysis of the relation to be investigated... Two things should be done: first, the necessity to know exactly what relation one is interested in and second, to know what factors should be the correct relation (p.207).

In specifying the empirical money demand function, income or wealth, the rate of interest and the price level have traditionally been viewed to be the principal determinants. The long run or steady-state money demand can therefore be represented by the relation:

$$M_t^* = \alpha_0 + \alpha_1 Y_t + \alpha_2 R_t + \alpha_3 P_t + e_t \quad \text{(3-2-1)}$$

where $\mathbf{M}^*$ represents the desired nominal stock of money balances; defined in either a narrow or broad sense; **Y** is some measure of income or wealth which acts as the scale or constraint variable; **R** is the opportunity cost of holding money as represented by the interest rate or rate of return on an appropriate alternative asset; and **P** is the price level.

While variables specified in equation (3-2-1) represent long run determinants of desired money balances, the presence of $\mathbf{e}_t$ is to capture the gaps (differences) between the actual money balances and the values suggested by the explanatory variables (i.e., **Y**, **R** and **P**) in short run. The residual term, **e**, captures the effect of all other influences upon **M**, while α_0, α_1, α_2 and α_3 are the parameters of the equation. It follows therefore that $\mathbf{e}_t$ is independent implying it is stationary with zero mean and constant variance (i.e. $\mathbf{e}_t \sim \mathbf{N(0,\delta^2_e)}$.

A prominent feature of econometric models of money demand is the use of the conventional Partial Adjustment (PA) or Adaptive Expectation Mechanism to "transform" equilibrium structure into dynamic ones. We talk about adjustment mechanism when the actual level of a variable is not the same with the desired level (hence, the estimation of speed of adjustment is important here). Usually, the essence of partial adjustment model is that actual balances held, in any time period, may not necessarily equal desired long run holdings, as given by equation (3-2-1). This situation arises because of inertia habit persistence, transaction and information costs, expectation processes and adjustment cost (Courakis, 1978). It, therefore, becomes necessary to specify some form of short run adjustment mechanism by which actual balances move towards desired holdings.

The simple partial adjustment mechanism, described by either the real {Chow (1966) and Goldfeld (1973)} or nominal {Goldfeld (1976)} partial adjustment model, assumes that the change in money holdings, between two periods, is a constant fraction of the discrepancy between desired balances in the current period and actual holdings in the previous period. We can write these mechanisms as:

$$m_t - m_{t-1} = \Theta(m_t^* - m_{t-1}) \quad (3\text{-}2\text{-}2)$$

$$M_t - M_{t-1} = \Theta(M_t^* - M_{t-1}) \quad (3\text{-}2\text{-}3)$$

where $\mathbf{m_t}$ is real money, $\mathbf{M_t}$ is nominal money and $\mathbf{\Theta}$ is the partial adjustment parameter. Combining the nominal adjustment model in equation (3-2-3) with desired money holdings in equation (3-2-1), the short run money demand equation becomes:

$$M_t = a_0 + a_1Y_t + a_2R_t + a_3P_t + (1-\Theta)M_{t-1} + e_t \quad (3\text{-}2\text{-}4)$$

where $\mathbf{a_0} = \mathbf{\Theta}\alpha_0$, $\mathbf{a_1} = \mathbf{\Theta}\alpha_1$, $\mathbf{a_2} = \mathbf{\Theta}\alpha_2$, $\mathbf{a_3} = \mathbf{\Theta}\alpha_3$ and $\mathbf{e_t} = \mathbf{\Theta e_t}$.

Usually, this method incorporates lagged values of the endogenous variable (here money demand variable) to represent lags in economic agents's responses to economic stimuli. The specification in equation (3-2-4) known in literature as first order lags is, therefore, often employed. In such empirical models, important explanatory variables are often omitted and/or accurately proxied by the lagged dependent variables.

In view of the nature of economic behaviour any realistic formulation of economic models should, therefore, involve some lagged variables among the explanatory variables. Lagged variables are one way of taking into account the length of time in adjustment processes of economic behaviour and perhaps, the most efficient way for rendering them dynamics. Lagged models have become increasingly popular in applied econometric research. In short, lagged models offer much flexibility to the formulation of models of economic behaviour.

However, most traditional empirical studies on money demand function have typically specified their lagged structures, as a simple process of partial adjustment by arbitrary yet unwitting imposition of severe restriction on the models' lag structure prior to estimation. Even though these models' performances usually appeared satisfactory to an extent in explaining past money developments, the problem is that out-of-sample forecasts based on these models in most cases yielded inadequate results. This led to new theorising in econometric modelling.

Recent version of the demand for money function postulates that the current level of money balances depends on the past levels of money balances and both the current and past levels of the regressors. According to Hacche (1974):

> The desire money balances are a linear function of both current and lagged values of the appropriate explanatory (and independent) variables...(while) actual money balances adjust towards desired money balances with a lag such that a constant proportion (which is to be estimated) of any remaining adjustment towards equilibrium is accomplished in each quarter (p.285).

The version, which is data-based dynamic specification, and known in literature as Auto-regressive Distributed Lag (ADL) model of money demand function is expressed as:

$$M^d_t = \alpha_0 + \Sigma\alpha_i M^d_{t-i} + \beta_0 Y_t + \Sigma\beta_j Y_{t-j} + \phi_0 R_t + \Sigma\phi_k R_{t-k} + e_t \quad \ldots\ldots \quad (3\text{-}2\text{-}5)$$

is often adopted. The more general distributed-lag models involve a high degree of empirical study which is due to the unsatisfactory state of economic theory with regards to the length of the adjustment processes of economic phenomena. Economic theory, even where it recognizes the importance of time lags, never suggests the precise number of lags that should be included in a function. Researchers experiment with models including different lag patterns; geometric lags, arbitrary lags, polynomial lags, compound geometric lags, etc., and choose among them the one that gives most satisfactory fit on the basis which is mainly statistical criteria.

While it seems naturally and superficially appealing to researchers to run countless regressions and attempt to choose that which appears to be the best model, this approach has been widely criticized as failing to provide credible results. Indeed, in the mid-1970s, first order partial adjustment and Auto-regressive Distributed Lag (ADL) models began to loose their adequacy in explaining developments in money demand as major divergences emerged between the forecast and actual values. Hacche (1974) however, explains that:

> there may be evidence of mis-specification in (which) case the structure of the equation should be modified (p.298).

Following Hacche's argument, attempts were made to rectify the situation. Such efforts include an attempt to improve the explanatory power of the conventional functions by the inclusion of new explanatory candidates such as wealth, dummy variables and attempt to incorporate the explicit impacts of financial deregulation into the function. Within the standard theoretical models of partial adjustment or adaptive expectations all these approaches failed as vast majority of the specifications presented to explain past episodes of apparent money demand instability achieved only limited success in predicting future money demands (see Roley, 1984). This led to new perspective/revolution in modelling time series.

3.3 Recent Developments in Econometric Methods Applicable to Money Demand:

Earlier empirical studies on money demand functions, as noted, have depended solely on Partial Adjustment (PA) and its refinements. However, since the end of 1970s, these methods to empirical studies have invited serious criticism led by the time series econometricians. On the theoretical grounds, time series are more appropriate for estimation of economic relationships such as money demand. Indeed, the use of time series models and techniques has become widespread in econometrics (i.e., research studies). However, in practice, we find that there are many problems associated with time series as recent studies are gradually identifying major defects in the conventional approach to regression analysis with time series data, the most important being the problem of intercorrelation of the explanatory variables (i.e., serial correlation) which tends to change contemporaneously over time.

Widely acknowledged is the work of Davidson et al. (1978) on modelling aggregate consumption in the United Kingdom which has had an important influence on the way many econometricians now use time series data to model economic relationship. Some of the strands of their analysis have since received considerable attention which in turn has led to the development of new econometric approaches and ideas. These new developments include: general to specific modelling; cointegration and encompassing which are all relevant for time series rather than cross-section analysis.

The statistical analysis that follows the majority of statistical procedures which are designed to be used with data originating from series of independent experiments or survey interview is largely concerned with making inferences about the properties of the population from sample. Given this type of data, the order in which the sample is presented to the statistician is irrelevant. This is not the case given time series data. A time series is a sequence of values or readings ordered by a time parameter such as monthly Gross National Product (GNP), quarterly Money Supply (M^s), annual interest rate (R) etc. Since the order of the data is now of considerable importance, most of the classical statistical techniques are no longer relevant and so new techniques have to be devised.

In applied studies, the degree of reliance on time series models is extremely variable. However, it is important that any time series method used in research study should be adequate and appropriate for its intended purpose. The contention of Pagan (1985) that the interpretation and formulation of dynamic specifications is inextricably bound up with the nature of time series used in modelling exercise seems pertinent.

Past regression analyses on money demand were often run without a thorough examination of the characteristics of time series economic data. Granger and Newbold (1974) argue that applying the traditional or conventional econometric approach raises the possibility that the regression may be "spurious". An important feature of time series models that have been considered in many research studies on money demand is that the series are stationary under the null hypothesis. Accusations that some of them are spurious regressions, despite an excellent fit between unrelated variables (particularly when levels of the variables are used in the regression) is, therefore, a difficult task.

However, this assumption of stationary is too restrictive in the sense that series actually employed in research studies are in some way non-stationary. Aside, these regressions using time series to determine economic relationships often give highly correlated residuals which can bias conventional hypothesis tests. Courakis (1978) points out that such approximation and assumption of stationarity can create econometric complications if no regard is paid to the properties of the residual term. For instance, their independence property may be lost and this should be taken into consideration in the choice of estimation method. Indeed, it is possible that the appropriate model has been specified but that this "true" model exhibits autocorrelated disturbance terms.

There has recently been a great deal of interest in the case in which the null hypothesis is that series actually employed in modelling have Autoregressive (AR) components with unit roots and so non-stationary in levels. In this case we cannot assess the accuracy of our estimates simply because there is tendency towards indeterminacy and instability of the coefficients of the relationship. Recent discussion in econometrics theory and practice have focused more attention on the properties of time series data typically employed in regression analysis. Nelson and Plosser (1982) observe that a great number of time series employed in econometric analysis are non-stationary i.e., they have a persistent tendency to increase or decrease over time. Indeed, recent discussion has turned to the properties of stochastic time series, focusing on the concept of stationarity and non-stationarity.

3.3.1 Stationary and Non-Stationary Series:

Most of economic time series consist of readings taken at predetermined equal-interval time points so that one might get hourly, daily, monthly, quarterly and annually readings\values. Such data form a discrete time series, denoted by $\mathbf{y}_t$ as distinct from a continuous time series, denoted by $\mathbf{y(t)}$ in which it is possible to take measurements at every moment of time. The initial objective of time series analysis is to make inferences about the properties or basic features of the stochastic or random process from the information contained in the observed series. The first step in the analysis is usually to form certain summary statistics, but the eventual aim is to construct a model from the data; a model that is hoped has similar properties of those of the generating mechanism of the stochastic process.

Thus, when a model has been obtained it can be used either to test some hypothesis or theory about the generating mechanism of the process, and can be used to forecast future values of the series and it may be used to decide on a system of controlling future values. To fully characterize random variables, one needs to specify distribution function. If the process is assumed to have normal distribution for every set, then the mean and variance or covariance will be sufficient for a complete characterization of the distributional properties of the process. If, on the other hand, normality is not assumed, but if the generating process is taken to be linear, in the sense that the process is generated by a linear combination of past and present values of other process, again the major properties of the process are captured in the means and variances.

In the literature, the concept of time series is often used alongside the concept of a stochastic process. If we understand the time series to be single realization of a stochastic process, then it is necessary to start with a description of some elementary concept of stochastic process and time series analysis. By stochastic process we mean a family of real-valued random variable (say **y**) index by "**t**" (i.e., $\mathbf{y}_t$, where **t** represents time).

A stochastic process is said to be stationary (or more precisely, is stationary in a strict or strong sense), if the joint and conditional probability distributions of the process are unchanged if displaced in time. That is, a stochastic process $\mathbf{y}_t$ is said to be stationary if:

$$E(y_t) = \mu = \text{constant}$$

$$var(y_t) = \delta^2 = \text{constant} \quad \ldots\ldots\ldots\ldots\ldots \quad (3\text{-}3\text{-}1)$$

and $cov(y_t,y_{t+1}) = \delta_i$

Thus, the means and variances of the stationary process are constant over time, while the value of the covariance between the two periods depends only on the gap between the periods, and not the actual time at which this covariance is considered.

If one (or more) of the conditions in equation (3-3-1) above is not fulfilled, the process is said to be non-stationary. However, non-stationary of time series has always been regarded as a problem in econometric analysis. It has been shown in a number of theoretical works that, in general, the statistical properties of regression analysis using non-stationary time series are dubious (Phillips, 1986). We can then indicate that if series are non-stationary, one is likely to finish up with a model showing promising diagnostic test statistics even in the case where there is no sense in the regression analysis.

The simplest model of non-stationary series is the random walk (i.e., each successive change in y_t is drawn independently from a probability distribution with zero mean and constant variance. Thus, the process, $\mathbf{y_t}$, is determined by:

$$y_t = y_{t-1} + e_t \quad \ldots\ldots\ldots\ldots\ldots \quad (3\text{-}3\text{-}2)$$

with $\mathbf{e_t \sim N(0,\delta^2_e)}$ and $\mathbf{E(e_t,e_s) = 0}$, for $\mathbf{t \neq s}$, where $\mathbf{e_t}$, the error term stands for the combined influence of other variables omitted from equation (3-3-2), none of which is individually important enough to be explicitly included. In equation (3-3-2) above, the forecast value for "l" period ahead is the same as the forecast value for one period (i.e.,

$\hat{y}_{t+1} = \hat{y}_{t+l} = y_t$) but the variance of the forecast error will grow as **l** become larger. For one period ahead it is δ^2_e, while it is $l\delta^2_e$ for **l** period.

A simple extension of the stochastic process above which is another example of non-stationary series encountered in time series analysis is the random walk with drift. This process accounts for a trend (upward or downward) in the series y_t thereby allows us to embody that trend in our forecast. In this process, y_t is determined by:

$$y_t = d + y_{t-1} + e_t \quad \ldots\ldots\ldots\ldots\ldots\ldots \quad (3\text{-}3\text{-}3)$$

so that on the average, the process will tend to move upward (for $d > 0$). For one-period forecast, $y_{t+1} = y_t + d$ and l-period forecast is $y_{t+l} = y_t + ld$ while the variance of the forecast will be the same as before.

Another example of a developing tendency in a non-stationary stochastic process is where the mean of the process is itself a specific function of time. If such function is a linear then the simplest extrapolation model called the linear trend model is given as:

$$y_t = d + \alpha t + y_{t-1} + e_t \quad \ldots\ldots\ldots\ldots\ldots\ldots \quad (3\text{-}3\text{-}4)$$

In all these expressions, it has been assumed that the expected values of e_t are zero and that the stochastic process e_t is white noise, but these conditions may be relaxed to allow for autocorrelation in the series of e_t. If residuals (e_t) are autocorrelated, the processes (3-3-2) to (3-3-4) can no longer be called random walks. Notwithstanding, variable y_t will still be non-stationary.

The contrast between stationary and non-stationary series can be illustrated in term of Figure 2 and 3 below. Both series are cases of a simple Autoregressive (AR) model of the form:

$$y_t = \beta y_{t-1} + e_t \; ; \quad y \equiv 0 \quad \ldots\ldots\ldots\ldots\ldots\ldots \quad (3\text{-}3\text{-}5)$$

A stationary series is one where $|\beta| < 1$, have a finite variance, transitory innovations from the mean, and a tendency for

the series to return to its mean value. In fact, stationary series are generally less smooth with more obvious fluctuations. This can be clearly seen from Figure 2. Consequently, the mean value of stationary series is independent of time, and thus, intuitively, no matter at what point in its history the series is examined we would always recover the same information about its structure (in a probabilistic sense). In contrast, the non-stationary series is one where $|\beta| \geq 1$, has a variance which is asymptotically infinite, and the series rarely crosses the mean (in finite sample), and innovations to the series are permanent. A special case of class of non-stationary is where $|\beta| = 1$ which is known as random walk and expressed as:

$$y_t = y_{t-1} + e_t$$

or $$\triangle y_t = y_t - y_{t-1} = e_t \quad \ldots\ldots\ldots\ldots\ldots\ldots \quad (3\text{-}3\text{-}6)$$

In summary, a series is said to be stationary if and only if it has a constant mean and constant finite variance while it is non-stationary if it has time-varying mean and variance. Thus, a time series $\mathbf{y_t}$ is stationary if its mean $\mathbf{E(y_t)}$ is independent of time and its variance, $\{\mathbf{E(y_t - E(y_t)}\}^2$ is bounded by some finite number and does not vary systematically with time. A stationary series will tend to return to its mean with the

