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The Demand for money function in Nigeria: an empirical investigation

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THE DEMAND FOR MONEY FUNCTION IN NIGERIA: AN EMPIRICAL INVESTIGATION

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ABSTRACT

This paper provides further empirical evidence on the nature of the demand for money function in Nigeria for the period 1960-1991. The paper also addressed the issue of the appropriate adjustment process, structural stability of the estimated equations, as well as the influence of external factors on money demand function in an open economy, such as Nigeria. The main conclusions which emerged from the analysis are that, the real adjustment mechanism appeared to be the most appropriate adjustment process for modelling money demand in Nigeria; the influence of external variables like the foreign interest rate and exchange rate should not be discounted in any specification of money demand function in Nigeria, the domestic interest rate in addition to inflationary expectations are relevant domestic opportunity cost variables in Nigeria's demand for money function; there is absence of economies of scale in cash management in Nigeria; and the adjustment period is very long. The battery of diagnostic tests produced conflicting results, making it difficult to select a particular equation for each definition of money as the most adequate representation of the data for the period of analysis.

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I. INTRODUCTION

Despite over three decades of substantial theoretical and empirical investigations into the demand for money function, the subject has to date continued to attract considerable attention from theoreticians and practitioners alike, in both developed and developing countries. 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. A poorly specified money demand function could lead, for example, to spurious inferences on the underlying stability of money demand - a consideration crucial in the formulation of monetary policy. The setting of target paths for monetary aggregates is predicated on the existence of reasonably stable relationships between the demand for money and the ultimate objectives of policy, like the level of prices and real output.

In the pursuit of a meaningful policy regarding money supply, understanding the demand for money plays an important role. The analysis of money demand helps policy makers to forecast money demand and determine the optimum growth rate of money supply which is crucial in the control of the rate of inflation. The identification of the demand for money function is equally important as it plays a crucial role in the transmission mechanism of both monetary and fiscal policy. In addition, the temporal stability of such identified function is also crucial if monetary policy is to have a predictable effect on the ultimate objectives of economic policy.

In Nigeria, there have been substantial empirical studies on the demand for money function, beginning with the seminal work of Tomori (1972) through the famous 'TATOO' debate of the 1970's to the studies carried out in the 1980s.[1] The objective of this study is to provide further empirical evidence on the nature of demand for money function in Nigeria, taking advantage of longer time series data, which incorporates the period of interest rates and foreign exchange deregulation. The paper also seeks to examine the extent to which domestic money holdings have been influenced by foreign monetary developments as summarized by expected short-term foreign interest rates and foreign exchange considerations (expected rate of depreciation of a country's currency) - an influence known as 'currency substitution.' From the point of view of policy, knowledge of the degree to which domestic money holdings respond to foreign exchange considerations is important for the design of monetary and exchange rate policies.[2] We argue in the paper that the controversy surrounding the significance or otherwise of interest rate in the money demand function in Nigeria may no longer hold sway, in the light of interest rates deregulation, the financial innovations that accompanied the adoption of the Structural Adjustment Programme in general and the other measures introduced to achieve the deregulation of the financial sector in particular. Preliminary investigation revealed that interest rate may after all be an important explanatory variable in any demand for money function in Nigeria in view of these developments.

In this paper, we intend to specify and estimate demand for money function

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1 TATOO is the acronym for Tomori, Ajayi, Teriba, Ojo and Odama.

2 Apart from Darrat (1986) which included an arithmetic average of short term interest rates of major OECD countries as an argument in his specification, we are not aware of any previous study that has attempted to determine the influence of these factors on the demand for money in Nigeria.

for Nigeria for the period 1960-1991 based on theoretical considerations and previous empirical studies. We also hope to address the issue of appropriate adjustment process whereby the actual money stock adjust to the desired level -that is, whether the relevant adjustment process in Nigeria is the real or nominal partial adjustment mechanism. Furthermore, since the usefulness of any regression equation for policy analysis hinges crucially on its structural stability, we will examine the stability property of the estimated money demand function through the use of several formal stability tests. Another major distinguishing feature of this study from the previous studies is the variety of diagnostic tests relating to specification errors to which the estimated demand for money function is subjected to. The rest of the paper is organized as follows. Section II undertakes a fairly comprehensive survey of the literature on demand for money function in Nigeria. Section III briefly discusses the theoretical issues for money demand specification. In section IV, the specification of the demand for money function for Nigeria is presented, with a discussion of the main issues involved. The empirical results are presented and discussed in section V. Section VI is devoted to a discussion of the battery of diagnostic tests and examines the question of the structural stability of the estimated money demand equation, applying some formal tests. The paper ends with some concluding remarks in section VII.

II. A SURVEY OF LITERATURE ON DEMAND FOR MONEY IN NIGERIA

The theoretical underpinning of the demand for money has given rise to many issues which have been the focus of empirical investigation in Nigeria over the years. The main theoretical issues involved in the estimation of the demand for money has given rise to the following questions: (1) Is the demand for money measured in nominal terms, proportional to the price level? (2) Should income or wealth or both be included in the demand for money function? (3) Is the rate of interest an important variable in the function? Or put differently, is the demand for money responsive to interest rates? (4) Are there any significant economies of scale in money holdings? (5) Does the rate of inflation or its expected value exert any significant influence on the demand for money? (6) Has there been any evidence of instability in the demand for money function? (7) What definition of money provides a better specification? and (8) How close is the complementarity relationship between money and physical assets as propounded by Mckinnon (1973) in the process of economic development?

In Nigeria, 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 (1972). A summary of the main results of these studies is presented in Table 1, while only a brief summary of the issues involved/conclusions, is attempted in this section.[3] These studies have attempted to examine one or more of the main issues highlighted in the preceding paragraph, while most of them followed the conventional specification found in the economic literature.

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3 We do not attempt a critique of these studies. The interested reader is referred to these studies for a detailed analysis/discussion.

Tomori (1972) in his pioneering effort set out to (a) examine the factors which have influenced the demand for money in the Nigerian economy; (b) establish whether there is or there is not a stable demand for money function, and (c) examine what constitutes a better definition of money in the Nigerian context. He adopted a very simple linear model which expressed nominal (and real) narrow (and broad) money as a function of either nominal (or real) GDP - a proxy for income or both income and interest rate (official discount rate) representing the opportunity cost of holding money. The model was estimated using annual data for the period 1960 to 1970, while a test for stability was conducted by running a separate regression for the period 1960 - 1966 and comparing the coefficients obtained with that of the full sample. Applying the ordinary least squares (OLS) technique, the following conclusions were made: (i) income is a significant variable explaining variations in the demand for money, irrespective of which definition is adopted; (ii) income is a more important variable determining the demand for money than the interest rate; (iii) the narrow definition of money seems to perform better than the broad definition; (iv) on average, real income seems to show a more significant relationship than nominal income in the demand for money; (v) the coefficient of the interest rate is not significant and this seems to confirm the proposition that there is a stable demand for money in the period under review.

The methodology and conclusions of Tomori's work generated a spate of reactions and criticisms that prompted further empirical studies to be carried out on the demand for money in Nigeria. Ojo (1974a) commenting on Tomori's paper seriously questioned the appropriateness of his statistical methodology, the measure of real interest rate adopted in the demand for money equation, and some of the conclusions reached. In a closely related comment, Odama (1974) criticized the econometric technique adopted by Tomori emphasizing the error in approaches. Specifically, his comments focused on two aspects of Tomori's results. The first concerns the formulation of an alternative model and the relevance of such a model for policy actions. The second relates to the statistical results and the conclusions therefrom. According to him, Tomori's model is devoid of any policy use in view of the fact that the only policy instrument (discount rate) turned out to be statistically insignificant. He cautioned that the result in Tomori's paper should be interpreted with utmost caution.

In his comment Teriba (1974) observed that Tomori's paper suffered from several methodological pitfalls and interpretational defects, including the problems of inadequate model specification. In order to remedy the shortcomings of Tomori's paper, Teriba in his comments/study advocated for the inclusion of different interest rates, either individually or in combination, so as to throw more light on the degree of substitutability between money and other financial assets, and also to identify the closest substitute for money. He further contended that estimating an aggregate demand function was not sufficient in itself, but that demand for its components should be specified and estimated as well. This, according to him would throw more interesting light on the demand for money in Nigeria than the aggregated function. The issue of adjustment mechanism between the actual and the desired levels of money balances which was absent in Tomori's paper was also taken up by Teriba.

Employing the OLS technique and the log linear relationship between real balances (or its components) and its determinants, Teriba specified and estimated a short-run demand for money function that relate real balances to aggregate real national income, lagged real balances and a variety of interest rates - Federal Government long-term interest rate, RL; Central Bank short-term interest rate, RG; time deposit interest rate, Rm; and savings deposit interest rate, Rs. A war dummy was included to account for the civil war years, 1967-1969. On the basis of his empirical work, Teriba arrived at the following conclusions: (a) of all the assets included in the study time deposits are the closest substitute for money narrowly defined or its components, currency and demand deposits; (b) real income is the most important variable determining the demand for money as well as the components; (c) there are evidences that to some extent treasury bills are also close substitutes for money or currency, while savings deposit appears to be close substitutes for demand deposits than treasury bills; (d) the war years had negative but insignificant effect on the demand for narrow money or its components; (e) the speed of adjustment between actual and desired balances for narrow money and currency is very slow, while in the case of demand deposits it is fairly fast; (f) the short-run and long-run interest elasticity of demand for currency is not significantly different from zero, while the short-run income elasticity is in all cases below one, the long-run elasticity is in all cases much greater than unity; (g) in the case of demand deposits, the interest elasticities are very low and insignificant, while the short-run income elasticity was never below 0.8 and the long-run elasticity was generally about 1.4; (h) the result of the disaggregated equations for currency and demand deposits differ substantially from those for the aggregate equation; and (i) what is money is basically an empirical question.

Ajayi (1974) in addition to criticising Tomori's (1972) paper, sought to address the shortcomings inherent in the paper. Specifically, Ajayi sought to provide answers to such questions as the stability of the demand function, the adjustment mechanism and calculation of elasticities for policy decision making. Like Teriba (1974), Ajayi employed the partial adjustment framework, but instead he specified his equations in linear form with real balances (and nominal balances), narrow and broad, expressed as a function of current nominal income, short term interest rate and lagged real (or nominal) balances. Using the OLS technique to estimate the equations, Ajayi came to the following conclusions: (a) income alone explains about 81 per cent of the demand for money when the narrow definition is used and between 85-86 per cent when the wider definition of money is used; (b) interest rates have wrong signs and are statistically insignificant; (c) the wider definition of money performs better, irrespective of whether real or nominal balances is adopted; (d) interest elasticity of the demand for money at the mean is low, while the income elasticity is high ranging from 1.5 to 1.9 for nominal money balances, thus indicating that demand for money is not sensitive to interest rate. However, income elasticity for real balances using both narrow and broad money are less than unity; and (e) the speed of adjustment is fast.

Ojo (1974b) was concerned mainly with establishing that in a developing economy like Nigeria, characterised by underdeveloped money market and lack of financial assets, the choice facing an individual is more between money and physical assets rather than between money and financial assets. Consequently, he specified and estimated (using the OLS technique) two kinds of relationship (in log-linear

form) between money and its determinants. He first specified real money balances as a function of current nominal income and interest rate. Following the insignificance of interest rate variable in this equation, he specified real money balances as a function of nominal income and expected rate of inflation. In this framework he adopted the adaptive expectations hypothesis to derive the expected rate of inflation that eventually entered the equation for money demand. His estimate of this equation suggested that the demand for money is inelastic with respect to income and price change expectations. The coefficient of inflation rate appeared with the right (negative) sign and was statistically significant, thus confirming Ojo's belief that physical goods are close substitutes for money in our type of economy. He, however, cautioned that this finding should not be stretched too far since with the development of the money market, financial instruments and financial intermediation, the role of interest rates may become a significant variable in money demand functions in Nigeria and hence in the adjustment process.

