

Empirical Verification of Milton Friedman's Theory of Demand for Real Money Balances in Nigeria: Generalized Linear Model Analysis

Ernest Simeon O. Odior¹, Raymond Osi Alenoghena²

Abstract

This study empirically investigates the relationship between real money balances (demand for money) using the Milton Friedman's money demand function and real income, bonds, equities, stocks, interest rates, and inflation rate in Nigeria. The study used annual time series spanning 32 years, a sample period from 1981-2013. Methodically, this study models a standard money demand function and employed the use of ADF - Fisher Chi-square and Phillips-Perron test statistic to test for the unit root, the Engle-Granger single-equation to test for the cointegration and using the Generalized Linear Model (GLM) (IRLS - Fisher Scoring) method to dilate the impacts of the explanatory variables on the explained variable and using the Ramsey Reset Test diagnostics for functional form misspecification. Partially consistent with theoretical postulates, this study finds that money demand function is partially stable in Nigeria for the sample period and that income, inflation and lag of real money demand are the most significant determinants of the demand for money. The study shows that real money demand positively responds to an increase in real income, inflation and past real money demand and negatively to a rise in the interest rates spreads. It was also gathered that stock market variables can improve the performance of money demand function in Nigeria. The study recommended policies aimed at improving stock market activities and also monetary targeting as a tool for inflation control.

Keywords: Milton Friedman, Money Demand, Generalized Linear Model

1. Introduction

The demand for money concept has attracted a lot of attention from several economists over the years. People and businesses always keep money close as they require it to carry out transactions on a regular basis. Economic agents require money not just for exchange in the regular commodity market but also for transactions in Money market, capital market and foreign exchange market. This is why the use of money has a direct bearing on monetary policy and also relevant to the study of macro-economics. The focus on the demand for money is attributed to the fact that monetary policy will only be effective if the demand for money function is stable. Stability of the demand for money is crucial in understanding the behaviour of critical macro-economic variables (Essien et al, 1996).

The relation between the demand for money and its main determinants is an important building block in macroeconomic theories and is a crucial component in the conduct of monetary policy (Goldfeld, 1994). As a result, the demand for money is one of the topical issues that have attracted the most attention in the literature both in developed and developing countries. In the context of developed countries it is argued that disequilibrium in the demand for money (defined as the difference between the real money stock and the long-term equilibrium real money stock) may affect the efficacy of interest rate policy in the long run via its impact on output gap and/or inflation.

¹PhD, Department of Economics, Faculty of Social Sciences University of Lagos, Akoka, Lagos, Nigeria

²Department of Economics, Faculty of Social Sciences University of Lagos, Akoka Lagos, Nigeria

Theoretically, the demand for real money balances could be divided into transactions demand component, which is positively related to the income and inversely related to interest rates, precautionary demand component, positively related to income and speculative demand component, inversely related to interest rates. In addition, the paper includes the cost of credit as a determinant of demand for money. Following the previous studies and real world experience, the cost of credit does matter in developing countries. Since, in developing countries the transaction using broad money (M2) very often takes place. The government, the business and investors are using credit or lending to ensure the smooth running of their development activities. The banking system and other financial institutions create money by giving loans. However, it is a practice that during economic boom and the returns on investment is high and it encourages an increase in borrowing and lending activities with a relatively lower cost of credit. By contrast, during economic crisis either it is inflation or deflation, the banks and other financial institutions increase the cost of borrowing in order to discourage the clients from borrowing. So an increase in the cost of borrowing is likely to decrease the demand for money.

Many advanced economies switch between instruments of monetary policy by moving away from policies that influence the money supply towards those which influence the bank rate (McPhail, 1991; Haug, 1999). In developing countries, policymakers are concerned with the stability of money demand. Central banks in many developing economies have followed suit and switch towards monetary policies directed at the bank rate. However, recent studies have raised doubts about the validity and strength of central bank interest rate targeting in developing economies (Bahmani-Oskooee and Rehman, 2005; Rao *et al.*, 2009; Rao and Kumar, 2009a and 2009b)

During the '90s the growing importance of stock markets has again fed the idea that the primary source of instability is related to monetary aggregates. Moreover, the preference for liquidity in itself might be highly unstable. This could be because of wealth effects which influence non-monotonically the demand for money. It follows that the degree of instability will strongly depend not only on the fluctuations of the individual components of money demand, but also on the degree of correlation of these components with one another. Therefore, these components can significantly determine the dynamics and the stability of money demand.