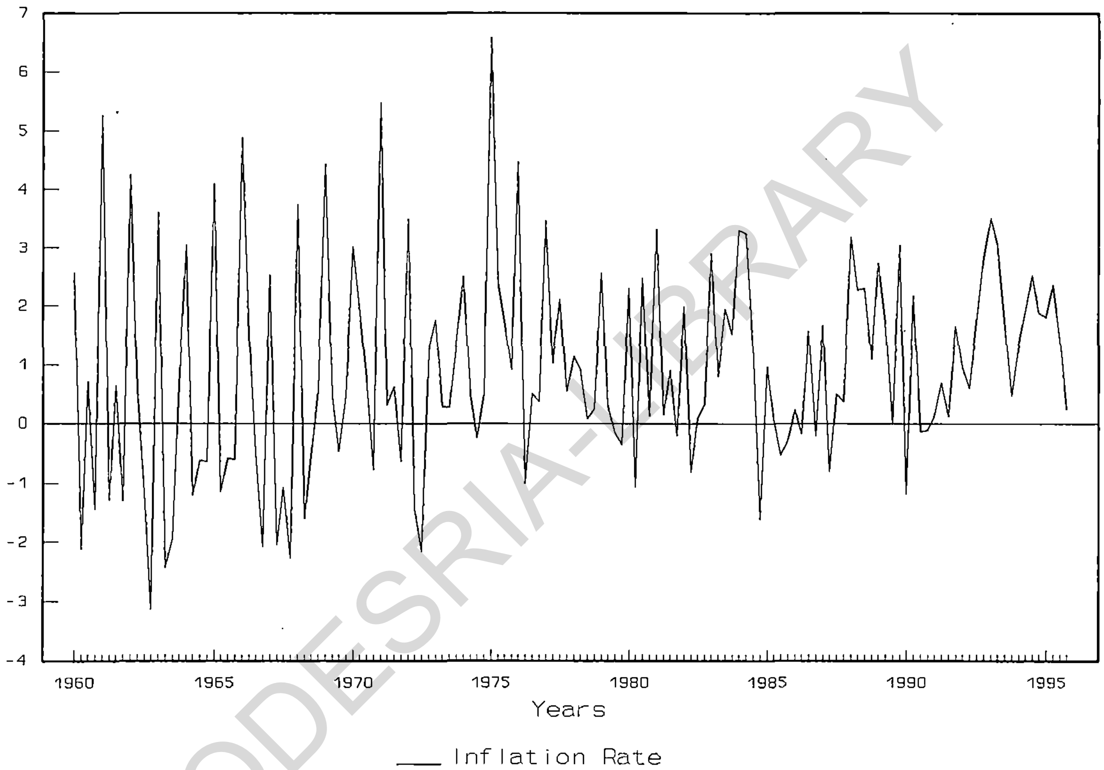

Fig.2: Stationary Series $\{y \sim I(0)\}$

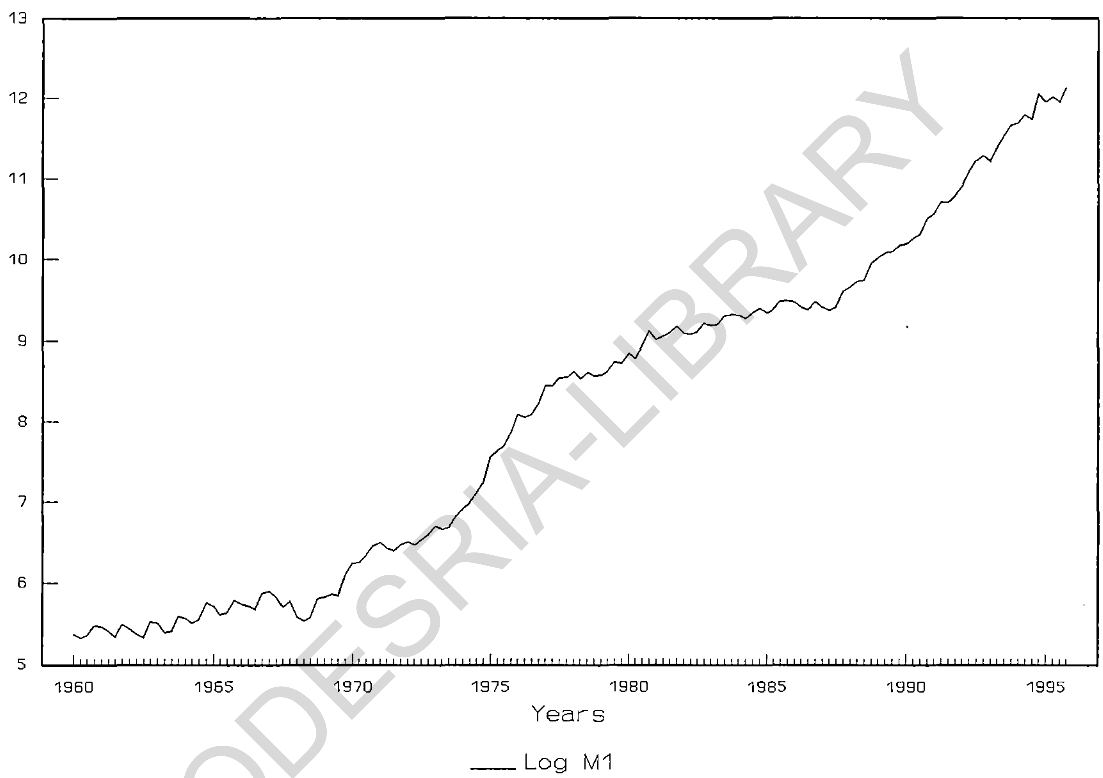

Fig.3: Non-Stationary Series {y ~ I(1)}

fluctuation around this having a constant amplitude while non-stationary series will diverge completely from its mean and cannot be referred to without making reference to some particular time period.[1]

Therefore, in time series analysis, the properties of each series must be clearly identified. When all the data series are stationary, we can confidently and conveniently apply estimation technique such as the Ordinary Least Square (OLS) method. When non-stationary variables are to be included in a regression, it is generally recommended that first difference form be used in order to transform such series into stationary. This leads us to the order of integration of variables and unit root tests.

3.3.2 Integrated Variables and Unit Root Tests:

The properties of stationary series, denoted as I(0) are quite unlike those of non-stationary series, denoted as I(1). An I(0) series, as discussed in section 3.3.1, has a constant mean and variance while an I(1) series has a variance and mean that change with time. While I(0) series will be seen to return to the mean value often, an I(1) series will rarely revert back to any particular value, including its starting point.

Most empirical time series exhibit variation that changes in both the mean and dispersion in proportion to absolute level of the series. For instance, as the narrow money demand (M1) series (depicted in Figure 3) evolves through time, it is quite evidenced that both mean and variance increase. While application of the difference

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[1] see Engle and Granger (1987) and Pagan and Wickens (1989) for useful discussion of the differences between stationary and non-stationary series.

operator frequently removes a time-dependent mean, it has little effect on stabilizing the variance of the empirical time series.

Before any sensible regression analysis can be performed, it is highly essential to identify the order of integration of each time series (variable), provided of course, that the variable can be transformed into a stationary variable through differencing. A non-stationary series which can be transformed to a stationary series by differencing **d** times is said to be integrated of order **d**. This implies that an observable time series variable, $\mathbf{y_t}$, is said to be integrated of order **d**, denoted by $\mathbf{y_t \sim I(d)}$, if $\triangle^d \mathbf{y_t}$ is stationary (where $\triangle$ = first difference operator i.e., $\triangle$ = **(1-L);** $\triangle \mathbf{y_t = y_t - y_{t-1}}$).

It follows, therefore, that $\mathbf{y_t}$ has to be differenced **d** times before it becomes stationary. A stationary series is, thus, integrated of order zero, I(0) (i.e., no differencing is necessary) while I(1) series will need to be differenced once to become stationary. The same holds for an I(2) series which will need to be differenced twice to become stationary. This implies that the first differences of the first differences of $\mathbf{y_t}$ (which is termed second order differencing) is stationary. i.e.,

$$\triangle^2 y_t = \triangle\triangle y_t = \triangle(y_t - y_{t-1}) = y_t - 2y_{t-1} + y_{t-2} \quad \ldots\ldots\ldots\ldots \quad (3\text{-}3\text{-}7)$$

It has been assumed in most studies that time series are stationary so that $\mathbf{y_t \sim I(0)}$. However, Nelson and Plosser (1982) have argued that this assumption is inappropriate for most economic variables and that these variables are better modelled as I(1) processes (i.e., non-stationary). The simplest model for an integrated I(1) variable is the random walk:

$$y_t = by_{t-1} + e_t \; ; \quad e_t \sim N(0,\delta^2_e) \quad \ldots\ldots\ldots\ldots \quad (3\text{-}3\text{-}8)$$

It is sometimes useful to generalize equation (3-3-8) to allow for drift and drift in addition to time trend as in equations (3-3-3) and (3-3-4) above to obtain;

$$y_t = d + by_{t-1} + e_t \quad \ldots\ldots\ldots\ldots \quad (3\text{-}3\text{-}9)$$

$$y_t = d + \beta t + by_{t-1} + e_t \quad \ldots\ldots\ldots\ldots \quad (3\text{-}3\text{-}10)$$

The assumption that a series $\mathbf{y_t}$ is non-stationary can, however, be viewed as a testable hypothesis by performing unit root tests. Regarding equation (3-3-8) as a restricted version of Autoregressive, AR(1), model in equation (3-3-2) that is obtained by imposing (H_0: b=1), the conventional asymptotic tests require that $| b | < 1$, hence, they cannot be employed to testing H_0. In general, alternative approaches are needed for testing for a unit root in AR operator of a time series model.

One family test for unit root has its origin in the work of Fuller (1976) and Dickey and Fuller (1979, 1981). The simplest form of the test is obtained by checking the adequacy of equation (3-3-2). The Dickey-Fuller (DF) test is carried out by applying first difference operation to equation (3-3-8) which becomes;

$$\triangle y_t = (b-1)y_{t-1} + e_t$$

$$\text{or } \triangle y_t = \beta y_{t-1} + e_t \,; \quad (e_t \sim N(0,\delta^2_e)) \quad \ldots\ldots\ldots\ldots \quad (3\text{-}3\text{-}11)$$

The assumption of unit root can be tested by investigating the significance of $\mathbf{y_{t-1}}$ (i.e., **(b-1)** or **ß**) in equation (3-3-11). This is done by ordinary least square estimation of equation (3-3-11). As noted earlier, this testing problem is non-standard and the classical t-test is inappropriate, even in large samples (since (b-1)=0 on H_0: b=1). Appropriate test can be based upon either the OLS coefficient estimate (b-1) or the associated t statistic. Since the conventional asymptotic cannot be applied, Monte Carlos methods have been employed to obtain the critical values for n(b-1) which are provided by Fuller.[2]

If it is certain that the variable is non-stationary in level then first difference can be taken and the result will be applied to $\triangle y_t$ rather than y_t itself. The alternative model is then taken by applying first difference operation to equation (3-3-11) which becomes;

$$\triangle\triangle y_t = \beta\triangle y_{t-1} + e_t \ ; \quad (e_t \sim N(0,\delta^2_e) \quad \ldots\ldots\ldots\ldots \quad (3\text{-}3\text{-}12)$$

In the same vein, Dickey-Fuller (DF) test can be applied to equations (3-3-9) and (3-3-10) which then become;

$$\triangle y_t = d + \beta y_{t-1} + e_t \quad \ldots\ldots\ldots\ldots \quad (3\text{-}3\text{-}13)$$

and

$$\triangle y_t = d + \alpha t + \beta y_{t-1} + e_t \quad \ldots\ldots\ldots\ldots \quad (3\text{-}3\text{-}14)$$

Models with intercept and time trend such as equation (3-3-14) have been considered by Dickey and Fuller (1981). The inclusion of a time trend in models such as equation (3-3-14) is important because non-stationary time series are sometimes modelled as polynomial trends with covariance-stationary errors. West (1987) argues that the DF tests will be inconsistent if the process under scrutiny is stationary about a trend and the time trend is not included in the regression used to generate the test statistic. Given the argument of West, it is useful to include a time trend term in the regressor set in order to avoid the risk of low power.

One of the drawbacks of the DF test is that it necessarily assumes that the data generating process is an AR(1) process under the null hypothesis. If this assumption

[2] see Fuller (1976) (Table 8.5.1, p.371) and Appendix C. If the t-statistic is less than the critical t-value we reject the null hypothesis of non-stationary

does not hold then autocorrelation in residual terms (e_t) will bias the test. In order to overcome this problem, the "Augmented" Dickey-Fuller (ADF) test can be employed. This is done by generalizing the basic DF framework of equations (3-3-11), (3-3-13) and (3-3-14) to allow the series of first differences, $\triangle y_t$, to be autocorrelated. The ADF test is implemented by the OLS estimation of the following equations:

$$\triangle y_t = \beta y_{t-1} + \Sigma \alpha_i \triangle y_{t-i} + e_t \quad \text{(3-3-15)}$$

$$\triangle y_t = d + \beta y_{t-1} + \Sigma \alpha_i \triangle y_{t-i} + e_t \quad \text{(3-3-16)}$$

and $$\triangle y_t = d + \alpha t + \beta y_{t-1} + \Sigma \alpha_i \triangle y_{t-i} + e_t \quad \text{(3-3-17)}$$

Equation (3-3-17) above follows West's argument. However, the inclusion of a time trend does not guarantee that ADF tests for unit roots will be powerful in every application. Perron (1989) shows that such tests cannot reject the unit root hypothesis when the true data process is a stationary error about a trend function with a one-time break.

3.3.3 Cointegration and Error Correction Modelling Techniques:

The grin fact is that in macroeconomic modelling, most time series (i.e., series ordered by time) are subject to some stochastic trends. One remedy suggested above is to difference a series successively until stationary is achieved. Nevertheless, this does not seem to be an ideal solution. It has been shown in earlier studies that applying first differences to variables in a regression (or strictly speaking, to natural logarithms of variables) leads to the loss of long run solution. The desire to evaluate models which combine both short and long run properties and which at the same time maintain stationarity in all the variables has prompted reconsideration of the problem of regression using variables measured in their levels.

A pertinent question is whether there are situations where one can run a regression between two or more variables in levels, even though the variables are non-stationary. Sometimes, two or more variables will follow random walks, but a linear combination of these variables will be stationary. Granger (1981) hypothesized that economic variables may individually be non-stationary, but are not mutually independent. Rather, there seems to be a mechanism that prevents wide divergence. For instance, it may be that the variables $\mathbf{x}_t$ and $\mathbf{y}_t$ are random walks but the variable $\mathbf{z}_t = \mathbf{x}_t - \phi\mathbf{y}_t$ is stationary (where $\mathbf{z}_t$ is the linear combination of the two variables). If this is the case, we say that $\mathbf{x}_t$ and $\mathbf{y}_t$ are cointegrated and we call ϕ the cointegrating parameter or vector if $\mathbf{x}_t$ and $\mathbf{y}_t$ are vectors of variables (Engle and Granger, 1987). Cointegrated variables are shown in Figure 4 below.

In the event of non-stationary of the series, we conduct tests of cointegration. Here, we apply both the DF and ADF tests to the residuals of the static cointegrating (long run) regressions. The intuition behind this definition is that even if each time series is non-stationary, there might exist linear combinations of such time series that are stationary. In that case, multiple time series are cointegrated and share some common stochastic trends. We can interprete the presence of cointegration to imply that long run movements in these multiple times series are related to each other. Indeed, if there is a long run relationship between two or more non-stationary variables, then the idea of

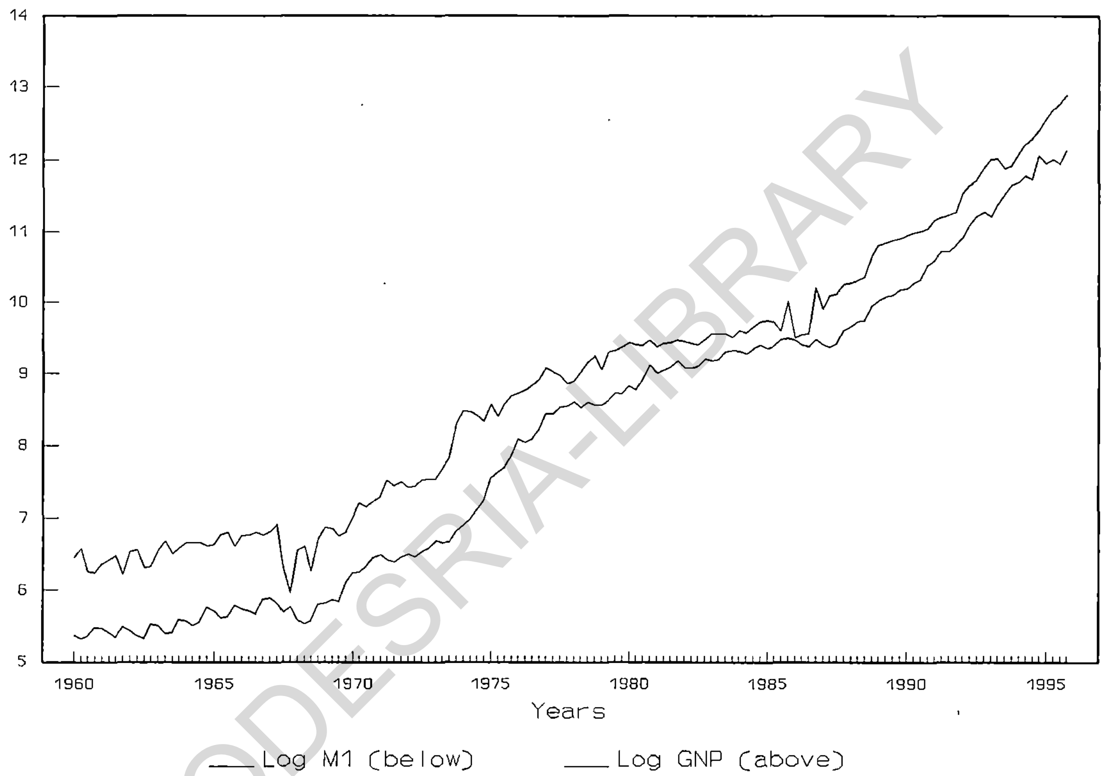

Fig.4: Cointegrated Variables {Money Demand and GNP Series}

the general concept of cointegration is that deviations from this long run path are stationary. If this is the case, the variables in question are said to be cointegrated. However, time series can only be cointegrated if they are integrated of the same order.

The fact that variables are cointegrated implies that there is some adjustment process which prevent the errors in the long run relationship becoming larger and larger. Engle and Granger (1987) have shown that any cointegrated series have an error correction presentation. It also follows that cointegration is a necessary condition for error correction model to hold. Hylleberg and Mizon (1989) have given a detailed analysis of cointegration and error correction mechanism. Also, Phillips and Loretan (1991) have considered a variety of ways of representing cointegrated systems with particular emphasis on error correction model representations. Indeed, such models incorporate both the economic theory relating to the long run relationship between variables and short run disequilibrium behaviour.