Iyoha (1976) sought to test the applicability of the permanent income hypothesis to Nigeria by estimating a demand for money incorporating this variable as a determinant for the period 1950-1965. A secondary objective of the study was to establish that interest rate play little or no role in the demand for money and that income elasticity is less than unity contrary to Adekunle (1968) presumption of a higher income elasticity for our type of economy. Two sets of regression were carried out in both linear and log-linear using current income (or permanent income) and/or interest rate (U.K. bond rate) and/or lagged real balances. The permanent income variable used for his analysis was derived from a distributed lag of current and past income levels with exponentially declining weights. The following conclusions emerged from Iyoha's analysis - (a) the log linear fits are slightly better than the linear ones; (b) for current income equation, the income elasticity of demand for money is significantly greater than unity in both cases; (c) the permanent income equations seem to have provided slightly better overall fit than equations employing current income as the scale variable; (d) for permanent income equations the short-run income elasticity was significantly less than unity, while the long-run elasticity was about one; (e) interest rate has little or no influence on the demand for money in Nigeria, however, this result is preliminary and the conclusion should be used with caution; (f) there is some evidence that the current income specification is superior to that of permanent income, i. e. it seems that current (real) income is a better predictor of the demand for real balances than permanent (real) income in Nigeria.

Unlike the earlier studies, Akinnifesi and Phillips (1978) in their study approached the specification and estimation of demand for money function from a simultaneous equation framework, by specifying a money supply and money demand function. According to them, their objective was "to present a framework for predicting monetary behavior by identifying the variables which determine the supply of and the demand for money in the Nigerian economy." They also stated that their enquiry into the demand for money function was prompted by the need to understand the transmission mechanism of how monetary policy affects peoples' decision to spend. Their demand for money function was based

on the Friedman' approach, which states that the demand for money is dependent on the rates of return on all assets which are alternatives to money and total wealth. Both linear and log-linear relationship were estimated using the OLS technique for the period 1962-1975, while the adaptive expectation approach was employed to convert the unobservable expected income and interest rates variables to their observable counterparts. Equations were specified and estimated for the two monetary aggregates, M1 and M2, as well as for their components - currency, demand deposits, time deposits and savings deposits, in real terms with a variety of interest rates, namely - rate on saving deposits, time deposits rate, long-term rates, minimum rediscount rate, average lending rate, treasury bill rate and the Federal Savings Bank rate, entering the equations. The main conclusions of Akinnifesi and Phillips were that: (a) multi-collinearity was a problem where five or more interest rates entered the equations; (b) the civil war did not significantly affect the demand for money or its components; (c) the linear logarithmic specification performed better than the simple linear model; (d) generally, the demand for real money balances in Nigeria can be described as a function of its own lagged value, expected real income and expected rate of interest; (e) there are evidences that demand for money and its components are responsive to some crucial interest rates - average lending rate, minimum rediscount rate and treasury bill rate, which the monetary authorities could focus on for policy purposes; (f) expectations in Nigeria's monetary sector are non-static so that expected or permanent income and expected rate of interest are significant arguments in the demand for money function in aggregate and component forms; (g) the lag in income and interest rate expectations formation are fairly long, although varying from asset to asset; (h) savings deposit is a good proxy for money; (i) income elasticities are positive and significantly greater than one, while interest rate elasticities are negative as expected and significantly different from zero, thus implying that money balances are close substitutes for the financial assets considered; and (j) the result for interest elasticity of the demand for money is indicative that monetary policy may not necessarily enjoy maximum effectiveness.

The study by Shahi and Sheikh (1979) was essentially aimed at examining the short-run demand for money in a situation of inflationary expectations, determine the elasticity of price expectations and that of real cash balance adjustment, and to find out whether inflation in Nigeria is self-generating or not. Starting with the framework advocated by Friedman (1956), and adopting both the partial adjustment and adaptive expectation mechanisms, they arrived at an equation which made demand for money to depend only on the price level and lagged dependent variable. Employing a two-stage least squares constrained non-linear regression technique and using quarterly data from 1960:1 to 1978:1 to estimate their model, the following conclusions were arrived at: first, the structural parameters suggest the presence of both expectations and adjustment lags and the adjustment of the actual to the desired level of real cash balances is quite reflective of the inflationary situation in the country when judged in terms of the speed of such adjustment. Second, there were no indications of the self-generating character of inflation in Nigeria, hence the explanation for the rise in the price level should probably be sought in terms of factors other than increased supply of money alone. Commenting on this paper, Mutambuka (1983) criticized the specification, estimation methodology and results, as well as the conclusions reached by Shahi and Sheikh (1979).

Unlike the preceding studies, Fakiyesi (1980a) approached the issue of an appropriate money demand function for Nigeria from an entirely different framework. Using quarterly data for the period 1960:1 to 1975:4, Fakiyesi specified and estimated a log-linear distributed lag function for both narrow and broad money balances, with polymonials of orders two and three. The Almon lag technique was adopted in determining the weights. Permanent income and permanent prices were the key arguments that entered his specification. From his empirical analysis, he came to the conclusion that the lag in income is shorter than the lag in the price level; the income elasticity (in absolute terms) is lower than the price elasticity for both M1 and M2 and the elasticities were significantly different from zero, with the price elasticity not significantly different from unity; and whether M1 or M2, permanent income and permanent prices have a role to play in explaining the asset behaviour of Nigerians. He concluded that from the result it matters for the policy-makers which definition of money they prefer for the purpose of monetary policy.

In another paper, Fakiyesi (1980b) sought to examine the structural stability of the demand for money function in Nigeria for the period 1960:1 to 1976:4. He specified two variants each of the demand for real money balances (M1 and M2) in log-linear form - one with interest rate as the opportunity cost variable, and the other with expected rate of inflation as the opportunity cost of holding real balances. Employing the adaptive expectations framework for the underlying model in the latter case and using the Chow (1960) F-test and the Goldfeld (1977) Likelihood Ratio test (distributed as χ^2) for the sub-periods 1960:1 to 1967:2 and 1967:3 to 1976:4, 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. He, however, observed that the demand for money was volatile with respect to certain interest rates variables, namely the bill rate and the first class lending rate.

Like Fakiyesi, Darrat (1986) in his study of the demand for money functions for three OPEC countries, including Nigeria employed the distributed lag framework (modified Almon Polynomial procedure) for his model specification for currency, narrow money and broad money. A major departure from earlier studies was the consideration given to the international monetary influences on domestic money holdings, through the inclusion of foreign interest rate, along with income and expected rate of inflation in his specification. The Cochrane-Orcutt procedure was used to correct for serial correlation problem detected. Using quarterly data for the period 1963-1979 and employing battery of diagnostic tests, particularly for testing temporal stability of the estimated equation, he came to the following conclusions: expected (permanent) real income and inflationary expectations play significant roles in determining real balances in Nigeria, foreign interest rate exert a significant negative impact on real money demand and it exerts a stronger effect on real money demand in terms of long-run elasticities than expected inflation rate; long-run income elasticity is not significantly different from unity; the demand for money exhibited structural stability during the period covered by the study. In the light of his findings he stated *inter-alia* that, "money demand function in open economies that do not include foreign interest rates among their explanatory variables may be seriously misspecified to the extent of potentially rendering the whole money demand relationship structurally unstable."

Although the study by Asogu and Mordi (1987) was not specifically devoted to analysing money demand function in Nigeria, the study incorporated equations for demand for various components of nominal money balance, viz: currency, demand, time and savings deposits.[4] Like the studies carried out in the 1970s, the study adopted a partial adjustment framework to specify the equations with current income, interest rate and inflation rate, among other variables, as arguments in the equations. A linear and nominal relationship was used throughout, while estimation was carried out using the OLS technique for the period 1960 to 1986. Their result showed that apart from current income, inflation rate, time deposit rate and lagged dependent variable, the number of bank branches (or its change) was significant in explaining the demand for these components of nominal money balance. However, these variables did not appear in every equation.

Adejugbe (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 narrow and broad real money balances. Both studies specified their equations in log-linear form, but the latter study placed more emphasis on the temporal stability question. Current income, rate of interest and inflation rate were the arguments in their equations.[5] While Adejugbe carried out his estimation using the Aitkens generalized least squares procedure, the OLS technique was adopted by Audu.[6] In testing for stability the former utilized the Chow (1960) test, while the latter employed the Gujarati (1970 a,b) test. The conclusions reached by Adejugbe were that: measured income, rate of interest and lagged variables constituted effective determinants of the demand for money; interest rate is a superior opportunity cost variable than the rate of inflation; real money is interest elastic, but income inelastic; adjustment from actual to desired level is fast for real M1; M2 was stable over the period covered by the study, 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 significance of the coefficients of the predictor variables and the intercept term; oil sector GDP had no significant impact in influencing a shift in demand for money function; real balance is inelastic with respect to both interest rate and inflation rate; income elasticity of M1 was greater than that of M2; M2 always performed better than M1; and the adjustment period for money demand is long.

The study by Ajewole (1989) was mainly concerned with testing the relevance or otherwise of the Mckinnon model of demand for money to Nigeria. From his empirical findings he concluded *inter-alia* that real demand for money in Nigeria is considerably influenced by real income and average return on physical assets; broad definition of money is more relevant in modelling real demand for money in Nigeria, there is no significant difference in real money demand when expected or current (actual) income is used; a stable demand for money function exists in Nigeria; interest rate does not significantly influence money demand in Nigeria, even though it is correctly signed; and finally, the Mckinnon model of money demand is relevant and applicable to Nigeria.

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4 The equations were part of a model of the monetary sector.

5 Audu in his study also tried using non-oil GDP as the scale variable instead of aggregate GDP.

6. Unfortunately, the tables containing the estimated equations in Adejugbe's paper were omitted in the publication. The period covered by the study was not indicated. Audu's study covered the period 1960 to 1987, using annual data.

The World Bank (1991) in a preliminary study of money demand relation in Nigeria specified and estimated a log-linear relationship for real broad money for the period 1961 to 1966 and 1974 to 1989 using annual data. Implicitly assuming instantaneous adjustment, the study specified real demand for broad money as a function of non-agricultural GDP, the rate of inflation and the real deposit rate. All the variables turned out with the expected signs and were all significant at the one per cent level. The main conclusions were that the results of the estimates were stable over different periods, the elasticity of money demand with respect to non-agricultural GDP growth was about 1.2, and as inflation rises, depositors are marginally less willing to hold money, while as real interest rate rises they seem to be slightly more willing to hold money in the banking system.

The Central Bank of Nigeria in the formulation of monetary policy, has over the years relied on a log-linear real demand for money function (for both broad money and quasi money) predicated on the conventional partial adjustment framework, with measured real income, inflation rate and lagged real balances as the principal arguments.

III. THEORETICAL ISSUES

The theoretical underpinnings of the demand for money in an economy are very familiar and common; therefore we do not intend to go into them here. Also, we do not want to join the debate in the literature as to the form of demand for money function. It is sufficient to adopt the form which appears to be the most popular.There appears to be a consensus that the demand for money for all purposes is the demand for real balances. The explanatory variables commonly used in the literature are interest rates, expected rate of inflation and real income. The interest rate could be real or nominal depending on the definition of money adopted; it could be for deposits of varying maturity, bonds of short-term or long term maturity. The rate is expected to reflect the substitutability between money and bonds or other forms of financial assets which are alternatives in the portfolio of assets of wealth owners. The expected rate of inflation reflects the reaction of wealth owners with respect to money holding and changes in the prices of goods of all category. Persistent pressures on aggregate demand, resulting in higher levels of inflation rate could cause wealth owners to reduce the amount of real money balances they wish to hold especially if the situation leads to speculation about the state of future prices. The inclusion of the expected inflation rate in demand for money function is, therefore, designed to capture the rate of substitution between goods and money. The real income is an important economic variable in the demand for money function, reflecting the state of wealth or the transactions motives for holding money. *A priori* expectations are that the coefficient of income should be positive in a demand for money function since real money demanded are expected to rise with the value of transactions in real terms at a given rate of interest. The coefficient of interest rate could be positive or negative depending on whether the interest rate is real or nominal; and also on the measurement of money adopted; that is, narrow (M1) or broad money (M2). If the measure of money is broad money (M2), wealth owners could shift their assets to deposits as hedge against higher inflationary expectations, thereby making the coefficient of real interest rate positive in the demand function for M2. Thus, for any economy, the sign of the coefficient of interest rate is an empirical issue.