Our case study focuses on the Nigerian economy, which enjoyed huge economic benefits from the oil boom of since the 1970s but suffered various political coups in the 1980s. Since the effort to stabilize in a democratic dispensation, various economic programmes have been designed and implemented by successive administrations and have made significant impact on the range of existing economic relationships that determine the demand for real money balances by the average Nigerian. In this study, we draw attention to the influence of wealth on money demand in Nigerian, an area which has been scarcely investigated empirically by researchers.

The main objective of this study is to empirically investigate if demand for real money balances function in Nigerian economy is consistent with the Milton Friedman's theory of demand for real money Balances for any economy. The study examines the role of real income, bonds, equity, stock, interest rates, inflation and past level of real money demand in the money demand function as the appropriate measure of opportunities cost of holding money. The appropriate research question for this study is, does the components in Milton Friedman's money demand function actually explains the opportunities cost of holding real money balances in Nigeria?

In the effort to justify the underlying the objectives and for this study, the hypotheses to be tested may be summarized that no significant relationship exists between money balances and the components of Milton Friedman's money demand function (include; income, wealth, returns on other assets and expected inflation). The justification for this study stems from the fact that despite the avalanche of literature on the money demand function in Nigeria, very few studies have focused on the impact of wealth in the demand for money function. The other short coming in earlier studies on this subject matter is in part related to methodology. Most of the studies adopted the traditional Ordinary Least Squares (OLS) method of analysis This study fills that gap by estimating a money demand function for Nigeria and by assessing the relationship

between real money demand (RM1 and RM2) and its determinants in accordance with Milton Friedman's demand for money theory.

The study is divided into six sections; the first section gives a background to the theory of Milton Friedman's hypothesis of money demand stating the problems and objectives of the study. Section 2 looks into the review of existing and related literature on the topic, while section 3 presents the theoretical framework and outlines the model specification. Section 4 explains the analytical and estimation technique. Section 5 discusses the empirical results of the study and section 6 presents the recommendations and conclusion.

2. Review of Literature

Despite the limited number of empirical studies on the relation between money demand and wealth, this issue has been the focus of many theoretical studies in the last century. The concept of "money demand" has over the years attracted the interest of great economists. Unlike the demand for goods it is not restricted to one market but also involves other markets (Money market, capital market commodity market and foreign exchange market), hence it has a direct bearing on monetary policy and so relevant to the study of macro-economics. The focus on the demand for money is attributed to the fact that monetary policy will only be effective if the demand for money function is stable. Stability of the demand for money is crucial in understanding the behaviour of critical macro-economic variables (Essien et al., 1996).

Why do individuals hold money? Answering this question has attracted the interest of great economists, from Irving Fisher in the early 1900s, to John Maynard Keynes in the early 1920s and 1930s, to William Baumol, James Tobin and Milton Friedman from the 1950s and on. Money generally refers to coins or paper notes and in a technical perspective includes a person's wealth including their property. In economics, the liquidity approach to the definition of money sees money in two ways. Firstly, its narrow sense as the sum of deposit and currency. Since the demand for money is the desire to hold cash, money demand is the sum of deposit demand (D^d) and currency demand (C^{urd}), $Md = D^d + C^{urd}$, hence factors affecting money demand are the same as factors affecting deposits demand plus any factors affecting currency demand. Secondly, the liquidity approach sees money in a broader sense to include M2 and M3, but due to the low degree of liquidity of assets classified under M3, it becomes almost impossible to include any components of M3, hence moneyiness, according to them, is a matter of degree.

According to Carpenter and Lange (2002), money is an asset with a particular set of characteristics, most notably its liquidity. Like other financial assets, demand for money is part of a portfolio allocation decision, in which an agent's wealth is distributed among competing assets based on each asset's relative benefits (Tobin, 1969). To a certain extent, agents are willing to give up the higher return of alternative assets in order to receive the benefit of liquidity that money provides. Carpenter and Lange (2002) further explained that, standard money demand equations include an interest rate or interest rate spread to measure the opportunity cost of holding non-interest earning money. This is true in the sense that since opportunity cost is the cost of alternative foregone, a higher return on alternative assets depletes liquidity (cash holding).

The theoretical foundations on demand for money theories are well established in the economic literature with great consensus that the demand for money is in the first place determined by real cash balances (Lungu et al., 2012). According to Telyukova (2008), three dominant views can be distinguished, namely the classical, the Keynesian and the post-Keynesian view.