The main thrust of ECM is that people act to compensate for their past errors. Simply put, it is a model designed to account for economic realities in that observed economic data reflect behaviour that attempts to compensate for part of peoples' past error, i.e., a method of dynamic modelling. According to Yoshida (1990):

> ...from this perspective, it is fair to say that ECM is an attempt to integrate economic theory in characterizing a long term equilibrium with an observed disequilibrium by building a model that explicitly incorporates behaviour that would restore the equilibrium (p.2).

The starting point of ECM is a test against the null hypothesis that the residuals of the long run (static) model is non-stationary. This, as already discussed, can be done in two ways: first, a DF and second, ADF test can be performed on the residuals of the model. Alternatively, one can simply look at the Durbin-Watson statistic given from such model. A very low statistic indicates non-stationarity of the residuals. The evidence of stationarity of the residuals indicates that the variables in the model are indeed cointegrated (see Appendix C for critical t-values for cointegrated series).

Our next move is to switch to a short run model with an error correction mechanism. Adopting the Engle-Granger representation, we employ an error correction dynamic specification of the form:

$$\triangle M_t = \alpha_0 + \alpha_1 \triangle Z_t - \alpha_2 (M - Z)_{t-1} + e_t \quad \ldots\ldots\ldots\ldots\ldots\ldots \quad (3\text{-}3\text{-}18)$$

for both nominal and real M1 and M2 where **Z** is the vector of variables that cointegrate with each money demand equation. Alternatively, equation (3-3-18) can be written as:

$$\triangle M_t = \alpha_0 + \alpha_1 L(\triangle Z) - \alpha_2 ECM_{t-1} + e_t \quad \ldots\ldots\ldots\ldots\ldots\ldots \quad (3\text{-}3\text{-}19)$$

where L is a general lag operator and ECM is the time series of residuals from the cointegrating vector.

Equation (3-3-19) incorporates a corrective mechanism by which previous disequilibria in the relationship between the level of money balances and the level of one or more of its determinants are permitted to affect the current change in money holdings. In this way, an allowance is made for any short run divergence in money balances from the long run target holding. Equation (3-3-19) can then be reduced to a parsimonious equation through the elimination of insignificant terms and the imposition of constraints that hold a reasonable approximation (see Adam, 1992 and Boughton, 1991). The result of re-parameterisation of this equation is then used in further analysis.

3.4 Specification and Data of Aggregate Money Demand Function in Nigeria:

The search for a reliable money demand function continues to be intensively conducted. In Nigeria, very little is known about contemporary relationships between money and the other key macroeconomic variables. Guided by theoretical considerations, the demand for money function adopted in this study follows portfolio or general asset approach to modelling money demand. In line with the general portfolio approach, a number of important issues arises when considering the appropriate measures to be employed for the variables of the model.

The first concerns the choice of money demand series. Since there is no time series data on the demand for money, we employ the time series data on the supply of money as a proxy for time series data on the demand for money. The justification for this is based on the neoclassical assumption that at equilibrium, the supply of money in the economy is equal to the demand for money. However, it is assumed that the supply of money is exogenously determined.

Related to this issue is the choice of money supply series. Some studies, based on the structure of an economy, adopt monetary aggregate narrowly defined (M1). As in the case of Nigeria, domestic assets are thin and the number of financial instruments is low, hence the justification for the use of M1. Given asset theory of money demand, the adoption of M1 in these studies seems inadequate since a broader monetary aggregate (M2) is required. However, in Nigeria, the two monetary aggregates have been adopted but the superiority of one monetary aggregate over the other is yet to be ascertained as battery of diagnostic tests on the preferred equations, indeed, produced conflicting and contradictory results (Oresotu and Mordi, 1992). As the two monetary aggregates are being published in Nigerian economy we, therefore, employ the two series in specification search for cointegration.

The issue of scale or constraint variable normally reduces to a choice between a narrow income measure and a broader wealth concept which may be associated with permanent income since the specification of money demand might be expected to reflect the factors which affect wide portfolio choice decisions. Empirically, GDP or GNP is widely employed as constraint variable. In the case of Nigerian economy which is an open economy, employing GDP as a measure of income variable will not adequately capture the portfolio demand for money. However, employing either GDP or GNP poses no serious problem since there are no significant differences in the results obtained by adopting either measure as both move closely together (Laidler, 1985). We, however, employ the two series for specification search for cointegration while the problem of quarterly series is tackled by decomposing or disaggregating annual series (see Mordi, 1986).

The next issue concerns the price series. Most studies of money demand in advanced nations often employ the GDP or GNP deflator. However, we employ Composite Consumers Price Index (CCPI) in this study as it is the only consistent quarterly price series available for Nigeria. Aside, CCPI shows the true reflection of the real prices faced by the Nigerian consumers and evidence for Nigeria suggests that the CCPI is the unbiased measure of the prevailing prices.

The choice among alternative rates of return, as measure of the opportunity cost of holding money, has traditionally been between a short-term rate of interest such as Treasury bill or discount rate and long term rate such as the yield on consols. Attempts have also been made to take account of the rates of return (both short and long term) on international equities.

On the choice of domestic opportunity cost of holding money in the Nigeria economy, we employ returns on alternative assets (both short and long terms) as well as returns on several components of the broader monetary aggregate (M2). Since the deregulation of the Nigerian economy, the mode of keeping wealth among owners of wealth seems to have changed. Indeed, recent developments in financial markets have resulted in substantial enlargement in the holding of financial assets, shares or stocks and other private instruments for borrowing. These developments seem to suggest that the form of the demand for money function which used to rely on the traditional assumptions of poorly developed financial markets in which wealth owners keep their wealth in money and goods alone so that variations in interest rate are neutral on money demand and vice versa is no longer valid.

We note, however, that there exists only a small number of interest-bearing assets which individuals can hold instead of money in Nigeria. Empirical evidence on demand for money in Nigeria has also shown that treasury bill rates and time deposit rates were the alternative (domestic) interest rate series for modelling (Teriba, 1994). Discount rate had been employed in Kenya as a proxy for treasury bill rate serving as a measurable approximation to the true domestic interest facing non-bank private sector (Adam, 1992).

Oresotu and Mordi (1992) employed the average of savings and time deposit rate at commercial banks in Nigeria as domestic interest rate. We, however, treat the issue of domestic interest rate as an empirical question. Hence, we employ discount rate, treasury bill rate, savings deposits rate, time deposits rate and federal government stock rate (20-year) eventhough most of these interest rates have until recently been regulated by Central Bank of Nigeria's fiat.

Another issue for proper consideration is the returns on foreign securities as opportunity cost variable. Since economic agents in Nigeria also hold foreign assets/securities rather than cash balances, ignoring the impact of these foreign asset in the modelling of money balances would definitely amount to mis-specification (see Hamburger, 1977; Arango and Nadiri, 1981; Djeto and Pourjeranmi, 1990 for examples). For this singular reason we shall consider the returns on foreign assets as opportunity cost variable. Using the Euro-dollar rate in UK as a proxy for foreign interest rate as seen in Oresotu and Mordi study may be inadequate. We, therefore, also treat foreign interest rate as an empirical issue by employing USA's discount rate, treasury bill rate, and long term interest rate in specification search for cointegration as it is still an important exercise to know which of the rates or in which form they enter the money demand equation. Indeed, each domestic interest rate considered in Nigeria is matched with its corresponding interest rate in USA's economy.

The final issue on the opportunity cost variable focuses on the rate of inflation. Friedman (1956) argues that the rate of return on real asset is related to the expected rate of inflation. Cagan (1956) suggests that such an opportunity cost variable is particularly relevant to the demand for money during times of rapid and highly variable rates of inflation, since it is then that expectations are likely to change most rapidly. Some empirical studies such as Milbourne (1983) and Hafer and Thornton (1986) have shown that inflation exerts no significant influence on demand for money balances in some economies. Strong evidence of inflation effects is, however, found by Artis and Lewis (1976), Budd and Holly (1986), Hall et al. (1990) and Oresotu and Mordi (1992). The use of an inflation rate variable in empirical money demand equations is, therefore, now well-established and the significant role found for the variable in these studies would appear to indicate that inflation has an effect upon the demand for money over and above any indirect influence it might exert via the nominal interest rate.

However, it has been posited that for inflation rate to appear in the money demand function independently of, and in addition to interest rate, it must be imperfectly correlated with them (see Baba et al., 1992). Since interest rates were highly regulated before the inception of SAP in 1986, it is expected that there would be a low correlation (if any at all) between inflation rate and interest rates. However, the issue is best resolved by empirical testing rather than by theoretical arguments. Hence, our model of money demand will incorporate inflation rate or price expectation as an argument.

Another development in the Nigerian economy is the trade and payment liberalization and the removal of pegged exchange rate system by the introduction of foreign exchange market for determining the naira exchange rate. The reform measures have also made it possible for wealth owners to keep their assets in foreign currency in interest earning domiciliary account. In applying returns on foreign assets therefore attempts should be made to capture the effect of the exchange rate (expectations) since such expectations exerts an influence on return on foreign assets.

There are two ways of achieving this, first by adjusting the foreign interest rates for exchange rate expectations and second, by including exchange rate expectations variable into the demand for money function in order to separate its effect. The two approaches had been employed and it was found that they are equivalent (Adam, 1991). However, we employ the second approach and since 1972, the value of the Nigerian currency has been closely related to the value of USA dollar, we employ Naira/USA dollar exchange rate as a proxy for exchange rate variable.

Given the structure of the Nigerian economy since and before financial deregulation and trade liberalization as well as voluminous empirical evidence in Nigeria and other nations of the world we specify the following long run aggregate money demand function:

$$M_i^d = f(Y, R^d, R^f, P, \pi^e, E^r) \quad \ldots\ldots\ldots\ldots \quad (3\text{-}4\text{-}1)$$

In light of the preceding discussions and assuming a logarithmic linear relationship, equation (3-4-1) in nominal term is written as:

$$\ln M_{i\,t}^{d} = \alpha_0 + \alpha_1 \ln Y_t + \alpha_2 \ln R_t^d + \alpha_3 \ln R_t^f + \alpha_4 \ln P_t + \alpha_5 \pi_t^e + \alpha_6 \ln E_t^r + \mu_t \quad \ldots\ldots\ldots\ldots \quad (3\text{-}4\text{-}2)$$

The use of logarithms in this model rather than the raw data in levels can be justified on grounds of both statistical and economic theory. Given that the dispersion of time series increases with the level of the series, it follows that the standard deviation of the series is proportional to its level, then data expressed in terms of logarithms will exhibit approximately constant variance. Also, if variables are measured in logarithms, then the seasonal differences can be shown to be measures of the growth rate of the variables (i.e., such an approach produces an equation in which the coefficient estimates can be interpreted to be elasticity values.

The general consensus is that the demand for money for all intents and purpose is the demand for real balances. Therefore, the equation to be estimated in real term is of the form:

$$\ln(m_{i\,t}^{d}) = \alpha_0 + \alpha_1 \ln y_t + \alpha_2 r_t^d + \alpha_3 r_t^f + \alpha_4 \pi_t^e + \alpha_5 e_t^r + \mu_t \quad \ldots\ldots \quad (3\text{-}4\text{-}3)$$

where:

M_i^d = Demand for nominal stock of money, (i = 1, 2)

(M1= money narrowly defined (i.e., currency outside banks plus privately held deposits with commercial and Central banks; M2= money broadly defined (i.e., M1 plus savings and time deposits with commercial banks and total deposits liabilities with merchant banks).

Y = Nominal income variable (i.e., GDP or GNP at current prices)

P = General price level index (CCPI, 1985 =100)

m_i^d = Demand for real money defined as $(M_i/P)^d$

y = Real income variable defined as (Y/P)

R^d = A representative of domestic interest paid on interest-bearing assets

r^d = A proxy for real domestic interest rate

R^f = A representative of foreign interest paid on interest-bearing assets

r^f = A proxy for real foreign interest rate

π^e = Inflation measured as quarterly percentage change in CCPI

E^r = Naira\US dollar exchange rate

μ = stochastic or error term which is assumed to be white noise

t = quarter

ln = natural logarithm

Following the adoption of general portfolio approach to modelling money demand, we assume that:

For nominal equations: $\alpha_1, \alpha_4 > 0; \alpha_2, \alpha_3, \alpha_6 < 0; \alpha_5 \leq 0$ for M1

$\alpha_1, \alpha_2, \alpha_3, \alpha_4, > 0; \alpha_6 < 0; \alpha_5 \geq 0$ for M2

For real equation: $\alpha_1 > 0; \alpha_2, \alpha_3, \alpha_5 < 0; \alpha_4 \leq 0$ for M1

$\alpha_1, \alpha_2, \alpha_3 > 0; \alpha_5 < 0; \alpha_4 \geq 0$ for M2

Quarterly data are used for estimating the equations above and the estimation sample is 1960(1) through 1995(4). All the time series data employed are gathered from different sources notably: CBN publications such as the Monthly and Annual Reports; Economic and Financial Review; Statistical Bulletin (for various years) augmented by relevant publications of the FOS and the International Financial Statistic of the IMF. This implies that a greater percentage of the data points on income variables would have to be decomposed given that data series on income variables, where available, are only given as annual figures.[3]

[3] see data series employed in Appendix B

3.5 Conclusion:

The analysis of economic data has been approached from two different philosophies; that proposed by the more classical econometric approach and time series analysts. This study favours the latter approach. In this approach progress has been made in understanding the inadequacies of classical results on estimation and inferences in the presence of non-stationarity and in obtaining results that asymptotically valid. The main question here is that do macroeconomic variables such as GNP, employment, money supply, interest rates, prices, etc tend to revert back to some long run trend following shock or do they follow random walk?

The importance of this question is that if these variables follow random walks, a regression of one against others can lead to spurious result since the OLS estimate would definitely not yield consistent parameter estimators. Therefore, the requirement in modelling the demand for money is an approach that captures the long run relationship between the variables while avoiding spurious inferences. This is why cointegration and error correction techniques have been found useful in modelling demand for money in several studies. This modelling technique is, therefore, the one applied in this study.

CHAPTER FOUR

EMPIRICAL ESTIMATION AND ANALYSIS OF AGGREGATE MONEY DEMAND FUNCTION IN NIGERIA

4.1 Introduction:

This chapter employs cointegration and error correction mechanism techniques to estimate aggregate money demand function. First, the time series property of data in equations 3-4-2 and 3-4-3 are investigated before actual model estimation for long run relationship. This is done by carrying out a unit root test on each variable. This will be followed by testing for cointegration of variables which appear in the aggregate money demand model using the sample period starting from 1960(1) to 1995(4). Having established the extent and form of cointegration relationships between the variables of the model, we then proceed to estimate an error correction model.[4]

4.2 Unit Root Tests:

Following the steps suggested in section 3.3.2 of chapter three, we start with the testing for the order of integration of the variables which appear in our models. To characterize the time series property of the variables of interest, the DF and ADF tests

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[4] The empirical results of this study have been obtained through the use of PC-GIVE computer package of econometric data analysis and estimation supplied by Hendry (1989)

were employed. The test performed considered both the null hypothesis of a random walk with a constant drift and a random walk with a constant drift and trend term. Four lags were sufficient to make error term in the ADF test to be white noise. The results of the unit root tests are reported in Table 1 and 2 below.

Using DF test, except for inflation rate, all other variables are regarded as non-stationary at their levels since each reported t statistic is not smaller than the 5% critical t-values of -2.86 and -3.65 for the untrended and trended series respectively. Again using ADF (for both untrended and trended), the null hypothesis of non-stationary is accepted for all the series investigated in levels with the exception of inflation rate. The ADF critical t-values are respectively -3.17 and -3.45 for the untrended and trended series. In general, the results of these tests shown in Table 1 are consistent with the present of a unit root in each of the variables investigated.[5]

This result is followed by testing whether first differences used once make the variables stationary. In other words, for each variable we tested the null hypothesis that the variables are I(1). The results of these tests are reported in Table 2. The results, however, confirm that differencing once is all that is required to bring these variables to stationary. The exceptions are the ADF trended narrow money (LM1) and untrended composite consumer price index (LCCI) variables whose t-statistics are close to their critical t-values. However, these variables are confirmed to be stationary at first difference given the DF test in the same table.[6]

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[5] This result was also confirmed by Teriba (1992) and Anyanwu (1994)

[6] The levels (without logarithm) of all opportunity cost variables were also tested and we confirmed that these variables are I(1) series.