In the literature some other variables are suggested as possible explanatory variables. Wealth, the ratio of current to permanent income, and one or more variables, measuring the cost of managing a cash balance are all suggested as variables which could explain the demand for money in an economy. However, since we are interested in a function that will serve the practical needs of policy, the variables to be used must be such that it is possible to obtain data on them on a continuous basis, not only currently but also in the immediate future. There is, therefore, no need to explore the role of these variables as at now.

The Nigerian money market has usually been regarded as less developed with insignificantly low level of financial assets. Consequently, in many empirical works, interest rate has not been regarded as a significant determinant of the demand for money in Nigeria. This has been moreso as the levels of interest rates were, in the past, administratively fixed low with a view to either minimising government expenditure in the case of treasury securities; or promoting investment in the real sector in the case of lending and deposit rates on financial assets. However, following the efforts to deregulate the Nigerian economy interest rates have been liberalised; and they are substantially market determined. Also, for most of the time since liberalisation, interest rates have remained positive in real terms. These developments have significantly affected the levels and structure of interest rates to the extent that it does not appear realistic to continue to assume that the demand for money in Nigeria will be neutral with respect to interest rates. However, it is still an important exercise to know which of the rates or in which form interest rates enter the demand for money equation.

Also, in response to the developments in the interest rates and other policy measures adopted to deregulate the Nigerian economy, the mode of keeping wealth among owners of wealth appears to have shifted. For instance, recent developments in the capital market have resulted in substantial enlargement in the holdings of shares, and other private sector instruments for borrowing. The range of available financial instruments for keeping wealth has widened suggesting increased depth of the financial market generally. These developments seem to suggest that the form of the demand for money functions which used to rely on the traditional assumptions of poorly developed money and capital markets in which wealth owners keep their wealth in money and goods only, so that variations in interest rates are neutral on the demand for money and vice versa, is no longer valid. The extent to which the changes enumerated above have affected the demand for money is, however, an empirical issue.

Equally important is the need to investigate the likely effects on demand for money of trade and payments liberalisation; and the introduction of the foreign exchange market for determining the naira exchange rate in the place of the administrative fixing of the rate by the authorities. These changes have not only increased the degree of openness of the Nigerian economy to foreign trade and payments, but have also led to pervasive changes in monetary aggregates. The increasing flexibility in the exchange rate has substantially affected the financial transactions of banks and non-banks to the extent that satisfactory explanation of monetary and price developments can not be made without reference to them. The reform measures have also made it possible for wealth owners to keep their assets in foreign currency in interest earning domiciliary account. Consequently, bearing in mind the theoretical implications in the economic literature on the likely

influence of the foreign interest rates, and the expected change in exchange rate on the demand for money, it does not sound realistic to continue to neglect these changes in the Nigerian situation of the moment.

IV. MODEL SPECIFICATION

In specifying the model adopted in this study, we have been guided by theoretical considerations, voluminous empirical evidence in Nigeria and other developing countries, as well as by the peculiarities of the Nigerian economy since deregulation. It is not uncommon to find that most empirical estimation of money demand functions begin by discussing a number of analytical and technical issues. However, since extensive treatment of many of these issues abound in the economic literature we do not consider it necessary to address them here.[7]

In line with the general portfolio approach, we assume that the desired real demand for money $(M/P)^d$ is positively related to permanent real income (y^p) and negatively related to the yields on alternative assets, namely, physical and financial assets which are considered close substitute for money. Conventionally, the expected rate of inflation (π^e) is often used to represent the yield on physical assets and expected interest rates (R^e) are used to represent the return on financial assets. In addition, empirical evidence has shown that apart from these traditional predictor variables, domestic real demand for money balances can and do in fact respond to foreign monetary variables in an open economy. Consequently, foreign interest rate (R^f) and/or expected change in exchange rate (X^e) (domestic currency units per unit of foreign currency) have been considered good candidates for inclusion in any demand for money function. Furthermore, expectations about the state of the economy have also been identified as possible explanatory variable in the demand for money function. In the light of these, therefore, our demand for money function can be written in a general form as follows:

$$m^d_t = f(y^p_t, \pi^e_t, R^e_t, R^f_t, X^e_t, S^e_t) \quad \ldots\ldots\ldots\ldots\ldots\ldots (1)$$
$$(+)\ (-)\ (\pm)\ (-)\ (-)\ (+)$$

where $m^d_t = (M/P)^d_t$ is the desired demand for real money balances, y^p_t is permanent real income (GDP), π^e_t is the expected rate of inflation, R^e_t is the expected domestic interest rate, R^f_t is the foreign interest rate, X^e_t is the expected change in exchange rate, and S^e_t represents a proxy for expectations about the state of the economy. The subscript t is the time period. The expected signs are as indicated below the respective variables.

The model specification in equation (1) and its significance for Nigeria deserves some further elaboration. y^p takes account of the transactionary motive for holding money, and captures the observed tendency for higher propensities to consume in a relatively low income economy. In developed countries, permanent income has been found to be more appropriate than current income. However, the evidence remains inconclusive in developing countries, and this has been confirmed for Nigeria from the comprehensive survey undertaken in section II

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7 The interested reader is referred to Laidler (1985) where these issues have been exhaustively examined.

above. Thus, in line with the arguments advanced by several writers, we have decided to use current (measured) income in our analysis. (See Adekunle (1968), Aghevli, *etal* (1979), Perera (1988) and Wong (1977)).

The inclusion of the expected inflation rate variable (π^e_t), is consistent with the empirical evidence found for developing countries. It represents the opportunity cost of holding money vis-a vis real assets, and is justified on the grounds that financial markets are thin and financial instruments scarce in developing countries, while interest rates are controlled and pegged at very low levels, with little or no variation over prolonged period of time, so that the desired substitution between money and financial assets is completely absent. This, according to the argument makes it difficult to detect empirically any systematic relationship between money and interest rate. This implies that substitution between money and real assets is more important than between money and financial assets in developing countries. While we share this belief and its relevance to the Nigerian situation before the mid-eighties, we are of the view that the evolution of the Nigerian financial market in the last decade may have to some extent weakened the argument.[8] Indeed in a recent study, Ogiogio (1989) concluded that the interest rate is an important monetary policy instrument in Nigeria. Consequently, we have included the expected domestic interest rate as an argument in our model. We hold the view that since the early 1980's, (particularly since 1986 when a more flexible interest rate policy was adopted) with a deliberate policy to encourage savings, through upward adjustment of interest rates, there is no plausible reason to believe that the average asset holder in Nigeria will continue to be unresponsive to interest rates changes.[9] However, the problem is that of modelling inflationary and interest rates expectations. There are several methods to measure expectations in the economic literature. However, following Crockett and Evans (1980), Darrat (1988) and Driscoll and Lahiri (1983) the realised inflation rate in any given year is employed as a proxy for the inflation rate expected.[10] By the same token actual interest rate is used to represent the expected interest rate. In fact as pointed out by Amoako-Adu (1991), the use of realised inflation is consistent with the rational expectation assumption. The sign of the interest rate variable is an empirical question and would depend on what measure of money is adopted.

The presence of foreign monetary variables R^f_t and X^e_t in the demand for money function equation (1) derives from the criticisms that the traditional money demand studies, particularly in the case of developing countries, implicitly and unrealistically assume closed-economy models in which external factors play no role in domestic money demand determination [Arango and Nadiri (1981), Darrat (1984, 1986) and Arize (1989, 1992)].[11] The argument is that given the open nature of most

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8 The Nigerian financial system is one of the most developed and sophisticated in the sub-saharan Africa.

9 See CBN Annual Reports for various years for the adjustments in interest rates during this period.

10. Crockett and Evans (1980) and Driscoll and Lahiri (1983) pointed that static inflationary expectations in developing countries is an appropriate assumption especially since annual data is going to be used to estimate the model.

11 The subsequent discussions on this draws extensively from Darrat (1984, 1986) and Arize (1989, 1992).

contemporary economies where capital movements are not completely controlled, including Nigeria, properly specified money demand models should include the effect of these external factors. This implies that due congnisance should be taken of the international opportunity costs of holding domestic money balances. Consequently, movements in foreign interest rates and/or exchange rates have been used as proxies for these external factors. With respect to foreign interest rates, the hypothesis is that an increase in foreign interest rate may *ceteris paribus* induce domestic residents to increase their holdings of foreign assets; thus stimulating capital outflow or reducing capital inflow. Since such increases in foreign assets holdings are likely to be financed by drawing down domestic money holdings it is postulated that domestic money holdings would respond inversely to a change in foreign interest rates.[12] With respect to exchange rate, a change is hypothesized to influence portfolio decisions concerning the degree of substitution between domestic money holdings of foreign financial assets. In the case where domestic currency is expected to depreciate (that is, X^e increases), domestic portfolio holders would be induced to adjust their portfolios in favour of foreign assets. Hence, it is postulated that the exchange rate expectations should have a negative impact on domestic money holdings.[13] The effects of expected change in exchange rate can be analysed both in terms of the transactions demand for money and speculative demand in the form of capital flows. An expected depreciation will cause residents to increase transactions demand in their bid to prosecute foreign payments. Similarly, an expected inflation may lead to capital flight into currencies which are expected to be stronger, thus causing domestic residents to increase their demand for money balances in order to finance the intended capital outflow.

It should be noted that the inclusion of foreign currency measure in the money demand function is somehow related to testing the significance of currency substitution phenomenon. Currency substitution has been described as a process whereby foreign-currency-denominated money has displaced, either fully or partially, domestic money in performing the function of a store of value, medium of exchange, and unit of account. This phenomenon is deemed to reflect the efforts of individuals to protect the value of their wealth and income and usually takes place in the context of deteriorating economic conditions (El-Erian, 1988). If we go by Miles' (1984) argument, then we can conveniently say that currency substitution has for sometime been a phenomenon in Nigeria, particularly during the eighties. He had observed that:

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12 Instead of foreign interest rate alone, some writers have used a composite term - foreign interest rate plus expected currency depreciation, as a measure of capital mobility. However, this did not preclude the inclusion of the foreign exchange rate as a separate explanatory variable (Darrat, 1984; Arize, 1989, 1992).

13 Hamburger (1977), Blejer (1978), Boughton (1979), Arango and Nadiri (1981), and Brissimis and Leventakis (1985) were among the first set of studies that included some measure of foreign currency in the demand for money function. It is necessary to note that the simultaneous inclusion of foreign interest rates and exchange rates variable in the demand for money function may likely lead to multi-collinearity problem.

"significant currency substitution does not require every little old lady on Main Street to hold foreign money. All that is required is a significant subset of individuals and enterprises which on the margin are indifferent between holding another dollar of their money portfolio in domestic versus foreign money". p. 1203

Arize (1989) has noted that currency substitution has important implications for the working of flexible exchange rates. According to him, "if the degree of currency substitution is high, small changes in the money supply would induce large changes in the exchange rate. Indeed, significant currency substitution would seriously undermine the ability of flexible exchange rates to provide monetary independence." He further argued that omission of foreign currency variable in the demand for money function particularly during periods in which it is considered to be an important alternative to domestic money in the wealth portfolio may bias the model into overstating the influence of inflation in the contest of domestic currency devaluation.[14]

The pertinent question now is how to model the expected foreign exchange rate or currency depreciation. However, following Arize (1992), expected rate of change in the exchange rate is proxied by the growth rate of the country's exchange rate for each U.S. dollar lagged one period.