The classical school kicked off the debate on the demand for money function and approaches the subject of money from the quantity theory which is based on the equation of exchange. Popularly referred to as the Fisher's equation of exchange it expresses the relationship between the nominal supply of money (M) and the total nominal expenditure on final goods and services produced in an economy (PY), indicating Prices (P) multiplied by Real Output (Y). The variable linking M and PY is the velocity of money (V). The precursor of this view within the classical school is Irving Fisher, who suggested that institutions in the economy

determine the velocity of money by affecting the way in which economic agents conduct transactions (Mishkin, 2009). He argued that because of slow advances in transactions' technology, the velocity of money will remain constant in the short run. Underlying the theory is the belief that agents hold money only for transactions' purposes, therefore ignoring the sensitivity of interest rate to money demand.

The Cambridge Equation (with Marshall and Pigou) represents what has been called the cash-balance approach to the value of money. It simply says that the value of money depends on demand for cash-balance and the supply thereof, at any given time. Here we need draw attention to one point on the demand side. The demand for money does not merely depend on the physical quantity of resources or of the goods and services, which are sought to be exchanged, but it largely depends on the period of time which the transactions are intended to cover. Thus, only a fraction of the whole income is kept in cash, the rest is invested. The amount of cash held should not be too much, because to keep cash locked up idly means a loss besides being a danger. Therefore, The Cambridge School asserts that people demand money as a medium of exchange and as store of wealth. The latter links the level of people's wealth to money demand and, as a result, wealth can be considered as a proportion of nominal income. In this way, wealth is a component of money demand. Patinkin (1956), following Pigou, argues that individuals hold part of their wealth in liquid form. The fundamental difference with respect to the Pigou's theory is that Patinkin believes that the amount of money holdings does not depend only on real variables, but also on what he called "real-balances effects".

Keynes (1936) developed the liquidity preference theory which explicitly highlights the transaction, precautionary and speculative motives for holding money. The most important innovation in Keynes' analysis is his speculative demand for money. The primary result of the Keynesian speculative theory is that there is a negative relationship between money demand and the rate of interest. Keynes defined the rate of interest as the reward for parting with liquidity for a specified period of time. According to him, the rate of interest is determined by the demand for and supply of money. Therefore, the higher the rate of interest, the lower the speculative demand for money, and lower the rate of interest, the higher the speculative demand for money.

To facilitate his analysis, Keynes used the assets' theory, indicating that if the expected return of holding bonds is greater than the return on holding money, individuals will hold bonds as a store of wealth rather than money (Mankiw, 2010). Profound developments of the Keynesian approach were conducted by Baumol and Tobin in order to understand the role of interest rates in the money demand. The three basic propositions of Keynes for holding money were maintained as a basis, but only precise theories were developed to explain the money demand motives (Mishkin, 2009).

According to the dominant Keynesian orthodoxy it was believed that this instability was mainly related to money markets. Therefore, the main idea was that monetary authorities should control the interest rates. The '70s were characterized by the first oil crisis; so many economists began to give greater weight to real shocks and to the inability of monetary authorities to correctly predict the expected rate of inflation. In a world where prices growth was highly volatile, they suggested the opportunity to control the money supply. A key role for the evolution of financial markets was brought by the liberalization process and the subsequent reaction of financial intermediaries. In the late '70s and during the '80s most industrialized countries experienced a process of liberalization of financial markets and credit. As a consequence, wealth was considered to be a factor that can greatly influence money demand. As a matter of fact, when wealth is omitted, the elasticity of money demand with respect to income changes, and this is probably enough to justify its inclusion. Friedman (1988) asserts that the increase in wealth, caused by the expansion of asset prices, may be related to the increase in the demand for other liquid assets, such as money, driven by portfolio choices.

Milton Friedman made very crucial contributions to the demand for money theory. Friedman relied on assets demand determinants which is almost in conformity with Keynes analysis. In his post-Keynesian view, money is considered as a type of asset implying its demand must also be influenced by the same factors affecting the demand of any other assets. Hence, he arranged bonds, equity and goods as types of assets to form his wealth concept. The assessment of an individual to hold an asset rather than money depends on the

expected return of the asset with respect to that of money. However, since the incentive to hold money does not change very much, the impact of interest on the demand for money is, according to Friedman's theory, very poor. This is in contradiction with the explanation of Keynes concerning the role of interest within the money demand function. The Friedman equation indicates that the money demand function is determined by the expected return on money and permanent income of which the permanent income is positive correlated with the demand for money while all other variables are negatively correlated (Mishkin, 2009). The permanent income which is the present value of all expected future income has short run fluctuations because many movements of the income are short-lived. Income will increase in times of economic growth, but because much of this increase is temporary, permanent income will not change much (Mankiw, 2010). This ensures that the demand for money does not fluctuate much with the cyclicity of the economy, which is usually also temporary.