Table 1: Unit Root Tests for the Variables in Levels.[7]

	DF		ADF	
Variable[8]	Untrended	Trended	Untrended	Trended
LM1	1.6563	-1.9008	0.4151	-2.9302
LM2	1.8588	-1.9474	0.4322	-3.0555
LRM1	-1.6270	-0.9256	-1.6489	-0.7864
LRM2	-1.8208	-0.0574	-1.7579	-0.3106
LGDP	0.9531	-2.5588	1.4987	-1.4336
LGNP	0.9803	-2.4857	1.5007	-1.3907
LRGDP	-2.3237	-2.8041	-2.0343	-1.8731
LRGNP	-2.3536	-2.7824	-2.0144	-1.8433
LCCPI	5.7960	1.1775	2.5215	-0.2011
LMRR	-0.6880	-2.2372	-0.5316	-1.8509
LRS	-0.7145	-2.0508	-0.7272	-1.9234
LRL	-0.6340	-2.1414	-0.5728	-2.1041
LSDR	-0.5044	-2.2172	-0.3713	-1.9534
LTDR	-0.5605	-2.3624	-0.4083	-2.3339
LIRM2	-0.4103	-2.2184	-0.3115	-2.1668
LRF	-1.3372	-1.1659	-2.5805	-2.4391
LRSF	-1.6491	-1.5644	-2.8740	-2.6725
LRLF	-1.4039	-0.3607	-1.7759	-0.8837
LER	1.0459	-0.9170	0.8557	-0.9150
CCPINF	-13.2909	-13.8228	-4.0859	-4.6142

[7] For the untrended and trended models equations (3-3-13) and (3-3-14) were respectively employed for DF tests while equations (3-3-16) and (3-3-17) were respectively employed for ADF tests

[8] see definition of variables in the Appendix A

Table 2: Unit Root Tests for the Variables in First Difference.[9]

	DF		ADF	
Variable	Untrended	Trended	Untrended	Trended
⌂LM1	-11.7814	-12.0505	-3.3156	-3.4250
⌂LM2	-10.0846	-10.3230	-3.7158	-3.8198
⌂LRM1	-12.9871	-13.1343	-4.0446	-4.3382
⌂LRM2	-11.8747	-12.2078	-4.1542	-4.6651
⌂LGDP	-14.0906	-14.3316	-5.2966	-5.6678
⌂LGNP	-14.1875	-14.4441	-5.2092	-5.5885
⌂LRGDP	-15.2345	-15.2082	-5.8179	-5.9286
⌂LRGNP	-15.4266	-15.3959	-5.8870	-5.9894
⌂LCCPI	-9.5643	-11.3096	-3.1358	-4.4799
⌂LMRR	-11.0121	-11.0003	-6.0187	-6.5970
⌂LRS	-11.5270	-11.5160	-5.7730	-6.5043
⌂LRL	-10.6243	-10.5962	-5.8185	-6.4492
⌂LSDR	-11.3325	-11.2988	-6.6319	-7.3209
⌂LTDR	-11.9872	-11.9815	-5.8490	-6.1970
⌂LIRM2	-11.0702	-11.0535	-6.2336	-6.5874
⌂LRF	-8.2591	-8.2772	-3.7800	-3.6198
⌂LRSF	-8.6669	-8.6756	-4.1214	-3.9893
⌂LRLF	-9.1561	-9.2989	-5.2922	-5.6382
⌂LER	-14.0049	-14.5364	-4.5733	-4.1547
⌂CCPINF	-22.5276	-22.4466	-6.7378	-6.7123

[9] ⌂ is first difference symbol

4.3 Tests for Cointegration:

Following our findings in section 4.2 that all variables of interest are of I(1) except for inflation rate we, therefore, test for possible cointegration among these variables. Adopting Engle and Granger two-step method, we first estimate the long run relation of money demand by OLS and test for stationarity of the residuals. Here, we test whether a postulated equality in the long run relationship between money and its determinants gives a stationary error. Again, DF and ADF tests were employed to test for cointegrated variables. The results of cointegration tests are reported in Table 3 for bivariate regressions.

Given the bivariate Cointegration Regression Durbin Watson (CRDW) and DF 5% critical t value of 0.30 and -3.30 respectively, all the bivariate variables reported in Table 3 are said to be cointegrated. The exception is the LRS on LTDR which is not cointegrated at 5% level. Also, most of these bivariate variables are not cointegrated given the ADF 5% critical value of -3.10. However, all the bivariate variables are cointegrated at 10% critical t value.[10] The exceptions are the LM1 on LGDP, LM2 on LGDP, LM2 on LGNP, LRM2 on LRGDP, LRM2 on LRGNP and LMRR on LTDR. Addressing the issue of appropriate income measure, we employ GNP for nominal and real M1 while appropriate income measure is sought for nominal and real M2.

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[10] 10% critical t vales for bivariate cointegration are respectively 0.27, -3.03 and -2.80 for CRDW, DF and ADF

Table 3: Cointegration Regressions for Bivariate Variables.[11]

Variable	constant	coeff.	CRDW	DF	ADF
LM1⇔LGDP	-1.4719	1.0797	0.51	-4.4474	-2.7303
LM1⇔LGNP	-1.5382	1.0923	0.55	-4.6522	-2.8567
LM2⇔LGDP	-1.3532	1.1201	0.43	-4.0020	-2.2188
LM2⇔LGNP	-1.4183	1.1329	0.46	-4.1013	-2.2616
LRM1⇔LRGDP	-1.7461	1.1908	0.49	-4.4719	-2.8516
LRM1⇔LRGNP	-1.8492	1.2208	0.51	-4.5798	-2.9130
LRM2⇔LRGDP	-1.9372	1.3209	0.42	-4.1924	-2.5716
LRM2⇔LRGNP	-2.0060	1.3452	0.42	-4.1775	-2.5498
LMRR⇔LRS	0.3276	0.8889	0.64	-5.2080	-3.2508
LMRR⇔LRL	-0.1687	1.0166	0.43	-4.3670	-3.0435
LMRR⇔LTDR	0.5431	0.7972	0.45	-4.2472	-2.5302
LRS⇔LTDR	0.2751	0.8779	0.27	-3.1844	-2.1891
LRL⇔LTDR	0.7281	0.7681	0.47	-4.5069	-3.5490
LRL⇔LIRM2	0.6839	0.7919	0.32	-3.5125	-3.2845
LSDR⇔LTDR	0.1274	0.9281	0.32	-4.0308	-3.1689
LRF⇔LRSF	0.1682	0.9020	0.52	-4.6268	-3.5174
CCPINF⇔LER	0.8635	0.2107	2.26	-13.6711	-4.3704

[11] Only a pair of cointegrated or near cointegrated variables are reported; (⇔) implies that cointegration is symmetric so that if y is cointegrated with x, then x will be cointegrated with y

In the case of money demand function, the model is multivariate and there may exist multiple cointegrating vectors linking money demand and some or all of its explanatory variables. The null hypothesis is that there is no cointegrating vector. If that hypothesis is rejected, one tests sequentially for additional cointegrating vector. The results of the multivariate cointegration regressions are reported in Tables 4 and 5 below.

Table 4 presents results of regressing nominal and real M1 balances on levels of nominal (or real) income, consumers price index and the relevant opportunity cost variables while Table 5 shows results of regressing nominal and real M2 on the values of nominal (or real) income, consumers price index and the opportunity cost variables. Two measures of income i.e., GDP and GNP were adopted in testing for cointegration in Table 5. The results of applying the formal DF and ADF tests for detecting a unit root in the residuals series are also shown in these tables. The DF and ADF t-values that appear on the lagged level of the residuals in the regression are shown in the last two rows respectively. Inflation rate measure (CCPINF) is not included in the cointegration regressions since it is stationary in level and indeed, its inclusion makes residuals of the models nonstationary.

More recent Monte Carlo evidence suggests that cointegration may be accepted too readily using DF. Therefore, only regressions in which both DF and ADF tests confirm stationarity of the residuals are taken to be cointegrated. In Tables 4 and 5,

Table 4: Cointegration Regressions for Multivariate Variables
(Nominal and Real M1 Models).[12]

	1	2	3	4	5	6
VAR	LM1	LM1	LM1	LM1	LM1	LM1
CONST	-1.3228	-1.2299	-0.9493	-1.0076	-1.1057	0.8915
LGNP**	0.8316	0.8266	0.7050	0.7890	0.8176	0.7152
LCCPI**	0.4972	0.5133	0.4967	0.4564	0.4887	0.4758
LMRR*	0.2524					
LRS*		0.1880				
LRL			0.1216			
LSDR*				0.4042		
LTDR*					0.2367	
LIRM2*						0.1804
LRF	-0.0701					
LRSF		-0.0488		-0.0762	-0.0656	
LRLF*			0.4106			0.3454
LER**	-0.3848	-0.3768	-0.1829	-0.3592	-0.3661	-0.2047
CRDW	0.81	0.80	0.71	0.88	0.81	0.74
Adj.R^2	0.9916	0.9915	0.9925	0.9927	0.9919	0.9927
δ	0.1936	0.1952	0.1831	0.1803	0.1904	0.1804
F*5,138	3257.56	3205.95	3646.58	3761.11	3369.25	3757.32
RSS	5.1730	5.2556	4.6253	4.4855	5.0029	4.4900
SC	-3.1193	-3.1035	-3.2312	-3.2619	-3.1527	-3.2609
FPE	0.0390	0.0397	0.0349	0.0339	0.0378	0.0339
n	6	6	6	6	6	6
DF	-5.7935	-5.7131	-5.4060	-6.1917	-5.8191	-5.5704
ADF	-4.0481	-3.9355	-4.3517	-4.3545	-4.1269	-4.4175

[12] T (i.e., number of observations) is 144. See critical t-values for cointegrated models in Appendix C

	7	8	9	10	11	12
VAR	LRM1	LRM1	LRM1	LRM1	LRM1	LRM1
CONST	-1.9496	-1.8970	-1.1218	-1.2878	-1.6057	-1.0460
LRGNP**	0.9847	1.0369	0.7296	0.8849	0.9870	0.7424
LMRR*	0.4661					
LRS*		0.3517				
LRL			0.1512			
LSDR*				0.6639		
LTDR*					0.4509	
LIRM2*						0.2306
LRF*	0.2565					
LRSF		0.2224		0.0417	0.1253	
LRLF*			0.7574			0.6463
LER	-0.0916	-0.0788	0.0173	-0.2008	-0.1320	-0.0263
CRDW	0.60	0.59	0.63	0.73	0.63	0.65
Adj.R^2	0.8618	0.8486	0.9080	0.9003	0.8706	0.9120
δ	0.2429	0.2542	0.1981	0.2063	0.2351	0.1938
F*4,139	216.74	194.76	343.15	313.86	233.71	359.98
RSS	8.1981	8.9831	5.4558	5.9142	7.6798	5.2232
SC	-2.6933	-2.6019	-3.1006	-3.0199	-2.7587	-3.1441
FPE	0.0610	0.0669	0.0406	0.0440	0.0572	0.0389
n	5	5	5	5	5	5
DF	-5.0738	-5.0216	-5.1572	-5.6683	-5.2457	-5.2935
ADF	-4.2535	-4.0418	-4.2953	-4.1806	-4.1522	-4.3015

* These variables are significant

** These variables are significant and correctly signed

Table 5: Cointegration Regressions for Multivariate Variables

(Nominal and Real M2 Models)

	1	2	3	4	5	6
VAR	LM2	LM2	LM2	LM2	LM2	LM2
CONST	-0.6420	-0.7111	-0.7676	-0.6503	-0.7009	-0.7375
LGDP**				0.8036	0.7913	0.7180
LGNP**	0.8045	0.7956	0.7188			
LCCPI**	0.4194	0.4125	0.4082	0.4382	0.4314	0.4336
LMRR**	-0.3245			-0.3344		
LRS**		-0.2372			-0.2600	
LRL			-0.0635			-0.0975
LIRM2*	0.7231	0.6754	0.3088	0.7166	0.6813	0.3310
LRF	0.0206			0.0065		
LRSF		0.0506			0.0294	
LRLF*			0.5821			0.5282
LER**	-0.3046	-0.2874	-0.1264	-0.3370	-0.3137	-0.1645
CRDW	0.73	0.69	0.68	0.80	0.74	0.72
Adj.R^2	0.9927	0.9927	0.9938	0.9933	0.9933	0.9941
δ	0.1874	0.1875	0.1730	0.1804	0.1804	0.1694
F*6,137	3122.66	3120.45	3669.51	3370.56	3372.06	3825.06
RSS	4.8119	4.8153	4.0992	4.4603	4.4583	3.9335
SC	-3.1571	-3.1564	-3.3174	-3.2330	-3.2335	-3.3587
FPE	0.0368	0.0369	0.0314	0.0341	0.0341	0.0301
n	7	7	7	7	7	7
DF	-5.5807	-5.3831	-5.4323	-5.8858	-5.6377	-5.5639
ADF	-4.1786	-4.2293	-4.7863	-3.2975	-4.3366	-4.7617

	7	8	9	10	11	12
VAR	LRM2	LRM2	LRM2	LRM2	LRM2	LRM2
CONST	-0.6353	-0.6228	-0.8364	-0.5857	-0.5648	-0.7855
LRGDP**				0.8542	0.8278	0.7277
LRGNP**	0.8624	0.8380	0.7342			
LMRR**	-0.5347			-0.5786		
LRS**		-0.4899			-0.5426	
LRL			-0.0932			-0.1390
LIRM2*	1.0590	1.0661	0.3604	1.0919	1.1099	0.3932
LRF*	0.1894			0.1827		
LRSF*		0.1611			0.1508	
LRLF*			0.7860			0.7824
LER	-0.1142	-0.1176	-0.0047	-0.1295	-0.1310	-0.0168
CRDW	0.64	0.60	0.65	0.65	0.62	0.65
Adj.R^2	0.9180	0.9209	0.9395	0.9199	0.9237	0.9398
δ	0.2084	0.2047	0.1790	0.2060	0.2010	0.1785
F*5,138	308.84	321.18	428.54	316.76	334.17	431.15
RSS	5.9947	5.7826	4.4215	5.8567	5.5749	4.3963
SC	-2.9719	-3.0079	-3.2763	-2.9951	-3.0445	-3.2820
FPE	0.0453	0.0436	0.0334	0.0442	0.0421	0.0332
n	6	6	6	6	6	6
DF	-5.3662	-5.1948	-5.4051	-5.4362	-5.2758	-5.3966
ADF	-4.4297	-4.2435	-4.8250	-4.4276	-4.2500	-4.7264

* These variables are significant

** These variables are significant and correctly signed columns 1-6 report nominal M1 and M2 while columns 7-12 report real M1 and M2. In all the cases in table 4, the DF confirms stationarity of the residuals while ADF completely invalidates stationarity of the error terms for nominal M1 at 5% t critical value. However, ADF 10% critical t value confirms stationarity of the residuals in some cases in nominal M1 models and in all cases for real M1 models.

In Table 4, income (GNP) and price (CCPI) variables are not only significant but also correctly signed in all models. With the exception of RL all of the domestic interest rates is significant for nominal M1 but the coefficients of these variables take wrong sign. This is also the case of real M1. The implication of this result may be that financial liberalization has really have a meaningful impact on money demand in Nigeria. The reverse of domestic interest rate is the case of foreign interest rate which is not significant in all models (with the exception of RLF) but correctly signed for nominal M1 while it takes a positive value but significant in the real M1 models. Exchange rate variable is correctly signed and significant in both nominal and real M1 cases.

Given DF and ADF results in Table 4, it is evidenced that the variables in nominal M1 models are not cointegrated while those of columns 9 and 12 are cointegrated for real M1 models at 5% critical t values. However, given 10% significant level, variables in columns 3, 4 and 6 are said to be cointegrated for nominal M1 models while all those in columns 7-12 are also cointegrated for real M1 models.

Results in Table 5 reveal that only variables in columns 3 and 6 are cointegrated for nominal M2 at 10% critical value. The reason for this is that M2 hardly cointegrates with any variable in the model (not even with GDP or GNP as shown in table 3). Not withstanding, both GDP and GNP series show the correct sign and significant in all cases. This is also the case of the measure of price variable (CCPI). Variables in columns 9 and 12 are cointegrated for real M2 at 5% critical value given the DF and ADF tests on the residuals. However, given 10% critical value, variables in columns 7, 9, 10 and 12 are confirmed cointegrated.

For all the nominal models, the exchange rate variable takes the correct sign significant while the variable is correctly signed in real M2 models but not significant in all the cases. In nominal M2 models, all the domestic interest rate takes the correct sign and significant except for RL (this is also true for real M2 models) while the foreign interest rate is wrongly signed and insignificant except for RLF in nominal M2 and significant in all real M2 models. The measure of return on M2 component, IRM2, is positively signed and significant implying that Quasi money, rather than M1, is the dominant part of M2.

In view of the fact that all the series identified to be cointegrated are non-nested, a non-nested test was conducted. This test known as model selection test employs several information criteria in selecting the best model among the competing cointegrated ones. We report these information criteria as regards each model in Tables 4 and 5. This exercise is necessitated in the sense that we need to choose model which can best explain money demand (whether nominal or real) in Nigeria. These criteria are discussed below:

Adj.R^2 is the coefficient of determination adjusted for the number of explanatory variables and the model with the highest R^2 is selected among the alternative ones;

δ is the estimated standard error of the model in which the model with the smallest standard error is selected;

F is the estimated F statistic in which the model with the highest F statistic is selected;

RSS is the estimated sum of the residuals of the fitted model where the model with the smallest RSS value is selected;

SC is the Schwarz Information criterion where model selection favours the model with the smallest value of SC;

FPE is the final prediction error criterion leading to selection of a model with the smallest ex-post prediction error.

Considering all these information criteria, models 4 and 12 are chosen as the best models explaining nominal and real M1 demand respectively as shown in table 4. In case of nominal M2 balances, model 6 is selected as the best model as contained in table 5 while model 12 is chosen for real M2. It then follows that while SDR and RSF are the appropriate proxies for both domestic and foreign rate of interest in nominal M1 model, IRM2 and RLF are adopted for real M1 models. Also, long term interest rate (RL and RLF) are the appropriate proxies for the domestic and foreign interest rate variable respectively in both nominal and real M2 models. Given these results, the residuals from the selected cointegration regressions can be taken to be the valid error correction term (ECM) which we then incorporate in modelling aggregate money demand in Nigeria.

However, in order to find cointegrating vectors a number of complications arose with the procedure. First, the key parameters are not consistent with conventional a priori regarding the shape of the long run demand function. Second, compounding this first problem, it is not obvious which of perhaps several candidates should be selected as the most relevant cointegrating vector. Third, the estimated steady state changes in the context of a more fully specified model, especially when constraints have been imposed at the initial stage.