On expectations about the state of the economy (S^e_t), we share the argument by Djeto and Pourgerami (1990) that, "the importance of this variable in the determination of the desired money demand should not be overlooked in Africa which has experienced frequent and prolonged periods of instability." However, considering the difficulty in getting a good proxy for the variable, S^e_t is omitted in the estimation.

In the light of the preceding discussions, and assuming a logarithmic linear relationship, equation (1) may now be written as:

$$\log m^d_t = a_o + a_1 \log y_t + a_2 \pi_t + a_3 R_t + a_4 R^f_t + a_5 X_t + U_t \quad \ldots (2)$$

where U_t is a white-noise disturbance term. Note that π^e_t, X_t, R_t and R^f_t - all opportunity cost variables - enter the equation linearly. This is because they are exponents of the exponential function in our specification.

Equation (2) is a long-run relationship which may not hold in the short-run. Also, m^d_t is unobservable, and for estimation purposes we need to replace it with an actual (or observable) real money demand, $\log m_t$. One technique that is very popular in money demand literature is the Koyck partial adjustment procedure. This procedure assumes that the adjustment of actual real money balances to the desired level is only a fraction of the gap between the desired level in the current period and the actual level in the previous period. However, the problem lies in determining whether the adjustment should be real or nominal. If a nominal partial adjustment scheme is assumed, then the adjustment of nominal money demand to

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14 The term "dollarization" has sometimes been used interchangeably with currency substitution. The introduction of domiciliary account (that is, foreign currency denominated deposits) in Nigeria in the late eighties may also have facilitated currency substitution.

the desired level is some fraction of the gap between the desired nominal level in the current period and the actual nominal level in the previous period. This scheme replaces the unobservable m^d_t with the observable measure of real money balances, $\log (M/P)_t = \log m_t$. Combining this nominal partial adjustment procedure with equation (2) yields an equation with regressors in equation (2) plus $\log (M_{t-1}/P_t)$, where P_t is the current price index. If real partial adjustment is found instead to be a more appropriate scheme, $\log (M_{t-1}/P_t)$ will be replaced by $\log m_{t-1}$ [i.e. $\log(M_{t-1}/P_{t-1})$].[15]

Mathematically, the real and nominal adjustment mechanism can be stated, respectively, as follows:

$$(\log m_t - \log m_{t-1}) = \lambda (\log m^d_t - \log m_{t-1}) + V_t \; ; \; 0 < \lambda < 1 \quad \ldots\ldots (3)$$

and

$$(\log M_t - \log M_{t-1}) = \gamma (\log M^d_t - \log M_{t-1}) + W_t ; \; 0 < \gamma > 1 \quad \ldots\ldots (4)$$

where V_t and W_t are white-noise disturbance terms, λ and γ are the adjustment coefficients (measures of speed of adjustment), $m_t = M_t/P_t$; M_t is nominal money balance and P_t is the price level. Combining (3) or (4) and the money demand equation (2), the final form of the money demand function becomes:[16]

$$\log m_t = \delta_0 + \delta_1 \log y_t + \delta_2 \pi_t + \delta_3 R_t + \delta_4 R^f_t + \delta_5 X_t + \delta_6 \log m_{t-1} + U^*_t \quad \ldots\ldots\ldots\ldots (5)$$

and

$$\log m_t = \beta_0 + \beta_1 \log y_t + \beta_2 \pi_t + \beta_3 R_t + \beta_4 R^f_t + \beta_5 X_t + \beta_6 \log (M_{t-1}/P_t) + U^{**}_t \quad \ldots\ldots\ldots (6)$$

where the δ_i's $= \lambda a_i$ and β_i's $= \gamma a_i$ $(i = 0, 1, \ldots, 5)$ and $\delta_6 = (1 - \lambda)$ and $\beta_6 = (1 - \gamma)$ are the parameters to be estimated, $U^*_t = \lambda u_{t-1} + V_t$ and $U^{**}_t = \gamma u_{t-1} + w_t$ are the disturbance terms assumed to be white-noise with zero means and constant variances. $\delta_6 = (1 - \lambda)$ and $\beta_6 = (1 - \gamma)$ yield the coefficients of real and nominal adjustment, respectively. Where the dependent and independent variables enter equations (5) and (6) logarithmically, the parameters give directly the short-run elasticity estimates and where the variables enter linearly the parameters give semi-elasticity estimates. The long-run elasticity estimates can be calculated as the ratio of the short-run elasticity over the speed of adjustment $(1 - \delta_6)$ or $(1 - \beta_6)$. The underlying theory predicts that:

$$\delta_1, \delta_6 \text{ and } \beta_1, \beta_6 > 0; \text{ while } \delta_2, \delta_4, \delta_5 \text{ and } \beta_2, \beta_4, \beta_5 < 0;$$

The sign of δ_3 and β_3 depends on which definition of money stock is adopted. For M1, the expected sign is negative; for quasi-money the expected sign is positive and for M2 the sign depends on whether M1 or quasi-money is the dominant component.

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15 For the development of the lively debate on the comparison of real partial adjustment mechanism and nominal partial adjustment, see Milbourne (1983, 1986), Hwang (1985), Hafer and Thornton (1986), and Goldfeld and Sichel (1987). See also Laumas and Spencer (1980) for a critique of the procedures.

16 For a formal derivation of these equations on the basis of the Koyck process, refer to any standard econometric textbook.

V. EMPIRICAL RESULTS

Equations (5) and (6) above were the demand for money relationship estimated for Nigeria over the sample period 1960 to 1991.[17] We have utilised different definitions of money stock to carry out the estimation exercise. Detailed description of the variables and sources of data are contained in the appendix. A dummy variable was included during estimation to account for the impact of the policies adopted under the Structural Adjustment Programme (SAP). We also experimented with real domestic interest rate during our estimation.[18] The estimated equations for the period 1960 to 1991, using alternative definitions of money - narrow money (M1), quasi - money (QM) and broad money (M2), as dependent variable are presented in Tables 1-3. In our estimation, we experimented with different combinations of explanatory variables, some of which have been presented in the tables. However, the preferred equations have been marked with an asterisk and these are the ones on which attention would be focused in subsequent analyses below. The preferred equations were chosen on the basis of the conventional statistical criteria of appropriate signs of the coefficients, and the summary statistics reported in the tables. Perhaps it is necessary to note at the onset that the dummy variable included in our estimation to account for possible structural shift from 1986 turned out to be statistically insignificant in the generality of cases and as such was dropped in most of the equations reported. Furthermore, the contemporaneous rate of change of exchange rate was used, but it turned out to be statistically insignificant and so we retained our static assumption of using the lagged actual value as an appropriate proxy for expected exchange rate depreciation. We now proceed to discuss the results.

(a) Equation for Narrow Money (M1)

Tables 1A and 1B contain estimated equations for M1 for real and nominal adjustment specifications, respectively. The preferred equations for real adjustment specification are A1.3 and A1.6, while equations B1.1 and B1.4 are preferred in the case of nominal adjustment specification. The statistical properties of the equations are quite satisfactory judging by the signs and significance of the coefficients, the high R^2 value, the small standard error of the estimates compared with the mean value of the dependent variable, and the overall significance of the equations (as measured by the F-statistic). Both models possess the partial adjustments form with very close degree of adjustment coefficients. For both adjustment mechanisms, the coefficient for the income variable has a positive effect on demand for M1 as expected and is statistically significant, with the coefficient of the nominal adjustment specification slightly higher than that of the real counterpart. This implies that current real income is a significant factor explaining the demand for real narrow money in Nigeria. The coefficients of the expected inflation and nominal interest rate variables have the expected signs in the real adjustment specification, but while the

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17 In Nigeria, we are not aware of any empirical evidence to support either of the two adjustment procedures, hence we proceed to estimate both.

18 Real domestic interest rate was constructed according to the following formula:

$$r = [(1+R_t) / (1 + \pi^e_t) - 1] \times 100$$

where r is the real domestic interest rate, R_t and π^e_t are as defined in the text

coefficient for inflation is statistically significant, that of nominal interest rate is not. In the nominal adjustment specification, the expected inflation rate coefficient, though statistically significant possesses the wrong sign. Interest rate on the other hand, has the appropriate sign but is statistically insignificant as in the real adjustment framework.

In the case of external factors, while the estimation exercise failed to established the influence of foreign interest rates on the demand for M1 in any of the two specifications, the importance of the exchange rate variable is confirmed by the high statistical significance of the coefficient in the two frameworks. The coefficient of exchange rate expectation in both the real and nominal adjustment specifications is positive and statistically significant at either the one or five per cent level. Although the sign of the coefficient is contrary to the theoretical expectations and empirical evidence in some developing countries, it could be explained in terms of the transactions demand for money. Since the demand for narrow money (M1), comprising currency outside bank and private sector demand deposits at both commercial and merchant banks, is basically for transactions purposes, it could be reasoned that as residents expect the domestic currency to depreciate, their demand for M1 to finance their transactions rises in view of the more domestic currency required per unit of the foreign currency.

The R^2 and the F values for the real adjustment specification are marginally higher than those of the nominal adjustment. Similarly, the standard error of the regression for the real adjustment is lower than that of the nominal adjustment specification. The t-ratios of the coefficients for income, inflation, and exchange rate in the equation with the nominal adjustment mechanism are marginally higher than those in the equations with the real adjustment mechanism indicating that the standard errors of the coefficients of these variables in the nominal adjustment equations are marginally less than in the real adjustment equation. The very high significant coefficients of the lagged dependent variable shows that the adjustment of actual real money balances (M1) to the desired level is not instantaneous. However, judged by the adjusted R^2 the equations for real adjustment appear preferable.

Table 4A provides summary result of the speed of adjustment and the short-run and long-run elasticities of the relevant explanatory variables for our preferred equations for narrow money. The speed of adjustment or coefficient of adjustment (λ or γ) implies that about 30 per cent of the discrepancy or disequilibrium between the desired and actual narrow money demand is made up within one year. The average adjustment period is slightly more than two years as indicated by the mean adjustment values given in the last row of Table 4A. The short-run elasticity of real narrow money demand with respect to real income is approximately one half, the corresponding long-run elasticity is significantly greater than unity and close to two. The magnitudes of the short-run and long-run elasticities are consistent with those found in previous studies for the developing countries. The long-run elasticity greater than unity implies that money is a "luxury good" in Nigeria. It may also be a reflection of the gradual absorption and monetisation of the unorganised money market through substantial improvements in banking institution. The short-run and long-run elasticities of real money demand with respect to inflationary expectation and

exchange rate expectation are quite small, they are nevertheless significantly non-zero, with that of exchange rate expectation insignificantly lower than that of inflationary expectation. This implies that Nigerians are sensitive to inflation and exchange rate changes. Consequently, real physical assets are viewed as an attractive alternative to the holding of narrow money as an asset during persistent inflation.