Money demand in part reflects a portfolio decision. As equities have become a significant store of wealth, it seems plausible that variations in equity markets could affect the money demand. Through time, the stock market has become a more important store of wealth for households. Growth and innovations in mutual fund industry and the emergence of internet trading have reduced transaction costs and thus increased the substitutability between equities and money.

In macroeconomic literature, an enormous research has been conducted to estimate the money demand function. The advancement in the time series econometrics has been a major contribution to the estimation of money demand function in the last few decades. Such advancement has motivated researchers to question the creditability and the significant findings of the previous empirical models. This section provides a brief survey of the empirical modeling and estimation techniques used in the applied money demand function.

James Tobin (1947) conducted one of the earliest studies on the link between interest rates and money demand using U.S. data. Tobin separated out transactions balances from other money balances, which he called "idle balances," assuming that transactions balances were proportional to income only, and idle balances were related to interest rates only. He then looked at whether his measure of idle balances was inversely related to interest rates in the period 1922–1941 by plotting the average level of idle balances each year against the average interest rate on commercial paper that year. When he found a clear-cut inverse relationship between interest rates and idle balances, Tobin concluded that the demand for money is sensitive to interest rates.

For developing countries, Arize (1989) estimates the demand for money in four Asian economies: Pakistan, the Philippines, South Korea, and Thailand. He argues that foreign interest rates, exchange rate depreciation and technological change are important determinants of the Asian money demand functions. Bahmani-Oskooee and Malixi (1991) estimate the demand for money function in 13 developing countries as a function of inflation, real income and the real effective exchange rate. They conclude that, *ceteris paribus*, depreciation in real effective exchange rate results in a fall in the demand for domestic currency. However, they did not include the interest rate spread to capture the general process of financial asset substitution.

Recently, Bahmani-Oskooee and Rehman (2005) analyzed the money demand functions for India and six other Asian countries during the period beginning with the first quarter of 1972 and ending with the fourth quarter of 2000. Using the ARDL approach described in Pesaran et al. (2001), they performed cointegration tests on real money supplies, industrial production, inflation rate, and exchange rates (in terms of US dollar). For India, cointegration relationships were detected when money supply was as M1, but not M2, so they concluded that M1 is the appropriate money supply definition to use in setting monetary policy.

Attempts to demonstrate the determinants and stability of the demand for money function in Nigeria dates back to the early 1970s. This debate started in the early 1970s amongst a group of scholars in Nigeria in what is popularly referred to as the "Tattoo Debate". Tomori (1972) generated a lot of debate (in what is now known as the "Tattoo Debate") on the subject matter and consequently led to further empirical investigations of the issue. Tomori (1972) found income, interest rate and real income to be the major

determinants of demand for money in Nigeria. Owing to perceived shortcomings of Tomori's work, Ajayi (1974), Teriba (1974), Ojo (1974) and Odama(1974) reacted to the findings. The debate centered around the significance of income in money demand function for Nigeria, the stability of the function, and the choice of appropriate definition of money demand function in Nigeria.

The Central Bank of Nigeria used the monetary aggregate M2, which consisting of cash held by the public, demand deposits, all short-term liabilities held by the public at banking institutions etc for monetary policy and analytical purposes. On the appropriate definition of money demand in Nigeria, Tomori concludes that M1 performs better than M2. In contrast, Ajayi asserts that M2 performs better than M1. In an attempt to mediate between Tomori and Ajayi, contends that both M1 and M2 can be used as the definition of money in Nigeria. As lively as the debate was, the issue still remains inconclusive.

One major issue that has influenced money demand in Nigeria is the introduction of economic reforms. Since the economic reform measures started, several studies have been carried out on the demand for money in Nigeria, though not all made explicit attempts at investigating the stability of money demand function. Asogu and Mordi (1987) examined the monetary sector in general to discover some major determinants of money demand function. Ikhida (1998) also examined interest rate deregulation in Nigeria to see whether it is of major significance in the money demand function in Nigeria. Essien, Onwioduokit and Osho (1996), in their work on the demand for money in a debt-constraint economy observed that indebtedness could signal to private economic agents the direction of government fiscal and monetary policy which in turn influences the demand for money in the domestic economy. Audu (1988) in a research on selected West African countries observed that for Nigeria, a stable money demand relationship exists.