One way out of this predicament would be to take the bivariate cointegrating vectors in Table 3 as point estimates of the steady state, and incorporate the lagged residuals from these equations as arguments in a dynamic error-correction equation linking changes in money demand to changes in the other variables. We note, however, that these bivariate cointegrating vectors are not very satisfying but the result shown in Table 3 do support the hypothesis that these data sets are characterized by error correction representations, with steady states that could be interpreted as conventional money demand relationships. For consistency tests we report the solved static long run equations for the bivariate money demand cointegration regressions in Table 6.

Results in Table 6 are not statistically different from the ones reported in Table 3. For this reason we take the residuals from cointegrated equations in Table 3 as error correction terms which we incorporate into our error correction model. However, given cointegration results in Table 3, one doubts if the long run money demand equations provided are properly specified. This doubt emanates from the Durbin-Watson (DW) statistic (below one in all the cases)

Table 6: Solved Static Long Run Solution to ADL (With 4 lags) for

Bivariate Models.[13]

VARIABLE	INTERCEPT	COEFF.	CRDW	DF	ADF
LM1→LGDP	-1.813 (.23193)	1.166 (.02951)	1.84	-3.6474	-10.8522
LM1→LGNP	-1.866 (.21804)	1.174 (.02777)	1.84	-3.6673	-10.8694
LRM1→LRGDP	-2.488 (.61409)	1.348 (.11903)	1.77	-4.4706	-10.4747
LRM1→LRGNP	-2.624 (.58054)	1.385 (.11348	1.77	-4.6163	-10.4752
LM2→LGDP	-1.511 (.36077)	1.209 (.04651)	1.95	-4.1207	-11.4788
LM2→LGNP	-1.570 (.37203)	1.222 (.04829)	1.95	-4.1311	-11.5138
LRM2→LRGDP	-2.223 (.84344)	1.398 (.16291)	1.82	-4.4012	-10.8077
LRM2→LRGNP	-2.370 (.84861)	1.439 (.16541)	1.82	-4.4413	-10.8128

[13] Figures in parentheses are standard errors of parameters

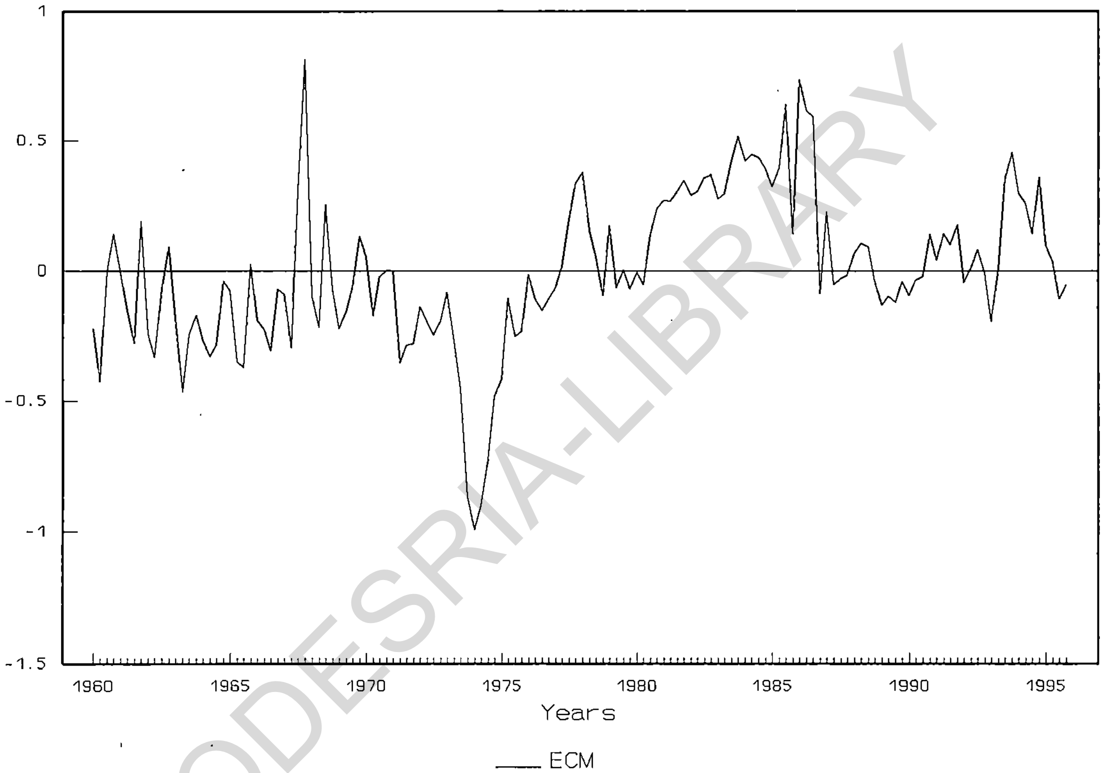

Fig.5: Engle-Granger Error Correction

arising from these models. In order to develop a model with an error correction mechanism we estimate an ADL model for aggregate money demand (as in Table Results in Table 6 are not statistically different from the ones reported in Table 3. For this reason we take the residuals from cointegrated equations in Table 3 as error correction terms which we incorporate into our error correction model. However, given cointegration results in Table 3, one doubts if the long run money demand equations provided are properly specified. This doubt emanates from the Durbin-Watson (DW) statistic (below one in all the cases) arising from these models. In order to develop a model with an error correction mechanism we estimate an ADL model for aggregate money demand (as in Table 6) and the errors from these long run models are in turn tested for stationarity. The results of these tests are also presented in Table 6.

The values of CRDW, DF and ADF confirm stationarity of residuals arising from these bivariate equations. Indeed, the ECM variable as depicted in Figure 5 shows that it is stationary. We, therefore, employ the lagged residuals from these equations in our search for dynamic models for aggregate money demand in Nigeria.

4.4 Error Correction Representation:

Our next move is to switch to short run models with an error correction mechanism in equation (3-3-19). This equation (3-3-19) estimates an over-parameterized error correction model by setting the lag length long enough in order to ensure that the dynamics of the model have not been constrained by a too short lag length.

EQ(4-4-1) Modelling ΔLM1 by OLS
The Sample is 1961(2) to 1995(4) less 0 Forecasts

Variable		Coefficient	Std Error	H.C.S.E	t-value	Partial r^2
ΔLM1	1	.6902853	.25440	.29314	2.71343	.0686
ΔLM1	2	-.0320125	.09128	.09137	-.35070	.0012
ΔLM1	3	-.0018558	.09274	.09795	-.02001	.0000
ΔLM1	4	.4620199	.09273	.09903	4.98226	.1989
CONSTANT		-.0226150	.01464	.01533	-1.54462	.0233
ΔLGNP		.0300013	.04554	.04663	.65885	.0043
ΔLGNP	1	.0508653	.04901	.05823	1.03787	.0107
ΔLGNP	2	.1126720	.04974	.05924	2.26540	.0488
ΔLGNP	3	-.0068684	.05826	.06748	-.11790	.0001
ΔLGNP	4	-.0777003	.05682	.06830	-1.36748	.0184
ΔLCCPI		-.4998495	.33494	.32613	-1.49235	.0218
ΔLCCPI	1	.1596677	.35338	.28883	.45184	.0020
ΔLCCPI	2	.1159905	.36280	.33584	.31971	.0010
ΔLCCPI	3	-.6490402	.33960	.29817	-1.91117	.0352
ΔLCCPI	4	-.1521502	.36440	.33542	-.41753	.0017
CPIINF		.0218113	.01247	.01290	1.74956	.0297
CPIINF	1	-.0039860	.01221	.01077	-.32653	.0011
CPIINF	2	-.0021473	.01225	.01092	-.17531	.0003
CPIINF	3	.0344305	.01154	.01030	2.98461	.0818
CPIINF	4	.0002923	.01279	.01185	.02285	.0000
ΔLRL		-.0604211	.09487	.07931	-.63686	.0040
ΔLRL	1	-.1499519	.08937	.11051	-1.67781	.0274
ΔLRL	2	.1999712	.08768	.06703	2.28062	.0494
ΔLRL	3	-.1106863	.08831	.10943	-1.25345	.0155
ΔLRL	4	.1350143	.08691	.08795	1.55358	.0236
ΔLRLF		.2083029	.11669	.13192	1.78504	.0309
ΔLRLF	1	-.1092158	.11898	.12200	-.91794	.0084
ΔLRLF	2	.1336058	.11986	.13167	1.11465	.0123
ΔLRLF	3	.0210832	.11846	.14647	.17798	.0003
ΔLRLF	4	.1384057	.12169	.13972	1.13735	.0128
ΔLER		-.0068942	.04991	.03695	-.13814	.0002
ΔLER	1	.1614772	.09750	.08195	1.65622	.0267
ΔLER	2	.0921020	.10297	.09459	.89448	.0079
ΔLER	3	-.0509766	.06260	.04651	-.81428	.0066
ΔLER	4	-.0316363	.05372	.04933	-.58896	.0035
ECM2	1	-.8374155	.26915	.31027	-3.11135	.0883
FD		-.1084711	.16070	.12669	-.67498	.0045
FD	1	-.0369846	.24120	.17116	-.15333	.0002
FD	2	.1540425	.16111	.12260	.95614	.0091

R^2 = .6189967 σ = .0677380 F(38,100) = 4.28 [.0000] DW = 1.936
RSS = .4588439892 for 39 Variables and 139 Observations
Information Criteria: SC = -4.329026; HQ = -4.817784; FPE =.005876

EQ(4-4-2) Modelling ΔLRM1 by OLS
The Sample is 1961(2) to 1995(4) less 0 Forecasts

Variable		Coefficient	Std Error	H.C.S.E	t-value	Partial r^2
ΔLRM1	1	.6208549	.20205	.25713	3.07271	.0840
ΔLRM1	2	-.0292953	.09174	.10047	-.31932	.0010
ΔLRM1	3	.0883686	.09447	.10979	.93541	.0084
ΔLRM1	4	.5151963	.09793	.10918	5.26112	.2118
CONSTANT		.0108688	.01145	.01060	.94917	.0087
ΔLRGNP		.0820617	.04664	.04865	1.75947	.0292
ΔLRGNP	1	-.0022326	.05662	.07315	-.03943	.0000
ΔLRGNP	2	.0869258	.05336	.06596	1.62894	.0251
ΔLRGNP	3	-.0120304	.06704	.08292	-.17945	.0003
ΔLRGNP	4	-.0290999	.05332	.06795	-.54580	.0029
CPIINF		-.0278291	.00529	.00674	-5.26362	.2120
CPIINF	1	-.0016937	.00526	.00588	-.32172	.0010
CPIINF	2	-.0062743	.00514	.00515	-1.22132	.0143
CPIINF	3	.0115636	.00510	.00548	2.26765	.0476
CPIINF	4	.0083440	.00545	.00565	1.52965	.0222
ΔLRL		-.0672941	.10576	.08505	-.63629	.0039
ΔLRL	1	-.0909870	.09786	.13303	-.92981	.0083
ΔLRL	2	.2086633	.09160	.07331	2.27792	.0480
ΔLRL	3	-.1499390	.09109	.10378	-1.64603	.0256
ΔLRL	4	.1957600	.09059	.12411	2.16105	.0434
ΔLRLF		.1129545	.12966	.15076	.87119	.0073
ΔLRLF	1	-.1197798	.13115	.14567	-.91328	.0080
ΔLRLF	2	.0621991	.13201	.13609	.47118	.0022
ΔLRLF	3	-.0331996	.12698	.16322	-.26145	.0007
ΔLRLF	4	.1617553	.13145	.15167	1.23051	.0145
ΔLER		-.0134212	.05401	.04422	-.24847	.0006
ΔLER	1	.1727620	.10637	.09779	1.62416	.0250
ΔLER	2	.0176456	.11261	.09498	.15670	.0002
ΔLER	3	-.0773682	.12144	.09273	-.63710	.0039
ΔLER	4	-.1626685	.10632	.12204	-1.52999	.0222
ECM4	1	-.6671450	.21530	.27272	-3.09865	.0853
FD		-.1113509	.17485	.15026	-.63683	.0039
FD	1	.0953644	.26039	.17932	.36624	.0013
FD	2	.0752602	.26370	.18812	.28541	.0008
FD	3	.1749210	.24963	.20747	.70071	.0047
FD	4	-.2321890	.16495	.16734	-1.40763	.0189

R^2 = .6602456 σ = .0734934 F(35,103) = 5.72 [.0000] DW = 1.999
RSS = .5563311022 for 36 Variables and 139 Observations
Information Criteria: SC = -4.242872; HQ = -4.694033; FPE = .006800

EQ(4-4-3) Modelling ΔLM2 by OLS
The Sample is 1961(2) to 1995(4) less 0 Forecasts

Variable	Coefficient	Std Error	H.C.S.E	t-value	Partial r^2
ΔLM2 1	1.1713922	.39335	.41290	2.97802	.0815
ΔLM2 2	-.1141750	.10961	.12041	-1.04165	.0107
ΔLM2 3	-.0399667	.10201	.10053	-.39180	.0015
ΔLM2 4	.3430620	.10209	.11580	3.36036	.1015
CONSTANT	-.0240306	.01605	.01790	-1.49733	.0219
ΔLGNP	.0519097	.03794	.05068	1.36803	.0184
ΔLGNP 1	.0150803	.04422	.04283	.34101	.0012
ΔLGNP 2	.0765332	.04044	.04323	1.89256	.0346
ΔLGNP 3	-.0272239	.04940	.05562	-.55112	.0030
ΔLGNP 4	-.1012793	.05965	.07312	-1.69785	.0280
ΔLCCPI	-.3986013	.27692	.24561	-1.43942	.0203
ΔLCCPI 1	.2031701	.29258	.25267	.69441	.0048
ΔLCCPI 2	-.0414975	.30664	.27124	-.13533	.0002
ΔLCCPI 3	-.6064927	.28944	.25398	-2.09539	.0421
ΔLCCPI 4	.0906271	.30720	.27599	.29501	.0009
CPIINF	.0152818	.01027	.00935	1.48820	.0217
CPIINF 1	-.0070730	.01020	.01057	-.69336	.0048
CPIINF 2	.0024863	.01049	.00880	.23699	.0006
CPIINF 3	.0296433	.00996	.00935	2.97556	.0813
CPIINF 4	-.0082147	.01082	.00935	-.75909	.0057
ΔLRL	-.0012994	.08679	.07283	-.01497	.0000
ΔLRL 1	-.1272317	.08406	.09077	-1.51358	.0224
ΔLRL 2	.1679567	.08419	.07191	1.99492	.0383
ΔLRL 3	-.0515395	.08518	.07470	-.60506	.0036
ΔLRL 4	.0552259	.08307	.07378	.66485	.0044
ΔLRLF	.1392824	.09215	.10303	1.51148	.0223
ΔLRLF 1	-.0751653	.09695	.09697	-.77527	.0060
ΔLRLF 2	.0953122	.09835	.10363	.96916	.0093
ΔLRLF 3	.0426115	.09595	.11033	.44411	.0020
ΔLRLF 4	.0653470	.09770	.10811	.66888	.0045
ΔLIRM2	-.0254557	.07747	.07678	-.32860	.0011
ΔLIRM2 1	.0348439	.07646	.07680	.45574	.0021
ΔLIRM2 2	.0024763	.07676	.07814	.03226	.0000
ΔLIRM2 3	-.0737142	.07743	.07482	-.95196	.0090
ΔLIRM2 4	.1244146	.07819	.06215	1.59113	.0247
ΔLER	.0543179	.04079	.02847	1.33155	.0174
ΔLER 1	.0337015	.04425	.03463	.76155	.0058
ECM6 1	-1.1048342	.41011	.42628	-2.69400	.0677
FD	.0067343	.01961	.01889	.34339	.0012

R^2 = .5212482 σ = .0560259 F(38,100) = 2.87 [.0000] DW = 2.018
RSS = .3138902406 for 39 Variables and 139 Observations
Information Criteria: SC = -4.708693; HQ = -5.197451; FPE =.004020

EQ(4-4-4) Modelling ΔLRM2 by OLS
The Sample is 1961(2) to 1995(4) less 0 Forecasts

Variable	Coefficient	Std Error	H.C.S.E	t-value	Partial r^2
ΔLRM2 1	.6274216	.27777	.30771	2.25875	.0485
ΔLRM2 2	-.0610737	.10142	.11106	-.60219	.0036
ΔLRM2 3	.0072147	.10326	.10797	.06987	.0000
ΔLRM2 4	.3368104	.11366	.12039	2.96337	.0807
CONSTANT	.0121412	.01016	.01166	1.19542	.0141
ΔLRGNP	.0981289	.04040	.05365	2.42916	.0557
ΔLRGNP 1	.0040117	.05989	.06570	.06698	.0000
ΔLRGNP 2	.0924171	.04679	.05089	1.97503	.0375
ΔLRGNP 3	.0121096	.06535	.07905	.18529	.0003
ΔLRGNP 4	-.0095941	.04835	.05844	-.19844	.0004
CPIINF	-.0308435	.00452	.00524	-6.82730	.3179
CPIINF 1	.0021936	.00494	.00545	.44370	.0020
CPIINF 2	-.0028506	.00479	.00411	-.59457	.0035
CPIINF 3	.0105234	.00482	.00482	2.18424	.0455
CPIINF 4	.0048570	.00514	.00595	.94538	.0089
ΔLRL	-.0430563	.09509	.08846	-.45280	.0020
ΔLRL 1	-.1419783	.09162	.10831	-1.54961	.0234
ΔLRL 2	.1463633	.09308	.10067	1.57238	.0241
ΔLRL 3	-.0669361	.08988	.08072	-.74472	.0055
ΔLRL 4	.0762276	.08882	.10215	.85824	.0073
ΔLRLF	.1348965	.11018	.12648	1.22437	.0148
ΔLRLF 1	-.0980849	.11131	.11853	-.88118	.0077
ΔLRLF 2	.0490961	.11173	.12106	.43943	.0019
ΔLRLF 3	-.0200745	.10861	.12361	-.18482	.0003
ΔLRLF 4	.0547850	.11148	.12577	.49144	.0024
ΔLIRM2	.0641002	.09005	.09272	.71184	.0050
ΔLIRM2 1	.1002584	.08748	.09075	1.14605	.0130
ΔLIRM2 2	.0202708	.08931	.09905	.22698	.0005
ΔLIRM2 3	-.0625275	.08361	.08550	-.74780	.0056
ΔLIRM2 4	.1443113	.08420	.07075	1.71395	.0285
ΔLER	.0370424	.04705	.03582	.78730	.0062
ΔLER 1	.0811973	.09014	.07999	.90082	.0080
ΔLER 2	-.0553173	.09503	.07514	-.58208	.0034
ΔLER 3	-.0850152	.05777	.04134	-1.47171	.0212
ΔLER 4	-.0305222	.05123	.05141	-.59574	.0035
ECM8 1	-.4801767	.28357	.30859	-1.69335	.0279
FD	-.0890890	.14633	.11244	-.60883	.0037
FD 1	.1543784	.22000	.14988	.70171	.0049
FD 2	-.0599213	.14594	.09506	-.41059	.0017