(b) Equation for Quasi Money (QM)

The results for real and nominal partial adjustment specifications are presented in Tables 2A and 2B, respectively, with the preferred equations asterisked. As in the case of narrow money, the statistical properties of the equations for quasi-money are quite satisfactory, R^2 and F-ratio values are high, while the standard errors of the estimates are small relative to the mean value of the dependent variable. Both models possess the partial adjustment form with approximately the same degree of adjustment coefficient. In the nominal adjustment specification, only income, exchange rate expectations and lagged dependent variable had the expected signs and are statistically significant. The remaining variables, inflationary expectation, nominal and real interest rate, as well as foreign interest rate possessed the wrong signs, even though they indicated statistical significance. In the real adjustment specification, only the interest rate (domestic and foreign) variables possessed perverse sign. In fact, when nominal domestic interest rate was used in addition to the foreign interest rate, the latter came out with the expected negative sign. In all cases, the coefficients of the explanatory variables were all statistically significant. The wrong sign of the domestic interest rate (nominal and real) may be due to the overriding influence of the prolonged period of interest rate control which characterised the data set used for our estimation. In fact, of the 32 data points used, only five years covered the period of interest rate deregulation. The importance of external monetary and financial variables as determinants of quasi-money holdings in Nigeria is clearly brought out in both the nominal and real adjustment frameworks. Consequently, foreign asset holdings and currency substitution are alternatives to domestic holdings of monetary assets. This is particularly true for equation A2.1 where both the foreign interest rate and exchange rate expectation are statistically significant and possessed the *apriori* signs. The poor performance of the foreign interest rate in the generality of cases may be due to the non-representative nature of the proxy used in our study. The R^2 and F statistic of the nominal adjustment equations (B2.1 and B2.7) are marginally higher than those of real adjustment equations (A2.1 and A2.6). Also, the latter has a slightly higher standard error than the former. The adjustment coefficient for both specification is about 0.25, implying that a quarter (25 per cent) of the discrepancy between the desired and actual quasi-money demand is covered in one year. The mean adjustment period is very long -approximately three years (see last row of Table 4B). From Table 4B, we observe that the short-run elasticity of real quasi-money with respect to real income is slightly less than the one half obtained for M1 - the range is 0.43 to 0.48. The corresponding long-run elasticity is significantly greater than one and range from 1.69 to 1.89, which compares with the range of 1.78 to 1.89 for M1. The short-run and long-run elasticities of real quasi money demand with respect to inflationary expectation, domestic interest rate and exchange rate expectations, as in the case of real M1 are low but significantly

different from zero, and in all cases but one are higher than those for real M1. This shows that the demand for quasi-money, which essentially represents precautionary and speculative motives for holding money is as expected more responsive to the opportunity cost variables included in our specification. Furthermore, the elasticity of real quasi money with respect to foreign interest rate is in most cases higher than that of exchange rate expectations and the domestic opportunity cost variable.

(c) Demand for Broad Money (M2)

The result for real and nominal partial adjustment specifications for broad money (M2) are contained in Tables 3A and 3B, respectively, with the preferred equations marked with an asterisk. The summary of speed of adjustment and elasticities are contained in Table 4C. As in the case of the components - M1 and QM, the statistical properties of the equations for broad money (A3.4, A3.13, B3.3 and B3.12) are satisfactory. R^2 values and the F ratios are high, while the standard error of the estimates are small relative to the mean value of the dependent variable. The partial adjustment form is confirmed for both specifications and as in the case of the components of M2, the adjustment coefficients are approximately the same. In terms of their performance, none of the two specifications seem to dominate the other, although the real adjustment specification outperform the nominal adjustment version with respect to the *apriori* signs of the explanatory variables. All the coefficients are statistically significant in both specifications, but the inflationary expectation coefficient possesses the wrong sign in one of the nominal adjustment equations (B3.3). The negative sign of the domestic interest rate variable is an indication that the demand for narrow money dominates the demand for quasi money in the broad money portfolio of asset holders in Nigeria. Unlike the demand for M1 and QM, the demand for M2 is not responsive to external monetary and financial developments as the coefficients of the exchange rate and foreign interest variables are in most cases statistically insignificant. The coefficient of adjustment for both the real and nominal adjustment specifications is roughly 0.26, implying that only 26 per cent of the disequilibrium between the desired and actual real broad money balances is covered within one year. The mean adjustment period is close to three years as indicated in the last row of Table 4C. The short-run income elasticity of the demand for real broad money is roughly one half, while the long run elasticity is roughly 2.0 implying that there is no evidence of economies of scale in cash management in Nigeria. This may have arisen out of the monetization process and rapid growth and improvements in the operations of the banking and other financial institutions. The elasticities of real broad money demand with respect to inflationary expectation and domestic interest rate though low compared with that of income are significantly non-zero. The elasticity with respect to interest rate is in most cases slightly higher than that of inflationary expectation. This confirms that even though asset holders in Nigeria view the holding of physical assets as an attractive alternative to monetary assets, they are nonetheless slightly responsive to interest rate changes.

In the light of the preceding simple statistical comparison of the two adjustment mechanisms for narrow money, quasi money and broad money, one can conclude that equations with the real partial adjustment mechanism are more appropriate for estimating demand for money function and its components in Nigeria. Therefore, subsequent discussions below are based on the equations with the real partial adjustment form, namely, A1.3, A1.6; A2.1, A2.6; A3.4 and A3.13.[19]

VI. DIAGNOSTIC TESTING AND STABILITY OF THE MONEY DEMAND FUNCTION

In view of the use(s) to which the estimated demand for money function is (are) likely to be put, we have subjected our preferred equations - A1.3, A1.6, A2.1, A2.6, A3.4 and A3.13 to a battery of diagnostic tests. This is intended to assist (with a great degree of confidence) in the choice of an appropriate equation for each definition of money stock. It is not uncommon in applied econometric research to estimate a totally meaningless model and still obtain very good results, in terms of the coefficients having the "expected signs" and a high goodness of fit statistics - high coefficient of multiple determination, R^2, and high t and F ratios. Granger and Newbold (1974) and Lovell (1983) drew attention to the ease with which high t-values could be obtained without the existence of any relationships whatsoever between variables. Kramer, *etal* (1985) recommended that conventional regression output be supplemented with a battery of specification tests since this will make it more difficult for results to appear significant because of "data mining." Similarly, Davidson and Mackinnon (1985) have pointed out that, "it is only from a model that appears to be consistent with the data that one can hope to make valid inferences."

Diagnostic tests are important in the assessment of the adequacy of a model. In this paper various diagnostic statistics of single equation were computed and considered for the specification of the equations and the evaluation of the statistical appropriateness in the estimation of the equations. In estimating our equations using the OLS techniques, we have implicitly assumed homoscedasticity, non-autocorrelation and normality of the disturbance term. In Tables 5 and 6 we provide a battery of diagnostic tests to support the empirical results in Tables 1 - 3 above.[20] In Tables 1 - 3, we reported the D.W. and Durbin's h-statistic to test the null hypothesis of no autocorrelation. The D.W. statistic reported is merely indicative, since it loses its power in the presence of a lagged dependent variable. The h-statistic shows no evidence of first-order serial correlation for all the equations. This is further confirmed by the Breusch-Pagan (1979) and Godfrey (1978) lagrange multiplier (LM) tests AR(1), 1-1 and the F-version in Table 5. All the equations passed this test as all the statistic reported are well below the critical values at the five per cent level of significance. To test for higher-order and general (unspecified) autocorrelation, we have also computed the BPG LM test for the k^{th}-order autocorrelation, as well as the Box-Pierce (1970) and Ljung-Box (1978) portmanteau

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19 A more robust procedure, like the non-nested tests would have been more appropriate for discriminating between the two specifications.

20 A detailed description of these tests and their implementation can be found in Johnston (1984), Judge, etal (1985, 1988), Kramer, etal (1986), Spanos (1986), Godfrey (1988), and Harvey (1990).

or Q-statistic. All the tests point to the acceptance of the null hypothesis of no serial correlation for equations A1.3 and A1.6. The remaining equations showed conflicting results, passing some of the tests and failing others. Equations A2.1, A2.6 and A3.13 passed the Box-Pierce test, but failed the Ljung-Box, and the BPG tests for higher-order serial correlation. Equation A3.4 on the other hand passed both the Box-Pierce and Ljung-Box, but failed the BPG tests for higher-order serial correlation. Thus, we fail to unequivocally reject the presence of serial correlation for equations A2.1, A2.6, A3.4 and A3.13.

A key assumption in linear regression is that the error should have a constant variance (that is, an absence of heteroscedasticity). When there exists heteroscedasticity of the disturbance term, parameter estimates are inefficient and the standard error is not valid, leading to invalid test statistics. To test whether this assumption is violated in our model, five different tests were performed. They are the Breusch Pagan (1979), White (1980), Pesaran (1988), Harvey (1990) tests, as well as the ARCH (Autoregressive Conditional Heteroscedasticity) test of Engle (1982). Again the tests show conflicting results. For all the equations, the results of the Breusch-Pagan test suggest the possibility of heteroscedasticity. It should, however, be noted that this test may be unreliable in small samples. All the equations, but two (A2.6 and A3.4) passed the White test, while all, except A2.1 and A2.6 passed the Harvey test. The Pesaran test is easily passed by all the equations. For the ARCH test, the statistic for equations A2.1 and A2.6 unequivocally rejects the ARCH form of heteroscedasticity, while equations A1.6 and A3.4 detects the presence of the ARCH form of heteroscedasticity of both the first and higher orders. In the case of equations A1.3 and A3.13, only the first and second-order ARCH processes are detected. Once again we can not unequivocally conclude that the empirical results do not violate the assumption of homoscedasticity.

To test for omitted variables and functional form mis-specification, we applied the Ramsey (1969) RESET (Regressor Specification Error Test). The resultant F-statistic for equations A2.1, A2.6, A3.4 and A3.13 were below the critical values at the 5 per cent level for the different powers of the estimated dependent variable included as additional regressor in the original model, thus providing no evidence of functional form mis-specification and omitted variables for these equations. However, for the remaining two equations A1.3 and A1.6, evidence of omitted variables and functional form mis-specification were detected.

The linear restriction imposed in respect of equation A1.6 was found to be appropriate as indicated by the ease with which the four tests conducted were all passed.[21] Next we report results of Bera and Jarque (1980) test for a non-normally distributed error term. The test statistic is a function of the third and fourth moments of residuals and asymptotically follows $\chi^2(2)$ distribution under the null hypothesis of normally distributed error term with 2 degrees of freedom. In this case, the BJ statistic for all the equations is smaller than the critical value of 5.991 at the five per cent significance level. Thus, the test is unable to reject the null hypothesis of normality of the regression residuals.

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21 The relationship between the Wald (W), likelihood ratio (LR) and lagrange multiplier (LM) tests is contained in Griliches and Intriligator (1984) and Harvey (1990). The condition that W> LR > LM is duly fulfilled.

The stability of the demand for money function is of curcial importance to the effectiveness of monetary policy and for drawing meaningful policy inferences from the estimated parameters. As Thornton (1983) pointed out, the demand for money provides the link between monetary policy and the rest of the economy. In order to adequately predict the impact of a given change in money supply on the other macroeconomic variables such as prices, interest rates, income, and unemployment with any confidence, one must be certain that the money demand function itself remain stable. Testing for temporal stability of money demand function usually refers to testing for the approximate constancy of the regression coefficients over time. The instability of the money demand function, is often associated with fundamental structural changes in the economy. Boughton (1981) recommended the use of a battery of stability tests since each stability test is designed to address different aspects of the stability. In line with this, we used three different stability tests to test our model, namely, Chow (1960), Farley-Hinich (1970) and the Gujarati (1970) tests. The Chow test is perhaps the most widely used of these techniques. To implement the Chow test the sample period is split into two parts at an *apriori* determined point and then the two sub-period money demand regressions are compared to the full-sample period money demand regression using an appropriate F-statistic. The Gujarati test constructs a slope dummy term for all independent variables such as $(DZ)_t = D*Z$ where D = 0 in the first sub-period and D = 1 in the second sub-period, and Z is any independent variable. Then, using an F-ratio, one tests for a possible drift in the parameters after the inclusion of the second sub-period dummy variable. To implement both the Chow and the Gujarati tests, one is required to choose a sample breaking date. In the absence of prior knowledge or information to guide in the choice, several breaking dates are usually employed. In our case, for the Chow test, we divided the sample period at all possible points where we suspected structural shifts, namely, 1973, 1977, 1979, 1982 and 1986 to coincide, respectively, with the adoption of flexible exchange rate regime and first oil price shock, oil price collapse, second oil price shock, second oil price collapse and the emergence of debt crises, and the introduction of deregulatory policies following the adoption of the Structural Adjustment Programme (SAP) in 1986. For the Gujarati test, instead of constructing several dummy variables for all the possible points, we used a single dummy variable which took the value of one for the periods 1967-1969, 1973-74, 1977-1978, 1979-1980, 1982 and 1986-1991, and zero for the remaining years. The Farley-Hinich test differs from the other two in that it tests for a gradual (in contrast to a single) shift in the parameters (Farley, Hinich and McGuire, 1975). Another virtue of the F-H test is that its implementation does not require splitting the data set at a certain pre-determined point because the test is applied to the full-sample period. To apply the test, the explanatory variables are treated as linear functions of time and the resulting variables are added to the original equation. Then, an appropriate F-ratio is used to test the null hypothesis that the coefficients on the added trend variables are jointly zero.[22]

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22 Other tests of stability exists in the literature, however, we felt these three would be sufficient to detect instability.