R^2 = .6448106 σ = .0624894 F(38,100) = 4.78 [.0000] DW = 2.057
RSS = .3904923691 for 39 Variables and 139 Observations
Information Criteria: SC = -4.490328; HQ = -4.979086; FPE =.005001

EQ(4-4-5) Modelling ΔLM1 by OLS
The Sample is 1961(2) to 1995(4) less 0 Forecasts

Variable	Coefficient	Std Error	H.C.S.E	t-value	Partial r^2
ΔLM1 1	.6689754	.13900	.13662	4.81280	.1532
ΔLM1 4	.4403510	.07298	.07597	6.03349	.2214
CONSTANT	-.0139825	.00933	.00899	-1.49923	.0173
ΔLGNP 2	.0963019	.03597	.04136	2.67761	.0530
ΔLCCPI 3	-.6856288	.21390	.22720	-3.20533	.0743
CPIINF 3	.0330091	.00770	.00780	4.28777	.1256
ΔLRL 1	-.1478245	.07252	.08447	-2.03842	.0314
ΔLRL 2	.1887222	.07419	.05718	2.54380	.0481
ΔLRL 3	-.1549083	.07455	.10951	-2.07793	.0326
ΔLER 1	.0903954	.04014	.02285	2.25226	.0381
ECM2 1	-.7559561	.15709	.15323	-4.81224	.1532

R^2 = .5354284 σ = .0661134 F(10,128) = 14.75 [.0000] DW = 1.899
RSS = .5594856509 for 11 Variables and 139 Observations
Information Criteria: SC = -5.124713; HQ = -5.262568; FPE =.004717

EQ(4-4-6) Modelling ΔLRM1 by OLS
The Sample is 1961(2) to 1995(4) less 0 Forecasts

Variable	Coefficient	Std Erro	H.C.S.E	t-value	Partial r^2
ΔLRM1 1	.6942850	.12408	.10641	5.59562	.1978
ΔLRM1 4	.4380173	.07261	.07268	6.03261	.2227
CONSTANT	.0078927	.00820	.00770	.96212	.0072
ΔLRGNP	.0854486	.04115	.04165	2.07676	.0328
ΔLRGNP 2	.0904999	.03959	.03963	2.28615	.0395
CPIINF	-.0263054	.00409	.00533	-6.42791	.2455
CPIINF 3	.0112477	.00404	.00390	2.78414	.0575
ΔLRL 2	.1572468	.08021	.06520	1.96052	.0294
ΔLRL 3	-.1640212	.08376	.10052	-1.95832	.0293
ΔLRL 4	.2229201	.08032	.10223	2.77552	.0572
ΔLER 1	.1002336	.04765	.03170	2.10365	.0337
ECM4 1	-.6636958	.13957	.12178	-4.75527	.1511

R^2 = .5964124 σ = .0721359 F(11,127) = 17.06 [.0000] DW = 2.145
RSS = .6608549519 for 12 Variables and 139 Observations
Information Criteria: SC = -4.922697; HQ = -5.073084; FPE = .005653

EQ(4-4-7) Modelling ΔLM2 by OLS
The Sample is 1961(2) to 1995(4) less 0 Forecasts

Variable	Coefficient	Std Erro	H.C.S.E	t-value	Partial r^2
ΔLM2 1	.8571135	.23953	.25809	3.57828	.0929
ΔLM2 4	.3333520	.08356	.09840	3.98945	.1129
CONSTANT	-.0176029	.01141	.01424	-1.54235	.0187
ΔLGNP	.0775842	.03115	.04382	2.49079	.0473
ΔLGNP 2	.0632101	.03061	.03064	2.06511	.0330
ΔLGNP 4	-.0823373	.03785	.04012	-2.17552	.0365
ΔLCCPI 3	-.6924920	.20510	.19225	-3.37632	.0836
CPIINF 3	.0303976	.00714	.00672	4.25811	.1267
ΔLRL 2	.1429966	.06082	.06096	2.35095	.0423
ΔLIRM2 4	.1128378	.05693	.05984	1.98218	.0305
ΔLER 4	-.1174836	.06084	.04386	-1.93104	.0290
ECM6 1	-.8180652	.25660	.28508	-3.18813	.0752
FD 3	.1936106	.10146	.06446	1.90828	.0283
FD 4	-.1769105	.09966	.06041	-1.77517	.0246

R^2 = .4547766 σ = .0534769 F(13,125) = 8.02 [.0000] DW = 1.925
RSS = .3574718457 for 14 Variables and 139 Observations
Information Criteria: SC = -5.466175; HQ = -5.641627; FPE = .003148

EQ(4-4-8) Modelling ΔLRM2 by OLS
The Sample is 1961(2) to 1995(4) less 0 Forecasts

Variable	Coefficient	Std Error	H.C.S.E	t-value	Partial r^2
ΔLRM2 1	.6707045	.12969	.09739	5.17175	.1706
ΔLRM2 4	.2852399	.06812	.06799	4.18741	.1188
CONSTANT	.0135531	.00668	.00765	2.02980	.0307
ΔLRGNP	.1145016	.03225	.04263	3.55041	.0884
ΔLRGNP 2	.0650315	.03255	.02977	1.99781	.0298
CPIINF	-.0274892	.00328	.00421	-8.36893	.3501
CPIINF 3	.0109069	.00309	.00287	3.52576	.0873
ΔLIRM2 4	.1495460	.06247	.07714	2.39407	.0422
ECM8 1	-.5341632	.14531	.12331	-3.67592	.0942

R^2 = .5839248 σ = .0593186 F(8,130) = 22.81 [.0000] DW = 2.211
RSS = .4574297849 for 9 Variables and 139 Observations
Information Criteria: SC = -5.397108; HQ= -5.509898; FPE =.003747

Equations (4-4-1) to (4-4-4) report the initial over-parameterized error correction of aggregate money demand in Nigeria. All the variables were lagged equally in these models (4 lags). GNP is employed as the appropriate income variable while RL and RLF were employed as the appropriate proxies for domestic and foreign interest rate respectively. However, these models seem difficult to interprete, we therefore simplify these models into a more interpretable and certainly more parsimonious models. This reduction exercise is carried out by imposing zero coefficients on those levels and lags where 't' statistic is low (below 1.90).[14]

The imposition of these conditions leads us to our final models for aggregate real M1 and M2. The resulting Schwarz information criterion (SC) and standard error (δ) were employed as guide to parsimonious reduction. A fall in both values are indication of model parsimony. The results parsimonious models are reported in equations (4-4-5) to (4-4-8). The results of parsimonious models as reported in equations (4-4-5) to (4-4-8) indicate models parsimony. These results clearly show a well-defined error correction term, ECM, which indicates a feedback of close to unity (between 53% and 82%) of the previous quarter's disequilibrium from the long run income elasticity of money demand. The implication of this is that income (GNP) maintains the money demand equilibrium through time. The effect of these "disequilibrium" error corrections are not only large but also have a negative sign as expected. The strong significance of the coefficient of ECM_{t-1} supports our earlier assertion that money demand and income are indeed cointegrated.

[14] see footnote 14 in Boughton (1991) and Adam (1992) p.31

We also observe the presence of short run income effect (both level and second lag) on money holdings and that the exchange rate of naira to US dollar is positively and correctly signed[15] in both the nominal and real M1 models while significant at the 1st lag with elasticity of 0.1 which support the phenomenon known as currency substitution. We also note that the current price change has a sharply negative effect while its third lagged has a positive effect on real money demand. However, the consumer price index and inflation rate assume wrong signs in all our nominal equations. This may arise as a result of high correlation between the two variables as inflation is derived from CCPI. For this reason, our further analysis is centred on real models rather than nominal.

4.5 Diagnostic Tests and Stability Analysis:

Apart from the R^2 that has fallen slightly, the standard error (δ) and SC information criterion indicate an improvement in parsimony. As shown in Figures 6 and 7, the models track the data well over the sample period. A series of diagnostic and stability tests were then conducted on these real models which are reported below.

[15] With devaluation of the naira, money demand is expected to rise

DIAGNOSTIC TESTS:[16] FOR REAL M1 FOR REAL M2

A. Langrange Multiplier Tests for 1st order serial correlation in residuals AR(1)

X(1): F(1,126)= .15(.7027)	F(1,129)= .01(.9218)

B.Langrange Multiplier Tests for nth order serial correlation in residuals AR(m)

X(2): F(2,125)= .19(.8091)	F(2,128)= .53(.5059)
X(1): F(3,124)= .23(.7237)	F(3,127)= .34(.6785)
X(1): F(4,123)= .14(.6165)	F(4,126)= .21(.8218)

C. Jarque-Bera Test for non-normality in error distribution

$X^2(2)$ = .938(.6980)	$X^2(2)$ = .044(.5220)

D. Ramsey's Tests (RESET) for Functional Mis-specification

F(1,126: .17 (.6808)	F(1,129): .22 (.6347)

E. LM Autoregressive-Conditional Hetero-scedasticity test [ARCH(m)]

F(1,125): .05 (.8299)	F(1,128): .41 (.8075)
F(2,123): .07 (.9321)	F(2,126): .70 (.5327)
F(3,121): .17 (.9195)	F(3,124): .73 (.5078)
F(4,119): .16 (.9575)	F(4,122): .23 (.6507)

F. Predictive Failure Test

$X^2(24)/24$ = 1.79(.6620)	$X^2(24)/24$ = 1.09(.7580)

G. Chow,s Test of the Stability of Regression coefficients

F(24,103) = 1.72 (.6321)	F(24,106) = 1.97 (.6101)

[16] The values in parentheses are probability values

EQ(4-4-9) Modelling ΔLRM1 by OLS
The Sample is 1961(2) to 1989(4) less 0 Forecasts

Variable	Coefficient	Std Error	H.C.S.E	t-value	Partial r^2
ΔLRM1 1	.5888880	.12732	.10494	4.62512	.1720
ΔLRM1 4	.4621587	.08331	.08946	5.54723	.2300
CONSTANT	.0060950	.00827	.00794	.73699	.0052
ΔLRGNP	.0680897	.04014	.04311	1.69632	.0272
ΔLRGNP 2	.1075527	.03854	.04106	2.79039	.0703
CPIINF	-.0196149	.00434	.00553	-4.52438	.1658
CPIINF 3	.0101850	.00438	.00444	2.32410	.0498
ΔLRL 2	.0505511	.13829	.10017	.36554	.0013
ΔLRL 3	.0328932	.14080	.09482	.23361	.0005
ΔLRL 4	-.0862617	.14033	.10848	-.61471	.0037
ΔLER 1	.0893460	.04956	.02987	1.80288	.0306
ECM4 1	-.6263750	.14658	.13982	-4.27322	.1506

R^2 = .6117549 σ = .0676544 F(11,103) = 14.75 [.0000] DW = 2.054
RSS = .4714424433 for 12 Variables and 115 Observations
Information Criteria: SC = -5.001767; HQ = -5.171935; FPE =.005055

EQ(4-4-10) Modelling ΔLRM2 by OLS
The Sample is 1961(2) to 1989(4) less 0 Forecasts

Variable	Coefficient	Std Error	H.C.S.E	t-value	Partial r^2
ΔLRM2 1	.6149954	.12556	.08925	4.89787	.1845
ΔLRM2 4	.3086549	.07582	.07621	4.07097	.1352
CONSTANT	.0090552	.00650	.00772	1.39282	.0180
ΔLRGNP	.1001873	.03049	.04286	3.28547	.0924
ΔLRGNP 2	.0808477	.03134	.03118	2.58002	.0591
CPIINF	-.0229228	.00343	.00439	-6.68960	.2969
CPIINF 3	.0113841	.00321	.00317	3.54373	.1059
ΔLIRM2 4	.1383235	.07730	.05557	1.78943	.0293
ECM8 1	-.5082047	.14324	.12560	-3.54802	.1062

R^2 = .6132330 σ = .0546276 F(8,106) = 21.01 [.0000] DW = 2.124
RSS = .3163227194 for 9 Variables and 115 Observations
Information Criteria: SC = -5.524582; HQ = -5.652208; FPE = .003218

A set of diagnostic tests reported above show that there is no evidence of first or higher order serial correlation in these equations errors (see A and B), non-normality in error distribution (see C), incorrect functional form (see D) and first and higher order heteroscedasticity (see E). In fact, the models exhibit in-sample predictive stability (see F) and the regression coefficients are constant over the sample period (see G). It then follows that the real models are consistent with the data.

However, all interpretation of our models for real money demand equations are carried out under the implicit assumption that the coefficient remained stable throughout the entire period under study. We, therefore, checked the stability of these models by re-estimating these models using the Recursive Least Square (RLS) estimator to test whether there has been any significant change in the value of the coefficients of the models throughout the period by estimating the models over the periods from 1960(1) to 1989(4) and then recursively thereafter quarter by quarter (these models are reported in equations (4-4-9) and (4-4-10) below). The resulting series of recursive estimators are then analyzed for their stability complemented by the one-step Chow test for the entire sample.

A comparison of equations (4-4-6) and (4-4-9) shows that the estimated coefficients for each explanatory variable hardly differ even though the sample period is shortened. This observation is also true for equations (4-4-8) and (4-4-10). From our observation, we confirm that the ECM-types of money demand function for Nigeria's M1 and M2 have remained stable for nearly three and a half decades and slightly affected by the marked shift in government's monetary policy of emphasising management of the money supply.

Evidence of within-sample forecast accuracy further supports this hypothesis with the models estimated to 1989 tracking the actual data from 1990 to 1995 with a high degree of accuracy. These stability evidence are shown in Figures 6 and 7 for M1 and M2 respectively. We, therefore conclude that for the full sample, the models adequately capture the salient features of the data and are consistent with the main implications of economic theory.

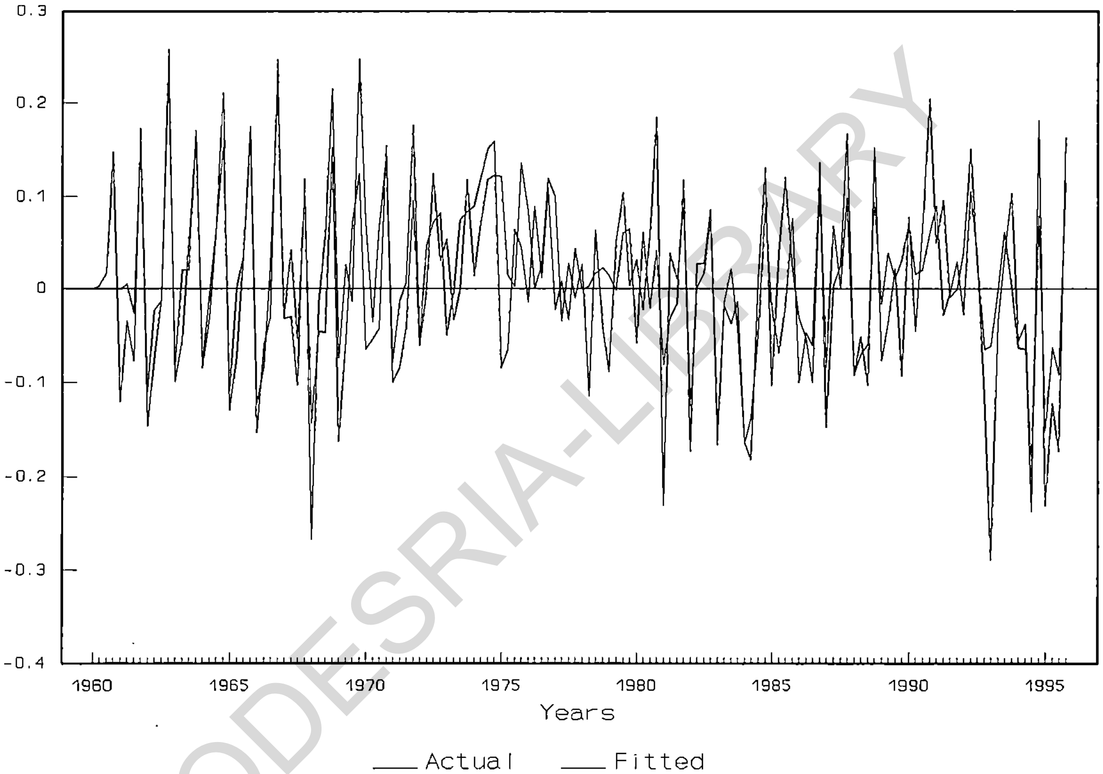

Fig.6: LRM1 {Actual Versus Fitted (Equation 4-4-6)}

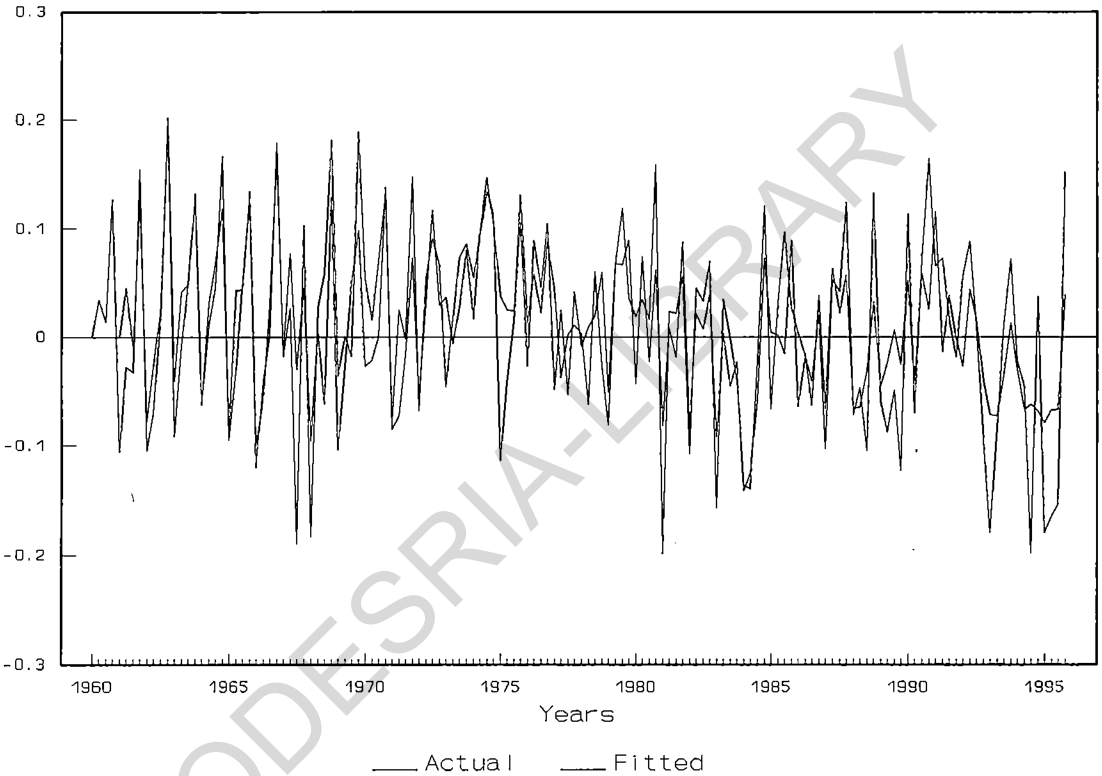

Fig.7: LRM2 {Actual Versus Fitted (Equation 4-4-8)}

CHAPTER FIVE

SUMMARY AND CONCLUSIONS

5.1 Summary and Findings:

The empirical model is developed in the light of recent developments in the methodology of econometric modelling and the analysis of time series with stochastic non-stationary components. Unlike the error correction model, the partial adjustment formulation of money demand dynamics characteristics of most previous studies in Nigeria (like that of Oresotu and Mordi, 1992) resulted in unstable relations and invalid conclusions, bringing to the fore once again the importance of investigating general specifications of short run dynamic processes.

Starting with an analysis of the integration or unit root properties of the relevant series (i.e., Nigeria's quarterly money demand series for both M1 and M2 (nominal and real), income, price, domestic interest rate, foreign interest rate, inflation rate and exchange rate series), the results clearly show that the tests fail to reject the null hypothesis that these variables are non-stationary (except for the inflation rate) and they are, indeed, of random walk {I(1)}.

Given the non-stationarity of the series, the cointegration equations were estimated. Indeed, the evidence consists of showing that M1 and M2 balances are cointegrated with income, price, both domestic and foreign interest rates and exchange rate but not when inflation rate is included. However, this relationship was not adopted due to wrong signs of the coefficients of these series in our static models. For this reason, the bivariate cointegration regressions for both nominal and real money balances with every variable were investigated.

It is clearly evident that nominal money demand series cointegrates with nominal income (GNP) while real money series also cointegrates with real income. Also, each domestic interest rate series cointegrates with another domestic interest rate but not with money demand series (not even with any other series). Cointegration were also found for short and long term foreign interest rate series and inflation and exchange rate series. It was also evident that neither of the income series (nominal or real) was found to be cointegrated with the interest rate series (whether domestic or foreign) nor with the price, inflation and exchange rate series. The existence of one cointegrating linear combination was, therefore, established which corresponds to a long run money demand function with respect to income series. On the basis of this information, an error correction models were developed which were shown to be well-specified relative to their own information set and capable of parsimoniously representing the data set.

Two-stage error-correction modelling, in which the errors from a bivariate cointegrating equation are used as argument in the dynamic adjustment equation is generally outperformed by a less restricted general to specific specification process. Adopting cointegration and error correction modelling strategy, the relation between demand for Nigeria's money (both narrow and broad) and their determinants were analyzed through a series of reduction from over-parameterized models interrelating money demand, exchange rate, inflation rate, measured income, price, domestic and foreign interest rates and error correction term.

The presence of the levels of GNP and CCPI in these reductions may however indicate non-acceptability of the initial estimate of the cointegrating vector as the steady state. Hence, the specification of the dynamics cannot be treated as recursive to the specification of the steady state.

The estimates presented in this study suggest that some of the most commonly accepted restrictions employed in the money demand literature may be inconsistent with the data. These questionable properties include homogeneity with respect to price level, unitary or less than unitary elasticity with respect to real income, and the restriction of the set of included interest rates to either short or long term rates to the exclusion of the others. However, the long run elasticity of money demand in relation to income was established not to be statistically different from unity.

We found also that the proxies for financial deregulation and trade liberalisation which come as consequences of Structural Adjustment Programme (SAP) in 1986 were statistically insignificant. Although, both policy shifts could have caused significant shift in money supply, the constant relationship of our models can be interpreted as demand equations rather that money supply relationships. It then follows that interest rate targeting for stabilisation purposes will be a useful exercise as would be the coordination of monetary and exchange rate policy.

Our findings also support the hypothesis that the demand for money is fairly stable as confirmed by the Chow tests and in-sample forecasts statistics. This finding seems to put some weight on the argument that the traditional specifications of money demand which have been commonly plagued by persistent overprediction, implausible parameter estimates and highly autocorrelated errors are largely due to specification and methodological errors.

5.2 Recommendations:

As our results show that the discrepancy between the actual and desired real money holdings in the previous period is not fully corrected in the present period, we recommend that the disequilibrium in the money market can be exploited by the authority to influence real income. Also attempts to control money holdings through domestic interest rate ceilings will be ineffective since this variable is less significant. However, effective control of money holdings can only be achieved through the adoption of an appropriate income policy.

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APPENDICES

APPENDIX A: Definition of Variables:

LM1:	Natural Log of Narrow Money (CC + DD)
LM2:	Natural Log of Broad Money (M1 + Quasi Money)
LRM1:	Natural Log of Real Narrow Money (M1/CCPI)
LRM2:	Natural Log of Real Broad Money (M2/CCPI)
LGDP:	Natural Log of Gross Domestic Product
LGNP:	Natural Log of Gross National Product
LRGDP:	Natural Log of Real Gross Domestic Product (GDP/CCPI)
LRGNP:	Natural Log of Real Gross National Product (GNP/CCPI)
LCCPI:	Natural Log of Composite Consumers Price Index (1985=100)
LMRR:	Natural Log of Minimum Rediscount Rate
LRS:	Natural Log of Short-Term (Treasury Bill) Rate
LRL:	Natural Log of Long-Term (Government Stock Rate
LSDR:	Natural Log of Savings Deposits Rate
LTDR:	Natural Log of Time deposits Rate
LIRM2:	Natural Log of M2 Rate { (SDR + TDR) / 2 }
LRF:	Natural Log of Foreign Interest Rate (Discount Rate)
LRSF:	Natural Log of Short-Term Foreign Interest Rate
LRLF:	Natural Log of Long-Term Foreign Interest Rate
LER:	Natural Log of Foreign Exchange (₦\US $) Rate
CCPIINF:	Inflation Rate Defined as Change in CCPI (1985 = 100)

APPENDIX B: Data Series Employed:

Quarter	M1	M2	GDP	GNP	MRR	RS	RL	SDR	TDR
1960 1	215.00	268.20	637.73	638.08	5.13	4.5	5.0	3.0	4.0
2	207.00	266.20	722.70	723.21	5.13	4.5	5.0	3.0	4.0
3	213.50	273.70	526.78	526.76	5.69	4.5	5.0	3.0	4.0
4	240.40	302.00	512.79	512.94	4.68	4.5	5.0	3.0	4.0
1961 1	237.50	302.70	589.24	588.24	4.38	4.0	5.0	3.0	4.0
2	223.50	286.90	625.31	623.81	4.69	4.0	5.0	3.0	3.0
3	209.60	281.40	660.39	658.69	6.00	4.5	5.0	3.0	4.0
4	242.60	319.80	503.06	502.74	5.50	4.5	5.0	3.0	4.0
1962 1	229.20	315.00	692.25	695.52	5.25	4.5	5.0	3.0	4.0
2	214.80	297.40	708.19	711.40	4.50	4.0	5.0	3.0	3.0
3	207.40	295.60	553.80	555.66	4.50	4.0	5.0	3.0	3.0
4	251.80	338.00	561.77	563.98	4.50	4.0	5.0	3.0	3.0
1963 1	246.00	333.00	710.20	701.68	4.00	3.5	5.0	3.0	3.0
2	221.30	314.10	812.38	802.82	4.00	3.5	5.0	3.0	3.0
3	223.90	316.70	680.86	673.46	4.00	3.5	5.0	3.0	3.0
4	267.60	366.40	742.57	733.82	4.00	3.5	5.0	3.0	3.0
1964 1	262.10	366.90	793.54	789.51	4.00	3.5	5.0	3.0	3.0
2	247.80	361.80	796.56	791.69	4.00	3.5	5.0	3.0	3.0
3	259.40	373.40	794.55	790.24	4.00	3.5	5.0	3.0	3.0
4	316.10	435.30	760.35	757.53	5.00	4.5	5.0	3.0	3.5
1965 1	303.00	431.80	778.67	765.08	5.00	4.5	5.0	3.5	3.5
2	275.00	408.40	897.76	881.89	5.00	4.5	5.0	3.5	3.5
3	281.20	424.60	928.30	912.17	5.00	4.5	5.0	3.5	3.5
4	326.30	472.90	756.28	743.45	5.00	4.5	5.0	3.5	3.5
1966 1	311.50	466.70	889.17	868.93	5.00	4.5	5.0	3.5	3.5
2	303.10	463.10	901.45	881.37	5.00	4.5	5.0	3.5	3.5
3	290.80	458.40	930.10	909.36	5.00	4.5	5.0	3.5	3.5
4	355.70	523.90	894.29	874.53	5.00	4.5	5.0	3.5	3.5
1967 1	364.30	544.10	942.18	915.59	5.00	4.5	5.0	3.5	3.5
2	338.30	534.30	1040.92	1011.66	5.00	4.5	5.0	3.5	3.5
3	298.40	432.00	570.86	555.05	5.00	4.5	5.0	3.5	3.5
4	320.10	456.50	397.03	386.04	5.00	4.5	5.0	3.5	3.5
1968 1	265.90	412.50	727.20	708.49	5.00	4.5	5.0	3.5	3.5
2	252.90	409.70	764.18	744.34	4.50	4.0	5.0	3.0	3.0
3	264.50	429.10	539.34	525.22	4.50	4.0	5.5	3.0	3.0
4	331.70	520.30	847.38	825.35	4.50	4.0	5.5	3.0	3.0
1969 1	340.00	554.70	1013.48	969.25	4.50	4.0	5.5	3.0	3.0
2	352.30	560.90	992.56	949.56	4.50	4.0	5.5	3.0	3.0
3	343.80	545.20	898.42	859.24	4.50	4.0	5.5	3.0	3.0
4	445.10	665.50	947.58	906.71	4.50	4.0	5.5	3.0	3.0
1970 1	513.80	753.40	1211.58	1103.75	4.50	4.0	5.5	3.0	3.0
2	519.70	802.20	1480.19	1348.92	4.50	4.0	5.5	3.0	3.0
3	566.20	875.60	1410.97	1286.04	4.50	4.0	5.5	3.0	3.0
4	639.80	981.50	1520.83	1386.29	4.50	4.0	5.5	3.0	3.0
1971 1	664.70	1035.50	1524.04	1471.40	4.50	4.0	5.5	3.0	3.0
2	615.90	970.50	1919.70	1853.73	4.50	4.0	5.5	3.0	3.0
3	599.50	969.50	1775.37	1713.73	4.50	4.0	5.5	3.0	3.0
4	649.20	1025.60	1879.09	1814.14	4.50	4.0	5.5	3.0	3.0
1972 1	669.20	1063.40	1817.88	1683.47	4.50	4.0	5.5	3.0	3.0
2	645.50	1056.90	1841.74	1705.70	4.50	4.0	5.5	3.0	3.0
3	691.60	1125.50	2012.00	1863.12	4.50	4.0	5.5	3.0	3.0
4	734.90	1196.10	2031.10	1880.71	4.50	4.0	5.5	3.0	3.0
1973 1	810.70	1297.80	1988.78	1878.50	4.50	4.0	5.5	3.0	3.0
2	789.80	1298.60	2276.00	2149.80	4.50	4.0	5.5	3.0	3.0
3	794.40	1344.40	2662.75	2515.10	4.50	4.0	5.5	3.0	3.0
4	925.80	1508.10	4271.16	4034.30	4.50	4.0	5.5	3.0	3.0
1974 1	1004.20	1641.60	4940.34	4826.10	4.50	4.0	5.5	3.0	3.0
2	1092.30	1834.90	4922.26	4808.40	4.50	4.0	5.5	3.0	3.0
3	1221.00	2110.70	4657.13	4549.40	4.50	4.0	5.5	3.0	3.0
4	1398.50	2371.70	4291.57	4192.30	4.50	2.8	4.0	3.0	3.0
1975 1	1914.30	2986.60	5365.02	5310.80	3.50	2.8	4.0	4.0	3.0
2	2086.80	3289.80	4513.14	4467.60	3.50	2.5	4.0	4.0	3.0
3	2205.00	3554.80	5370.62	5316.40	3.50	2.5	4.0	4.0	3.0
4	2594.90	4167.30	6530.22	6005.30	3.50	2.5	4.0	4.0	3.0
1976 1	3261.80	4875.40	6297.89	6235.30	3.50	2.5	4.0	4.0	3.0
2	3159.10	5002.70	6572.26	6507.00	3.50	2.5	4.0	4.0	3.0
3	3292.00	5195.70	7071.45	7001.20	3.50	2.5	4.0	4.0	2.5
4	3752.60	5731.80	7630.69	7554.90	3.50	2.5	4.0	4.0	2.5
1977 1	4656.70	6725.80	8996.20	8865.70	3.50	2.5	4.5	4.0	2.5
2	4656.10	6704.50	8489.20	8366.10	4.00	3.0	5.0	4.0	3.0
3	5140.30	7220.70	8022.20	7905.80	4.00	3.0	5.0	4.0	3.0
4	5184.10	7439.20	7239.40	7134.40	4.00	3.0	5.5	4.0	3.0