Table 6 presents the results for these tests for our preferred equations. The results of the Gujarati and Farley-Hinich tests indicate that the money demand equation estimated for the different definitions of money is structurally stable over the estimation period. However, the Chow test on the other hand, presents evidence of possible structural shifts in the eighties for all the equations. Once again, we are not able to unequivocally reject temporal instability in our model.

Finally, we test for the forecasting power of our respective equations using the percentage root mean square error (PRMSE) and the correlation coefficient between the actual and predicted dependent variable. The statistic reported in Table 6 indicates very good forecasting power by all the equations.[23]

VII. CONCLUDING REMARKS

The aim of this paper has been to provide further empirical evidence on the nature of demand for money function in Nigeria, taking advantage of longer time series data. The paper also examined the extent to which domestic money holdings in Nigeria have been influenced by foreign monetary variables such as foreign interest rate and exchange rate. In addition, the appropriate adjustment process and the temporal stability of the estimated money demand equations were examined. The main conclusions of the paper can be briefly summarised as follows.

First, current income and inflationary expectations are two most important domestic determinants of domestic money holdings in Nigeria. This implies that domestic asset holders view the holding of physical assets as attractive alternative to monetary assets. This notwithstanding, there is ample evidence that they are nonetheless slightly responsive to interest rate changes.

Secondly, the exchange rate exerts a significant effect on domestic money demand in an open Nigerian economy. Thus, non-inclusion of such variables could lead to biased results. There is, therefore, the need for policy makers to take cognisance of the response of domestic money demand to these external factors, so that monetary policy does not generate uncertain results.

Thirdly, foreign asset holdings and currency substitution are alternatives to domestic money holdings in Nigeria. However, it was found that the broad monetary aggregate, M2, unlike its components, M1 and quasi-money, does not respond to such external factors as foreign interest rate and exchange rate.

Fourthly, the short-run elasticity of M1 and M2 with respect to income is about one-half, while that for quasi money is marginally less than that. The long-run elasticity is more than one (and indeed very close to 2) indicating that money is a "luxury" good, and there is an absence of economies of scale in cash

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23 A more appropriate test for forecast performance is the out-of-sample forecast. However, because of the small size of data (annual data) we could not embark on this.

management in Nigeria. On the other hand, the short-run and long-run elasticities with respect to the opportunity cost variables - inflationary expectations, interest rates and exchange rate, are quite small though significantly different from zero.

Fifthly, the speed of adjustment in all cases is quite low, while the average adjustment period is longer than two years. With respect to the appropriate adjustment mechanism, while no significant difference could be detected between the two adjustment processes (real and nominal) examined, the little available evidence from the empirical results point to the real partial adjustment mechanism as the most appropriate for estimating money demand in Nigeria.

Finally, the battery of diagnostic tests to which the preferred equations were subjected, produced some conflicting and indeed contradictory results, thus making it extremely difficult to select particular equations as being adequate representation of the data for the various definitions of money for the period covered by the study. In the light of this, therefore, there is need for further research into the subject so that one can obtain the most parsimonious representation of the data generation process.

TABLE 1A: REAL PARTIAL ADJUSTMENT MECHANISM – NARROW MONEY (M1)

Model: Logm1 = d0 + d1Logy + d2Il + d3R + d4Rf + d5X + d6Logm1(t−1) + U* Annual Data: 1960 – 1991

Equation No.	Constant d0	Explanatory Variables: Real Income d1	Inflationary Expectation d2	Nominal Deposit Rate d3	Foreign Interest Rate d4	Exchange Rate Expectation d5	Lagged Real Money Demand d6	Dummy Variable d7*	Summary Statistics: Adjusted R Squared	SEE	F	D.W.	h	n
A1.1	−1.50192	0.574794	−0.00115	−0.00284	−0.0009	0.001458	0.697091							
	(4.8422)	(5.6501)***	(1.7464)**	(0.9460)	(0.2399)	(1.7168)**	(9.7787)***		0.9758	0.042839	195.926	1.664	0.9995	30
A1.2	−1.45994	0.555561	−0.00119	−0.00467	−0.00035	0.001668	0.710795	0.031731						
	(4.5506)	(5.1796)***	(1.7723)**	(1.1239)	(0.0895)	(1.8138)**	(9.4448)***	(0.6461)	0.9752	0.043392	163.742	1.700	0.9018	30
*A1.3	−1.49349	0.579044	−0.00116	−0.0029		0.001395	0.687804							
	(4.9443)	(5.8971)***	(1.8085)**	(0.9874)		(1.7634)**	(11.7238)***		0.9768	0.041989	244.709	1.667	0.9630	30
A1.4	−1.45556	0.556545	−0.00119	−0.00475		0.001651	0.707786	0.032694						
	(4.6930)	(5.3324)***	(1.8300)**	(1.1932)		(1.8762)**	(10.7463)***	(0.6975)	0.9762	0.042446	199.642	1.701	0.8780	30
A1.5	−1.53341	0.593038	−0.00127	−0.00655			0.68547							
	(5.2976)	(6.1627)***	(1.9445)**	(3.1555)**			(11.4555)***		0.9763	0.043103	301.583	1.624	1.1102	31
*A1.6	−1.37325	0.547166	−0.00115			0.001959	0.691957							
	(4.9703)	(5.9034)***	(1.7982)**			(3.5849)***	(11.8309)***		0.9768	0.041968	305.948	1.726	0.7921	30

Note: The numbers in parenthesis below the coefficient estimates are the absolute value of the t−ratios. Adjusted R−squared is the coefficient of determination adjusted for degrees of freedom. SEE is the standard error of the regression. F is the F−ratio which tests the goodness−of−fit of the regression. DW is the Durbin Watson statistic. h is the Durbin statistic to test for first order serial correlation when lagged dependent variable appears among the regressors. n is number of observations used in estimation after lag operations. *** indicates statistical significance at 1% level; ** indicates statistical significance at 5% level; * indicates statistical significance at 10% level.

TABLE 1B: NOMINAL PARTIAL ADJUSTMENT MECHANISM – NARROW MONEY (M1)

Model: Logm1 = d0 + d1Logy + d2Il + d3R + d4Rf + d5X + d6Log(M1t−1/Pt) + U**

Annual Data: 1960 – 1991

Equation No.	Explanatory Variables								Summary Statistics					
	Constant d0	Real Income d1	Inflationary Expectation d2	Nominal Deposit Rate d3	Foreign Interest Rate d4	Exchange Rate Expectation d5	Lagged Real Money Demand d6	Dummy Variable d7	Adjusted R Squared	SEE	F	D. W.	h	n
*B1.1	−1.55087	0.596333	0.001234	−0.00325		0.001378	0.683827							
	(5.1192)	(6.0537)***	(1.7990)**	(1.0910)		(1.7181)**	(11.5338)***		0.9761	0.042576	237.88	1.645	1.0279	30
B1.2	−1.52229	0.576351	0.00127	−0.00495		0.001612	0.701894	0.029895						
	(4.8781)	(5.5043)***	(1.8226)**	(1.2219)		(1.8041)**	(10.5438)***	(0.6289)	0.9755	0.043123	193.306	1.669	0.9735	30
B1.3	−1.58744	0.608326	0.001122	−0.0068[4]			0.681937							
	(5.4593)	(6.3066)***	(1.6170)*	(3.2563)***			(11.2890)***		0.9758	0.043632	302.944	1.598	1.1883	31
*B1.4	−1.42232	0.561564	0.001256			0.00201	0.687824							
	(5.0908)	(6.0020)***	(1.8250)**			(3.6114)***	(11.5794)***		0.9759	0.042738	294.809	1.709	0.8428	30

See footnote under Table 1A.

TABLE 2A: REAL PARTIAL ADJUSTMENT MECHANISM – QUASI MONEY (QM)

Model: $Logqm = d0 + d1Logy + d2Il + d3R + d4Rf + d5X + d6Logqm(t-1) + U^*$ — **Annual Data: 1960 – 1991**

Equation No.	Explanatory Variables									Summary Statistics					
	Constant d0	Real Income d1	Inflationary Expectation d2	Nominal Deposit Rate d3	Real Deposit Rate d3*	Foreign Interest Rate d4	Exchange Rate Expectation d5	Lagged Real Money Demand d6	Dummy Variable d7	Adjusted R Squared	SEE	F	D.W.	h	n
*A2.1	−1.25778	0.466595	−0.00178	−0.00599		−0.00615	−0.00182	0.745912		0.9894	0.037169	452.923	1.600	1.1715	30
	(3.7378)	(4.2997)***	(3.0121)***	(2.2752)***		(1.9705)**	(2.4362)**	(11.5260)***							
A2.2	−1.21286	0.421161	−0.00187	−0.0063			−0.00133	0.808349		0.9881	0.039337	484.533	1.526	1.3737	30
	(3.4135)	(3.7527)***	(2.9962)***	(2.2665)***			(1.7814)**	(13.5356)***							
A2.3	−1.08264	0.376299	−0.00181	−0.00302				0.827243		0.9889	0.040291	666.501	1.675	0.9570	31
	(3.0425)	(3.3612)***	(2.8684)***	(1.4718)*				(14.1387)***							
A2.4	−1.13057	0.465767			0.001655	0.006943	−0.00046	0.697441		0.986	0.042746	409.605	1.405	1.7731	30
	(2.9590)	(3.7454)***			(1.8977)**	(1.9406)**	(0.6720)	(9.6892)***							
A2.5	−1.10007	0.437037			0.001824	0.005894		0.729764		0.988	0.041781	619.368	1.49	1.5023	31
	(2.9722)	(3.7623)***			(2.1968)***	(1.9208)**		(12.4314)***							
*A2.6	−1.09753	0.429615	−0.00484		−0.00425	0.006128	−0.00151	0.745473		0.9885	0.038796	415.395	1.735	0.7823	30
	(3.1627)	(3.7749)***	(2.4769)***		(1.6916)*	(1.8776)**	(2.0028)**	(10.9391)***							
A2.7	−1.04325	0.381711	−0.00521		−0.00464		−0.00103	0.808427		0.9873	0.040787	450.376	1.665	0.9762	30
	(2.8695)	(3.2737)***	(2.5490)***		(1.7617)**		(1.3847)*	(12.9612)***							
A2.8	−1.08691	0.41598			0.001723			0.766553		0.9868	0.043812	749.893	1.334	1.9598	31
	(2.8009)	(3.4303)***			(1.9832)**			(13.1735)***							

See footnote under Table 1A.