1978	1	5534.80	7760.80	7434.80	7337.10	4.00	3.0	6.8	4.0	3.0
	2	5098.50	7533.80	8389.70	8279.50	5.00	4.0	6.8	5.0	4.8
	3	5446.70	8017.30	9657.70	9530.80	5.00	4.0	6.8	5.0	4.8
	4	5271.40	7873.10	10601.80	10462.60	5.00	4.0	6.8	5.0	4.8
1979	1	5292.30	7964.90	8684.00	8558.83	5.00	4.0	6.8	5.0	4.5
	2	5622.00	8589.80	11105.00	10946.23	5.00	4.0	6.8	5.0	4.5
	3	6206.80	9625.40	11401.40	11236.70	5.00	4.0	6.8	5.0	5.0
	4	6143.40	9845.50	11960.40	11789.78	5.00	4.0	6.8	5.0	5.5
1980	1	6899.00	10921.00	12785.40	12510.20	6.00	5.0	7.0	5.0	5.8
	2	6482.00	10868.00	12512.10	12242.80	6.00	5.0	7.0	6.0	5.8
	3	7539.00	12127.00	12314.30	12049.30	6.00	5.0	7.0	6.0	5.8
	4	9112.00	14275.00	13237.50	12952.60	6.00	5.0	7.0	6.0	5.8
1981	1	8238.00	13327.00	12150.00	11932.10	6.00	5.0	7.0	6.0	5.8
	2	8605.00	13723.00	12632.90	12406.40	6.00	5.0	7.0	6.0	5.8
	3	8998.00	14525.00	12789.70	12554.50	6.00	5.0	7.5	6.0	5.8
	4	9745.00	15239.00	13182.50	12946.10	6.00	5.0	7.8	6.0	5.8
1982	1	8879.00	14830.00	13004.40	12712.10	7.00	6.0	8.5	6.5	6.0
	2	8826.00	15012.00	12722.20	12436.20	9.00	8.0	10.5	8.5	8.3
	3	9099.00	15568.00	12522.00	12240.50	9.00	8.0	10.5	8.5	8.0
	4	10048.60	16894.00	13460.90	13158.30	8.00	7.0	9.5	7.5	7.5
1983	1	9767.00	16274.00	14405.70	14160.20	8.00	7.0	9.5	7.5	7.5
	2	9944.00	17413.10	14478.60	14231.80	8.00	7.0	9.5	7.5	7.3
	3	11025.90	18885.40	14439.80	14193.70	8.00	7.0	9.5	8.2	7.0
	4	11282.40	19368.90	13817.90	13582.40	8.00	7.0	9.5	7.5	7.3
1984	1	11102.40	19586.80	15238.90	14855.80	8.00	7.0	9.5	7.5	7.5
	2	10748.50	19795.30	14911.60	14536.70	8.50	8.5	10.0	9.5	9.0
	3	11540.10	20600.00	16145.80	15739.90	9.50	8.5	11.0	9.5	9.3
	4	12204.10	21600.50	17311.80	16876.60	10.00	8.5	11.5	9.5	9.3
1985	1	11502.60	21134.20	17505.40	17112.70	10.00	8.5	11.5	9.5	9.3
	2	11974.10	21882.20	17088.00	16704.70	10.00	8.5	11.5	9.5	9.3
	3	13180.80	23512.10	15065.10	14727.20	10.00	8.5	11.5	9.5	9.3
	4	13267.80	23818.60	22696.40	22187.30	10.00	8.5	11.5	9.5	9.3
1986	1	13000.90	24163.60	14354.30	13493.80	10.00	8.5	11.5	9.5	9.3
	2	12221.90	23571.20	15002.70	14103.30	10.00	8.5	11.5	9.5	9.3
	3	11892.30	24342.40	15162.80	14253.80	10.00	9.0	12.0	9.5	9.3
	4	13105.00	24592.70	28542.30	26831.20	10.00	11.8	12.5	9.5	9.8
1987	1	12238.60	24022.40	22295.80	19908.20	10.00	11.8	12.5	11.0	12.0
	2	11811.20	24369.80	26997.00	24106.00	10.00	11.8	12.5	11.0	11.3
	3	12403.90	26021.90	27681.80	24717.50	11.00	11.8	13.0	14.0	15.0
	4	14905.90	29994.60	31910.40	28493.30	12.75	11.8	13.0	14.0	14.9
1988	1	15884.00	32630.80	31666.30	28888.70	12.75	11.8	13.0	12.1	13.0
	2	16899.20	34904.80	32980.60	30087.70	12.75	11.8	13.5	12.0	13.0
	3	17168.30	35390.10	34520.70	31492.70	12.75	11.8	13.5	12.1	13.1
	4	21148.60	42780.30	46075.30	42033.80	12.75	11.8	14.0	12.0	13.0
1989	1	22654.00	46679.40	53364.20	49180.50	13.25	12.3	14.6	12.0	13.0
	2	23948.40	46976.60	55254.20	50922.30	13.25	12.3	14.6	12.0	13.0
	3	24439.60	44703.40	57144.30	52664.20	13.25	12.3	14.6	12.0	16.5
	4	26397.00	46922.30	59034.30	54406.00	18.50	16.4	19.6	16.5	17.5
1990	1	26722.20	49248.60	61872.10	56646.50	18.50	16.7	19.6	17.5	21.0
	2	28841.10	51920.00	64063.60	58652.90	18.50	17.5	19.6	17.4	19.6
	3	30522.30	55363.80	66254.90	60659.10	18.50	17.5	19.6	18.7	19.1
	4	37233.70	64902.70	68446.40	62665.50	18.50	17.5	19.6	18.8	19.6
1991	1	39364.00	69732.00	76884.00	71070.40	15.50	14.5	17.2	13.6	14.1
	2	45049.00	77897.00	79629.80	73608.60	15.50	14.5	17.2	14.0	14.1
	3	44922.00	79750.00	82375.70	76146.90	15.50	14.5	17.0	13.8	14.2
	4	49364.50	86152.50	85121.50	78685.10	15.50	14.5	17.0	14.0	14.2
1992	1	54265.00	96411.00	116484.70	102840.70	17.50	17.3	19.2	14.9	15.2
	2	65266.00	108988.00	130462.80	115181.60	17.50	17.3	19.2	15.5	16.0
	3	74549.00	122154.00	139781.60	123408.80	17.50	18.8	19.2	15.5	17.4
	4	79183.00	132298.00	163078.50	143976.90	17.50	21.0	19.2	16.1	18.4
1993	1	74237.60	138383.70	184948.30	165553.20	23.00	23.0	24.9	17.2	18.4
	2	87632.40	155668.20	186127.10	166608.30	26.00	25.0	28.1	16.9	19.2
	3	101841.60	177077.30	162353.70	145328.00	26.00	26.0	28.1	19.2	22.6
	4	116593.00	196318.00	168043.90	150421.50	26.00	28.0	28.1	16.7	20.9
1994	1	120574.00	210190.40	192010.20	178211.50	13.50	12.5	15.1	12.2	12.4
	2	132429.00	229142.00	219440.20	203670.20	13.50	12.5	15.1	12.2	12.2
	3	125098.80	225117.10	237726.90	220642.80	13.50	12.5	15.1	12.4	12.4
	4	172004.70	267759.80	265156.90	246101.50	13.50	12.5	15.1	12.3	12.7
1995	1	156180.30	256000.00	301696.50	288545.50	13.50	12.5	15.1	12.4	12.6
	2	165296.70	260000.00	344796.00	329766.20	13.50	12.5	15.1	12.4	12.4
	3	155148.20	249000.00	373529.00	357246.80	13.50	12.5	15.1	12.8	12.5
	4	185967.80	295211.80	416628.50	398467.50	13.50	12.5	15.1	12.6	12.5

Quarter		RF	RSF	RLF	ER	CCPI	CCPIINF	IRM2
1960	1	4	3.94	4.22	0.7143	7.4	2.571605	3.5
	2	3.5	3.09	4.11	0.7143	7.1	-2.11139	3.5
	3	3	2.39	3.82	0.7143	7.2	0.708493	3.5
	4	3	2.36	3.91	0.7143	7	-1.4477	3.5
1961	1	3	2.38	3.83	0.7143	7.8	5.268113	3.5
	2	3	2.33	3.80	0.7143	7.6	-1.28075	3.0
	3	3	2.32	3.97	0.7143	7.7	0.640402	3.5
	4	3	2.48	4.01	0.7143	7.5	-1.30612	3.5
1962	1	3	2.74	4.06	0.7143	8.2	4.240747	3.5
	2	3	2.72	3.89	0.7143	8.3	0.572778	3.0
	3	3	2.86	3.98	0.7143	8.1	-1.16601	3.0
	4	3	2.86	3.88	0.7143	7.6	-3.14158	3.0
1963	1	3	2.91	3.91	0.7143	8.2	3.611267	3.0
	2	3	2.94	3.98	0.7143	7.8	-2.43464	3.0
	3	3.5	3.28	4.01	0.7143	7.5	-1.94652	3.0
	4	3.5	3.5	4.10	0.7143	7.6	0.653064	3.0
1964	1	3.5	3.54	4.16	0.7143	8.1	3.045893	3.0
	2	3.5	3.48	4.16	0.7143	7.9	-1.20963	3.0
	3	3.5	3.5	4.14	0.7143	7.8	-0.62018	3.0
	4	4	3.68	4.14	0.7143	7.7	-0.63214	3.25
1965	1	4	3.9	4.15	0.7143	8.4	4.088445	3.5
	2	4	3.88	4.14	0.7143	8.2	-1.14525	3.5
	3	4	3.86	4.20	0.7143	8.1	-0.58656	3.5
	4	4.5	4.16	4.35	0.7143	8	-0.5974	3.5
1966	1	4.5	4.63	4.56	0.7143	8.9	4.876811	3.5
	2	4.5	4.6	4.58	0.7143	9.2	1.493885	3.5
	3	4.5	5.05	4.78	0.7143	9.1	-0.49492	3.5
	4	4.5	5.25	4.70	0.7143	8.7	-2.07789	3.5
1967	1	4.5	4.53	4.44	0.7143	9.2	2.518045	3.5
	2	4	3.66	4.71	0.7143	8.8	-2.04399	3.5
	3	4	4.34	4.93	0.7143	8.6	-1.0684	3.5
	4	4.5	4.74	5.33	0.7143	8.2	-2.26355	3.5
1968	1	5	5.06	5.24	0.7143	8.9	3.747261	3.5
	2	5.5	5.51	5.30	0.7143	8.6	-1.59353	3.0
	3	5.25	5.23	5.07	0.7143	8.5	-0.54653	3.0
	4	5.5	5.58	5.42	0.7143	8.6	0.543559	3.0
1969	1	5.5	6.14	6.07	0.7143	9.5	4.420995	3.0
	2	6	6.24	6.04	0.7143	9.6	0.462973	3.0
	3	6	7.05	6.41	0.7143	9.5	-0.46513	3.0
	4	6	7.32	6.53	0.7143	9.6	0.462973	3.0
1970	1	6	7.26	6.56	0.7143	10.3	3.017864	3.0
	2	6	6.75	6.82	0.7143	10.8	1.992067	3.0
	3	6	6.38	6.65	0.7143	11	0.76522	3.0
	4	5.5	5.36	6.27	0.7143	10.8	-0.77112	3.0
1971	1	4.75	3.86	5.82	0.7143	12.4	5.487167	3.0
	2	4.75	4.21	5.88	0.7143	12.5	0.31802	3.0
	3	5	5.05	5.75	0.6579	12.7	0.624535	3.0
	4	4.5	4.23	5.51	0.6579	12.5	-0.62846	3.0
1972	1	4.5	3.43	5.65	0.6579	13.7	3.502228	3.0
	2	4.5	3.75	5.66	0.6579	13.2	-1.44093	3.0
	3	4.5	4.24	5.60	0.6579	12.5	-2.15733	3.0
	4	4.5	4.85	5.61	0.6579	12.9	1.231751	3.0
1973	1	5.5	5.64	6.09	0.6579	13.5	1.746746	3.0
	2	6.5	6.61	6.22	0.6579	13.6	0.282751	3.0
	3	7.5	8.39	6.59	0.6579	13.7	0.279901	3.0
	4	7.5	7.46	6.31	0.6579	14.2	1.351026	3.0
1974	1	7.5	7.6	6.64	0.6579	15.2	2.500775	3.0
	2	8	8.27	7.05	0.6162	15.4	0.478064	3.0
	3	8	8.28	7.27	0.6135	15.3	-0.23882	3.0
	4	7.75	7.34	6.98	0.6162	15.5	0.473838	3.0
1975	1	6.25	5.87	6.67	0.6138	18.8	6.578943	3.5
	2	6	5.4	6.96	0.6077	20.2	2.389673	3.5
	3	6	6.33	7.08	0.6178	21.3	1.733552	3.5
	4	6	5.68	7.22	0.6257	21.9	0.900039	3.5
1976	1	5.5	4.95	6.91	0.6246	25.3	4.466933	3.5
	2	5.5	5.17	6.88	0.6262	24.5	-1.00452	3.5
	3	5.5	5.17	6.78	0.6265	24.9	0.503748	3.25
	4	5.25	4.68	6.55	0.6310	25.2	0.371144	3.25
1977	1	5.25	4.62	7.62	0.6370	28.3	3.470613	3.25
	2	5.25	4.83	7.68	0.6513	29.3	1.02812	3.5
	3	5.75	5.47	7.60	0.6513	31.5	2.098561	3.5
	4	6	6.14	7.78	0.6513	32.1	0.543939	3.5
1978	1	6.5	6.41	8.19	0.6203	33.4	1.131514	3.5
	2	7	6.48	8.43	0.6190	34.5	0.915104	4.9
	3	8	7.32	8.54	0.5892	34.6	0.081667	4.9
	4	9.5	8.68	8.78	0.5849	34.9	0.243023	4.9

1979	1	9.5	9.36	9.03	0.6396	38.3	2.55011	4.75
	2	9.5	9.38	9.08	0.6055	38.7	0.284198	4.75
	3	11	9.63	9.03	0.5749	38.5	-0.14193	5.0
	4	12	11.8	10.18	0.5703	38	-0.35936	5.25
1980	1	13	13.46	11.78	0.5591	41.4	2.301594	5.38
	2	11	10.05	10.58	0.5443	39.8	-1.06991	5.88
	3	11	9.24	10.95	0.5338	43.7	2.47478	5.88
	4	13	13.71	12.23	0.5419	43.9	0.120744	5.88
1981	1	13	14.37	12.74	0.5722	50	3.325865	5.88
	2	14	14.83	13.49	0.5905	50.3	0.152678	5.88
	3	14	15.09	14.50	0.6671	52.1	0.88941	5.88
	4	12	12.02	14.14	0.6356	51.7	-0.19534	5.88
1982	1	12	12.89	14.27	0.6643	56	1.984766	6.25
	2	12	12.36	13.74	0.6756	54.2	-0.81826	8.38
	3	10	9.71	12.94	0.6843	54.4	0.092161	8.25
	4	8.5	7.93	10.72	0.6720	55.1	0.318906	7.5
1983	1	8.5	8.08	10.87	0.6999	62.1	2.896678	7.5
	2	8.5	8.42	10.81	0.7272	64.2	0.799063	7.38
	3	8.5	9.19	11.79	0.7486	69.7	1.936694	7.58
	4	8.5	8.79	11.90	0.7486	74.4	1.514243	7.38
1984	1	8.5	9.13	12.09	0.7486	86.2	3.303238	7.5
	2	9	9.84	13.21	0.7543	100.1	3.245634	9.25
	3	9	10.34	12.83	0.7682	106.5	1.327625	9.38
	4	8	8.97	11.78	0.8081	98.9	-1.61155	9.38
1985	1	8	8.18	11.58	0.8746	103.4	0.959255	9.38
	2	7.5	7.52	10.81	0.8951	103.8	0.083166	9.38
	3	7.5	7.1	10.34	0.9157	101.3	-0.52792	9.38
	4	7.5	7.13	9.76	0.9595	100	-0.28047	9.38
1986	1	7.1	6.89	8.56	1.0016	101.1	0.236998	9.38
	2	6.5	6.13	7.60	1.1249	100.3	-0.1724	9.38
	3	5.5	5.53	7.31	4.6406	107.9	1.560262	9.38
	4	5.5	5.34	7.26	3.1828	106.9	-0.1993	9.63
1987	1	5.5	5.53	7.19	3.9213	115.7	1.665056	11.5
	2	5.5	5.73	8.34	4.0506	111.4	-0.80357	11.15
	3	6	6.03	8.88	4.2073	114.1	0.505548	14.5
	4	6	6	9.12	4.1664	116.1	0.365477	14.45
1988	1	6	5.76	8.42	4.3169	135.7	3.176796	12.55
	2	6	6.23	8.91	4.1913	152.1	2.270684	12.5
	3	6.5	6.99	9.10	4.7167	171.2	2.300177	12.6
	4	6.5	7.7	8.96	5.3530	181.2	1.091793	12.5
1989	1	7	8.53	9.21	7.5871	209.7	2.732613	12.5
	2	7	8.44	8.77	7.3471	230.2	1.714868	12.5
	3	7	7.85	8.11	7.3401	230	-0.01598	14.25
	4	7	7.63	7.91	7.6221	272.7	3.036404	17.0
1990	1	7	7.76	8.42	7.9388	255.4	-1.18245	19.25
	2	7	7.77	8.68	7.9424	288.7	2.163262	18.5
	3	7	7.49	8.70	7.9743	286.6	-0.12903	18.9
	4	6.5	7.02	8.40	8.7071	285	-0.09905	19.2
1991	1	6	6.05	8.02	9.4521	287.1	0.12971	13.85
	2	5.5	5.59	8.13	10.1722	298.5	0.683296	14.05
	3	5	5.41	7.94	10.2416	300.6	0.122866	14.0
	4	3.5	4.58	7.35	9.865	330.9	1.655266	14.1
1992	1	3.5	3.91	7.30	17.6107	350.1	0.962796	15.05
	2	3.5	3.72	7.38	18.4563	362.5	0.590627	15.75
	3	3	3.13	6.62	19.3497	401.9	1.720738	16.45
	4	3	3.08	6.74	19.6609	478.4	2.823846	17.25
1993	1	3	2.99	6.08	24.8651	598.8	3.510285	17.8
	2	3	2.98	5.99	21.8861	732.3	3.0512	18.05
	3	3	3.02	5.62	21.8861	823.5	1.748296	20.9
	4	3	3.08	5.61	21.8861	850	0.46956	18.8
1994	1	3	3.25	6.07	21.8861	930.7	1.326821	12.3
	2	3.5	4.04	7.08	21.8861	1062.1	1.895324	12.2
	3	4	4.51	7.33	21.8861	1271.6	2.518567	12.4
	4	4.75	5.28	7.95	21.8861	1458.4	1.88143	12.5
1995	1	5.25	5.78	7.48	21.8861	1668	1.809928	12.5
	2	5.25	5.62	6.62	21.8861	1995.7	2.360512	12.4
	3	5.25	5.38	6.32	21.8861	2227.9	1.427775	12.65
	4	5.25	5.27	5.89	21.8861	2270	0.242259	12.55

APPENDIX C:

DICKEY-FULLER t-STATISTIC TABLE ADAPTED FROM CHAREMZA AND DEADMAN

		5% CRITICAL VALUE		10% CRITICAL VALUE	
n	T	DF	ADF	DF	ADF
2	50	-3.67	-3.29	-3.10	-2.85
	100	-3.37	-3.17	-3.04	-2.82
	144	-3.30	-3.10	-3.03	-2.80
3	50	-4.11	-3.75	-3.40	-3.22
	100	-3.93	-3.68	-3.46	-3.29
	144	-3.80	-3.60	-3.49	-3.32
4	50	-4.35	-3.98	-3.70	-3.56
	100	-4.22	-3.92	-3.68	-3.65
	144	-4.20	-3.86	-3.50	-3.45
5	50	-4.33	-4.15	-3.99	-3.82
	100	-4.31	-4.07	-3.79	-3.73
	144	-4.29	-4.00	-3.66	-3.50
6	50	-4.58	-4.41	-4.22	-4.06
	100	-4.67	-4.51	-4.36	-4.20
	144	-4.70	-4.55	-4.42	-4.26
7	50	-4.79	-4.61	-4.45	-4.26
	100	-4.92	-4.73	-4.62	-4.42
	144	-4.98	-4.79	-4.70	-4.50