TABLE 2B: NOMINAL PARTIAL ADJUSTMENT MECHANISM – QUASI MONEY (QM)

Model: $Logqm = d0 + d1Logy + d2Il + d3R + d4Rf + d5X + d6Log(QM(t-1)/Pt) + U^{**}$ — Annual Data: 1960 – 1991

Equation No.	Explanatory Variables									Summary Statistics					
	Constant d0	Real Income d1	Inflationary Expectation d2	Nominal Deposit Rate d3	Real Deposit Rate d3*	Foreign Interest Rate d4	Exchange Rate Expectation d5	Lagged Real Money Demand d6	Dummy Variable d7	Adjusted R Squared	SEE	F	D. W.	h	n
*B2.1	−1.31593	0.480359	0.000833	−0.00635		0.006131	−0.00184	0.745526		0.9899	0.036377	473.019	1.505	1.444558	30
	(4.0423)	(4.5777)***	(1.4828)*	(2.4593)***		(2.0077)**	(2.5112)***	(11.8197)***							
B2.2	−1.27725	0.43671	0.000962	−0.00669			−0.00135	0.807414		0.9886	0.038605	503.265	1.447	1.598432	30
	(3.7035)	(4.0085)***	(1.6252)*	(2.4469)***			(1.8407)**	(13.8255)***							
B2.3	−1.14698	0.392652	0.001091	−0.00334				0.825175		0.9892	0.039669	687.767	1.621	1.113372	31
	(3.3095)	(3.6010)***	(1.8084)**	(1.6484)*				(14.3890)***							
B2.4	−1.12887	0.408212	0.000961					0.79379		0.9885	0.040911	861.337	1.469	1.555166	31
	(3.1599)	(3.6437)***	(1.5590)*					(14.2286)***							
B2.5	−1.11482	0.441745			−0.00154	0.006251	−0.00093	0.731327		0.9886	0.038494	506.203	1.491	1.49638	30
	(3.2708)	(3.9486)***			(1.9597)**	(1.9324)**	(1.5589)*	(11.0163)***							
B2.6	−1.07703	0.398737			−0.0015	0.003978		0.784495		0.9896	0.038931	714.335	1.624	1.106354	31
	(3.1324)	(3.6299)***			(1.8845)**	(1.3693)*		(13.4883)***							
*B2.7	−1.1306	0.433511	−0.00292		−0.00521	0.005965	−0.00162	0.751928		0.9893	0.037331	448.954	1.639	1.059565	30
	(3.4189)	(3.9912)***	(1.5871)*		(2.1406)***	(1.8984)**	(2.2396)***	(11.4492)***							
B2.8	−1.08161	0.387688	−0.00312		−0.00567		−0.00117	0.813369		0.9882	0.039304	485.365	1.575	1.232775	30
	(3.1161)	(3.4771)***	(1.6135)*		(2.2205)***		(1.6222)*	(13.5185)***							
B2.9	−1.05189	0.37798			−0.00169			0.813685		0.9893	0.039557	921.947	1.581	1.205349	31
	(3.0152)	(3.4192)***			(2.1166)***			(14.7989)***							

See footnote under Table 1A.

TABLE 3A: REAL PARTIAL ADJUSTMENT MECHANISM – BROAD MONEY (M2)

Model: Logm2 = d0 + d1Logy + d2Il + d3R + d4Rf + d5X + d6Logm2(t−1) + U

Annual Data: 1960 – 1991

Equation No.	Explanatory Variables									Summary Statistics					
	Constant d0	Real Income d1	Inflationary Expectation d2	Nominal Deposit Rate d3	Real Deposit Rate d3*	Foreign Interest Rate d4	Exchange Rate Expectation d5	Lagged Real Money Demand d6	Dummy Variable d7	Adjusted R Squared	SEE	F	D. W.	h	n
A3.1	−1.386	0.547536	−0.00145	−0.00458		0.002174	−0.00023	0.713413		0.9866	0.035271	356.281	1.608	1.1446	30
	(5.1983)	(5.8830)***	(2.6674)***	(1.9310)**		(0.7114)	(0.3194)	(11.2638)***							
A3.2	−1.36599	0.538918	−0.00143	−0.00422		0.001821		0.718713		0.9883	0.033914	507.795	1.619	1.1229	31
	(5.5656)	(6.2953)***	(2.7533)***	(2.4327)***		(0.6601)		(12.1876)***							
A3.3	−1.39716	0.533218	−0.00145	−0.00474			−6.1E−05	0.737484		0.9869	0.034906	436.417	1.572	1.2248	30
	(5.3040)	(5.9293)***	(2.6950)***	(1.9462)**			(0.0930)	(13.9177)***							
*A3.4	−1.39038	0.531265	−0.00144	−0.00458				0.737915		0.9886	0.033544	648.714	1.584	1.2073	31
	(5.7935)	(6.3327)***	(2.8135)***	(2.8034)***				(14.5443)***							
A3.5	−1.15204	0.501362			0.001351	0.002177	0.001013	0.700971		0.9832	0.039474	340.209	1.557	1.3157	30
	(4.1213)	(4.9256)***			(1.7015)**	(0.6366)	(1.7418)**	(9.9215)***							
A3.6	−1.0768	0.519594			0.001142	0.004782		0.654115		0.9835	0.04025	448.557	1.402	1.7918	31
	(3.9511)	(5.1146)***			(1.4304)*	(1.5377)*		(9.8488)***							
A3.7	−1.3099	0.55487			0.001445	0.001844		0.678532	−0.044763	0.9853	0.037993	403.578	1.587	1.2300	31
	(4.6553)	(5.6948)***			(1.8821)**	(0.5643)		(10.6321)***	(2.0446)***						
A3.8	−1.16334	0.48707			0.001347		0.001174	0.725064		0.9836	0.039002	435.52	1.545	1.3166	30
	(4.2207)	(4.9654)***			(1.7170)**		(2.2678)***	(12.3002)***							
A3.9	−1.26628	0.499079	−0.00453		−0.00426		0.000013	0.742646		0.9868	0.034972	434.749	1.708	0.8361	30
	(5.0620)	(5.6666)***	(2.6632)***		(1.9190)**		(0.0201)	(13.9418)***							
A3.10	−1.2595	0.51112	−0.00429		−0.00395	0.001827		0.722814		0.9883	0.033984	505.67	1.74	0.7673	31
	(5.3292)	(5.9563)***	(3.3870)***		(2.3972)***	(0.6604)		(12.1213)***							
A3.11	−1.08887	0.491827			0.00105			0.698942		0.9827	0.041255	568.556	1.223	2.3006	31
	(3.8997)	(4.7998)***			(1.2869)			(11.4272)***							
A3.12	−1.34194	0.550511			0.001453			0.69544	−0.050194	0.9857	0.037492	517.972	1.56	1.2882	31
	(4.9344)	(5.7437)***			(1.9185)**			(12.5073)***	(2.5867)***						
*A3.13	−1.27489	0.501044	−0.00456		−0.0042			0.742464		0.9885	0.033614	645.987	1.713	0.8334	31
	(5.4804)	(5.9988)***	(3.8302)***		(2.7782)***			(14.5254)***							

See footnote under Table 1A.

TABLE 3B: NOMINAL PARTIAL ADJUSTMENT MECHANISM – BROAD MONEY (M2)

Model: Logm2 = d0 + d1Logy + d2Il + d3R + d4Rf + d5X + d6Log(M2t−1/Pt) + U**

Annual Data: 1960 – 1991

Equation No.	Explanatory Variables									Summary Statistics					
	Constant d0	Real Income d1	Inflationary Expectation d2	Nominal Deposit Rate d3	Real Deposit Rate d3*	Foreign Interest Rate d4	Exchange Rate Expectation d5	Lagged Real Money Demand d6	Dummy Variable d7	Adjusted R Squared	SEE	F	D.W.	h	n
B3.1	−1.42215	0.554694	0.001085	−0.00449		0.001843		0.715288		0.9882	0.034095	502.35	1.575	1.252814	31
	(5.8090)	(6.5210)***	(2.0281)**	(2.5607)***		(0.6643)		(12.1118)***							
B3.2	−1.46171	0.550852	0.001126	−0.00509			−8.0E−05	0.73409		0.9867	0.035084	431.95	1.529	1.348044	30
	(5.5757)	(6.1653)***	(2.0471)***	(2.0785)***			(0.1209)	(13.8383)***							
*B3.3	−1.44833	0.54764	0.001139	−0.00487				0.734636		0.9884	0.033727	641.615	1.543	1.326441	31
	(6.0596)	(6.5605)***	(2.1768)***	(2.9599)***				(14.4555)***							
B3.4	−1.28478	0.512661	0.001126				0.000903	0.728514		0.985	0.037341	475.686	1.572	1.232376	30
	(4.8684)	(5.5088)***	(1.9219)**				(1.8298)**	(12.9197)***							
B3.5	−1.52146	0.585582					0.000725	0.704555		0.9834	0.039228	573.588	1.622	1.091268	30
	(6.2049)	(6.5597)***					(1.4236)*	(12.1956)***							
B3.6	−1.67027	0.616445		−0.00436				0.711091		0.9868	0.035986	750.051	1.646	1.031391	31
	(7.2413)	(7.4874)***		(2.5109)***				(13.4213)***							
B3.7	−1.17767	0.506249			−0.00188	0.002883		0.703633		0.9876	0.0349	598.773	1.586	1.222735	31
	(5.1589)	(5.8251)***			(2.5564)***	(1.0469)		(11.7303)***							
B3.8	−1.24078	0.494499			−0.00195		0.000562	0.739882		0.9868	0.035287	533.425	1.6	1.145992	30
	(5.0783)	(5.6679)***			(2.6705)***		(1.2172)	(13.7973)***							
B3.9	−1.31984	0.511257	−0.00258		0.005164		−0.00011	0.723285		0.9873	0.034325	451.48	1.621	1.083166	30
	(5.4305)	(5.9763)***	(1.5560)*		(2.3636)***		(0.1814)	(14.2368)***							
B3.10	−1.31004	0.520487	−0.00219		−0.00458	0.001601		0.726277		0.9886	0.033428	522.787	1.649	1.034082	31
	(5.6874)	(6.2254)***	(1.8274)**		(2.7979)***	(0.5867)		(12.3567)***							
B3.11	−1.18428	0.487169			−0.00206			0.733466		0.9876	0.034962	795.17	1.5	1.456492	31
	(5.1807)	(5.7229)***			(2.8783)***			(13.8712)***							
*B3.12	−1.32439	0.511763	−0.00237		−0.00489			0.743622		0.9889	0.033004	670.303	1.625	1.087209	31
	(5.8567)	(6.3001)***	(2.0732)***		(3.2093)***			(14.8262)***							
B3.13	−1.4033	0.557214	0.001077					0.705819	−0.038224	0.9867	0.036147	557.723	1.599	1.170154	31
	(5.4685)	(6.1487)***	(1.9224)**					(13.1090)***	(2.0643)***						
B3.14	−1.30738	0.523553	−0.00261		−0.0051	−0.00195	−0.00025	0.721633		0.987	0.034747	367.22	1.657	0.939472	30
	(5.2978)	(5.9058)***	(1.5553)*		(2.3051)***	(0.6485)	(0.3720)	(11.5436)***							

See footnote under Table 1A.

TABLE 4A: THE SPEED OF ADJUSTMENT AND THE SHORT- AND LONG-RUN ELASTICITIES/SEMI-ELASTICITIES OF THE MONEY DEMAND IN NIGERIA WITH RESPECT TO THE EXPLANATORY VARIABLES FOR THE PREFERRED EQUATIONS FOR NARROW MONEY (M1)

	Real Partial Adjustment Mechanism				Nominal Partial Adjustment Mechanism			
	Equation A1.2		Equation A1.6		Equation B1.1		Equation B1.4	
Explanatory Variable	Short Run	Long Run	Short Run	Long Run	Short Run	Long Run	Short Run	Long Run
Real Income	0.579044	1.854745	0.54717	1.776278	0.59633	1.886088	0.561564	1.79887
Inflationary Expectation	−0.00116	−0.01644	−0.00115	−0.0163	0.001234	0.017485	0.001256	0.017797
Nominal Deposit Rate	−0.0029	−0.01909			−0.00325	−0.0214		
Real Deposit Rate								
Foreign Interest Rate								
Exchange Rate Expectations	0.001395	−0.00848	0.00196	−0.01192	0.001378	−0.00838	0.00201	−0.01222
Speed of Adjustment +	0.312196		0.308043		0.316175		0.312176	
Mean Adjustment #	2.203116		2.2463		2.162825		2.203321	

TABLE 4B: THE SPEED OF ADJUSTMENT AND THE SHORT- AND LONG-RUN ELASTICITIES/SEMI-ELASTICITIES OF THE MONEY DEMAND IN NIGERIA WITH RESPECT TO THE EXPLANATORY VARIABLES FOR THE PREFERRED EQUATIONS FOR QUASI MONEY (QM)

	Real Partial Adjustment Mechanism				Nominal Partial Adjustment Mechanism			
	Equation A2.1		Equation A2.6		Equation B2.1		Equation B2.7	
Explanatory Variable	Short Run	Long Run	Short Run	Long Run	Short Run	Long Run	Short Run	Long Run
Real Income	0.466595	1.836352	0.429615	1.687896	0.480359	1.887655	0.433511	1.747521
Inflationary Expectation*	−0.00178	−0.02522	−0.00484	−0.06858	0.000833	0.011803	−0.00292	−0.04158
Nominal Deposit Rate*	−0.00599	−0.03944			−0.00635	−0.04181		
Real Deposit Rate*			−0.00425	0.023686			−0.00521	0.029037
Foreign Interest Rate*	−0.00615	−0.04972	0.006128	0.049539	0.006131	0.049563	0.005965	0.048221
Exchange Rate Expectations*	−0.00182	0.011064	−0.00151	0.00918	−0.00184	0.011186	−0.00182	0.009849
Speed of Adjustment +	0.254088		0.254527		0.254474		0.248072	
Mean Adjustment #	2.935644		2.928856		2.929675		3.031068	

TABLE 4C: THE SPEED OF ADJUSTMENT AND THE SHORT- AND LONG-RUN ELASTICITIES/SEMI-ELASTICITIES OF THE MONEY DEMAND IN NIGERIA WITH RESPECT TO THE EXPLANATORY VARIABLES FOR THE PREFERRED EQUATIONS FOR BROAD MONEY (M2)

	Real Partial Adjustment Mechanism				Nominal Partial Adjustment Mechanism			
	Equation A3.4		Equation A3.13		Equation B3.3		Equation B3.12	
Explanatory Variable	Short Run	Long Run	Short Run	Long Run	Short Run	Long Run	Short Run	Long Run
Real Income	0.531265	2.027071	0.501044	1.94553	0.54764	2.063731	0.511763	1.998127
Inflationary Expectation*	−0.00144	−0.02004	−0.00456	−0.06345	0.001139	0.015849	−0.00297	−0.03298
Nominal Deposit Rate*	−0.00458	−0.02971			−0.00487	−0.03159		
Real Deposit Rate*			−0.00429	0.023487			−0.00489	0.026772
Foreign Interest Rate*								
Exchange Rate Expectations*								
Speed of Adjustment +	0.262085		0.257536		0.265364		0.256378	
Mean Adjustment #	2.815556		2.882952		2.768409		2.900491	

Note:

* The short-run elasticity is the semi-elasticity of money demand with respect to the independent variable. Long-run elasticity calculated at the mean, that is, the semi-elasticity multiplied by the mean of the regressor.
+ Speed of adjustment is one minus the coefficient of the lagged dependent variable in the estimated equation.
# Mean adjustment is $(1-\lambda)$ divided by λ and $(1-\gamma)$ divided by γ for real and nominal adjustment mechanism, respectively.

TABLE 5: DIAGNOSTIC STATISTICS

Type	Tests	Equation A1.3 Chi-square version	Equation A1.3 F version	Equation A1.6 Chi-square version	Equation A1.6 F version	Equation A2.1 Chi-square version	Equation A2.1 F version	Equation A2.6 Chi-square version	Equation A2.6 F version	Equation A3.4 Chi-square version	Equation A3.4 F version	Equation A3.13 Chi-square version	Equation A3.13 F version
A. Serial Correlation	Box-Pierce (BP) Q	5.0991 (15)	–	6.3337 (15)	–	20.6806 (15)	–	19.8461 (15)	–	16.7018 (15)	–	19.7976 (15)	–
	Ljung-Box (LB) Q*	7.2938 (15)	–	9.0425 (15)	–	29.7101 (15)*	–	29.3452 (15)*	–	23.0168 (15)	–	28.3486 (15)*	–
	Breusch-Pagan-Godfrey (BPG)												
	AR(1), 1-1	0.0543 (1)	0.0413 (1,22)	0.1000 (1)	0.0796 (1,23)	0.5393 (1)	0.3979 (1,21)	0.3480 (1)	0.2551 (1,21)	0.3862 (1)	0.3130 (1,24)	0.0879 (1)	0.0705 (1,24)
	AR(2), 1-2	1.3307 (2)	0.4990 (2,20)	3.0562 (2)	1.2865 (2,21)	10.3238 (2)*	5.5485 (2,19)*	6.9315 (2)*	3.1255 (2,19)	9.4806 (2)*	5.3427 (2,22)*	7.6606 (2)*	3.9488 (2,22)*
	AR(3), 1-3	1.3530 (3)	0.3165 (3,18)	3.1051 (3)	0.8230 (3,19)	16.7848 (3)*	9.3110 (3,17)*	14.0468 (3)*	6.1451 (3,17)*	9.8541 (3)*	3.6203 (3,20)*	8.4949 (3)*	2.9035 (3,20)
	AR(4), 1-4	2.9871 (4)	0.5192 (4,16)	4.5646 (4)	0.9050 (4,17)	18.6852 (4)*	9.5791 (4,15)*	16.7896 (4)*	6.8358 (4,15)*	10.8844 (4)*	3.0393 (4,18)	11.1298 (4)*	3.1558 (4,18)*
B. Heteroscedasticity	Breusch-Pagan (BP)	14.6460 (5)*	–	11.4600 (4)*	–	15.8706 (6)*	–	13.8291 (6)*	–	13.3942 (4)*	–	12.2108 (4)*	–
	White	17.0427 (10)	–	13.3140 (8)	–	20.6019 (12)	–	21.6323 (12)*	–	16.4494 (8)*	–	14.1029 (8)	–
	Pesaran-	0.1948 (1)	–	0.0919 (1)	–	2.0714 (1)	–	2.7583 (1)	–	0.1897 (1)	–	0.4626 (1)	–
	Harvey	7.5377 (5)	–	7.1710 (5)	–	13.3294 (6)*	–	15.6199 (6)*	–	5.3321 (4)	–	4.6101 (4)	–
C. ARCH	Engle's												
	ARCH1, 1-1	8.1881 (1)*	–	12.0069 (1)*	–	3.2885 (1)	–	3.3471 (1)	–	5.3017 (1)*	–	4.2523 (1)*	–
	ARCH2, 1-2	7.7340 (2)*	–	11.6422 (2)*	–	4.9322 (2)	–	4.0081 (2)	–	7.3543 (2)*	–	6.7653 (2)*	–
	ARCH3, 1-3	7.7189 (3)	–	11.1047 (3)*	–	5.7874 (3)	–	4.3776 (3)	–	6.9784 (3)	–	6.2821 (3)	–
	ARCH4, 1-4	9.0167 (4)	–	14.0515 (4)*	–	6.0985 (4)	–	4.6057 (4)	–	9.7934 (4)*	–	8.0548 (4)	–
D. Functional form & Omitted variables	Ramsey												
	RESET1	–	7.6596 (1,23)*	–	5.7787 (1,24)*	–	0.00672 (1,22)	–	0.0344 (1,22)	–	1.0812 (1,25)	–	0.5406 (1,25)
	RESET2	–	3.7401 (2,22)*	–	2.7694 (2,23)	–	0.00532 (2,21)	–	0.0325 (2,21)	–	1.2705 (2,24)	–	0.7245 (2,24)
	RESET3	–	3.8153 (3,21)*	–	2.8062 (3,22)	–	0.2793 (3,20)	–	0.3517 (3,20)	–	1.2179 (3,23)	–	0.7571 (3,23)
E. Normality	Bera & Jarque	2.0087 (2)	–	0.0438 (2)	–	1.9044 (2)	–	5.0394 (2)	–	1.8262 (2)	–	0.1085 (2)	–
F. Linear Restriction (d3 = 0)		–	–	–	1.1016 (1,24)	–	–	–	–	–	–	–	–
	Wald (W)	–	–	1.2188 (1)	–	–	–	–	–	–	–	–	–
	LR	–	–	1.1947 (1)	–	–	–	–	–	–	–	–	–
	LM	–	–	1.1712 (1)	–	–	–	–	–	–	–	–	–

Significant at the 5% critical level, implies rejection of the null hypothesis.
Degrees of freedom given in parenthesis beside each statistic.

TABLE 6: TESTS OF STRUCTURAL STABILITY AND FORECASTING POWER OF THE MONEY DEMAND FUNCTION

Type	Breaking Date	Equation A1.3	Equation A1.6	Equation A2.1	Equation A2.6	Equation A3.4	Equation A3.13
Tests of Parameter Constancy (F–statistic)							
(a) Chow Test	1973	1.3085 (6,12)	1.3486 (6,13)	1.7544 (5,11)	1.7863 (5,11)	1.5420 (5,13)	1.5826 (5,13)
	1977	0.5006 (2,8)	−0.6839 (2,9)	−1.8007 (2,7)	−2.2998 (2,7)	−1.0798 (3,9)	−0.7449 (3,9)
	1979	0.7232 (6,6)	−0.0982 (6,7)	0.0777 (6,5)	0.0309 (6,5)	−0.0227 (7,7)	0.0956 (7,7)
	1982	2.2788 (9,15)	2.6011 (9,16)*	3.4894 (9,14)*	5.6948 (9,14)*	3.7336 (9,17)*	3.7529 (9,17)*
	1986	2.8593 (5,19)*	2.9216 (5,20)*	4.3013 (5,18)*	6.8450 (5,18)*	3.8647 (5,21)*	3.6555 (5,21)*
(b) Farley–Hinich Test	(Full sample)	0.00845 (6,18)	0.00257 (5,20)	0.0149 (7,16)	0.0197 (7,16)	0.00778 (5,21)	0.0102 (5,21)
(c) Gujarati Test	(Full sample)	0.00029 (6,18)	0.00054 (5,20)	0.00285 (7,16)	0.00355 (7,16)	0.00063 (5,21)	0.0009 (5,21)
Forecasting Power PRMSE		0.9791	0.9983	0.8547	0.886	0.7472	0.7478
Correlation Coefficient b/w Predicted and Actual		0.9903	0.9899	0.9958	0.9954	0.9815	0.9811

Significant at the 5% critical level, implies rejection of the null hypothesis.
PRMSE is the percentage root mean square error.
Degrees of freedom given in parenthesis beside each statistic.

APPENDIX

1. Sources of Data

All data are annual averages, except the income data, and were obtained from three sources:

(a) Central Bank of Nigeria, Economic and Financial Review (various issues) and from Research Department data files.
(b) Federal Office of Statistics (various publications)
(c) IMF International Financial Statistics (various issues).

2. Definition of Variables

Real money (m) is defined as the ratio of either M1, M2 or QM to the consumer price index (P) (1985 = 100). M1 is the narrow definition (currency plus demand deposits). M2 is M1 plus savings and time deposits privately held in the banks (broad definition), and QM is savings and time deposits in the banks (in million naira).

Nominal interest rates (R) is defined as the average of savings and time deposit rates at commercial banks (in per cent). Real interest rate is nominal interest rate deflated by the rate of inflation.

Price Level (P) is the twelve-month moving average of the consumer price index (1985 = 100).

Inflation rate (π) is the rate of change (in per cent) of the composite consumer price index.

Foreign interest rate (R^f) (in per cent) is proxied by the Eurodollar rate in U.K.

Exchange rate (X) (1985 = 100) is the exchange rate of the naira in terms of U.S.dollar converted to index form. Thus X^e_t was computed as $[(X_{t-1} - X_t/X_t) * 100]$.

Real Income (y) is represented by the Gross Domestic Product at constant 1984 factor cost (in million naira).

Dummy variable (D) which takes the value of zero before 1986 and one from 1986 to account for the deregulation that accompanied the adoption of the Structural Adjustment Programme (SAP).

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