Nwaobi (2002) has also made efforts to examine the stability of the Nigeria's money demand function and found it to be stable. Nwaobi then suggests that monetary policy could be effective and that income is an appropriate determinant in the estimation of money demand in Nigeria. Anoruo (2002) explores the stability of M2 money demand function in Nigeria during the Structural Adjustment Programme (SAP) period. He observed that M2 money demand function in Nigeria is stable for the study period. Again, like Nwaobi, he asserts – using M2 money demand function, that it is a viable monetary policy tool that could be used to stimulate economic activity in Nigeria. This study concurs with Nwaobi that income is an important variable in the demand for money in Nigeria and that interest rate is insignificant in the function making it stable.

3. Theoretical Framework and Specification of Model

Theories of money demand based on portfolio choices emphasize the role of money as a store of value. These theories point out that individuals hold money in their portfolios because it provides a low risk nominal return. Milton Friedman's theory considers money demand like the demand for any other asset (Friedman, 1956). Therefore, it should be a function of wealth and the returns of other assets relative to money. According to the author, money demand depends on three major sets of factors: (1) Total wealth, (2) the price and return on wealth, and (3) preferences. According to Friedman there is nothing special about money per se since it is one of several existing assets, and it is just one form in which a consumer can hold his wealth as a productive enterprise holds his capital good. If the demand for money is not different from the demand for any other commodity, we can simply specify the various factors which will influence the amount of it that is held. This, according to Friedman are the budget constraint of the individual which may be his income or his wealth, the prices of the various assets (this in the case of money demand should be the rate of return of the various assets which are or could be held as alternatives to money); and lastly, the tastes of preferences of the individual.

Against the background of the preceding discussion Friedman postulates and contends that, money demand, like the demand for any other asset, should be a function of wealth and the returns of other assets relative to money. In other words according to In Friedman, there are five different forms in which wealth could be held: money, bonds, equities, physical goods, and human capital. The allocation of total wealth between the various forms of assets is dependent on the relative rates of return on the various assets. In a

functional form, the demand for money in real terms is written by Friedman as follows

$$M^d = f\left(r_m, r_e, r_b, \frac{1}{p} \frac{dp}{dt}, w, y_p, \varepsilon\right) \quad (1)$$

where M^d denote demand for real balances, r_m is the expected return on money, r_e is the expected return on equity, r_b is the expected rate of return on bonds, $\frac{1}{p} \frac{dp}{dt}$ is the expected inflation rate (proxy for rate of return on physical assets), W is the ratio of human to nonhuman wealth, y_p is the permanent income (the expected long-run average of current and future income), that is the real GDP-production as a proxy to capture transactions and precautionary demand for money and ε is the tastes and preferences.

There are major differences between the Friedman formulation and the old quantity theory of money. First, in the Friedman analysis, velocity is no longer constant. Rather, velocity is a function of a limited number of variables. In the specification, k is expressed as a function of the rates of return on the assets that are alternatives to holding money. If there is a rise in any of the alternatives assets, k would fall implying the increased desirability of the alternative asset.

Also, from the above discussion, there are significant differences between the Keynes theory of the demand for money and that of the Friedman. First, Keynes's view of the demand for money was that it was unstable shifting with changes in the public confidence in the economy. Second, Friedman's analyses ignore the compartmentalization of money into the different motives as Keynes did. Friedman does not find it useful or necessary to separate the attributes which make money useful into separate demands based on the uses of money. Third, while Keynes focused on the choice between money versus bonds, Friedman's analytical framework includes separate yields for various financial assets and durable goods. Thus, an allowance is made in the Friedman's analyses for the possibility of substitution between financial assets and also substitution from money directly into commodities (durable goods) as there are changes in the rate of return.

To achieve our research objectives and analyze the marginal impacts (short and long run) of Milton Friedman's money demand determinants demand for real balance, it is necessary and proper to drive our model from Friedman's functional form (equation 1). That is we test for the effect of those Friedman's factors on demand for real balances (M^d) using the following equation (1). The empirical model adopted in this study after a minor modification of equation (1) is formally is specified as follows:

$$m_t^d = (m - p)_t = \gamma_0 + \gamma_1 y_t + \gamma_2 RM_t + \gamma_3 RB_t + \gamma_4 RS_t + \gamma_5 RE_t + \gamma_6 \Delta p_t + \gamma_7 (m - p)_{t-1} + \varepsilon_t \dots \dots (2)$$

where m_t^d is the real money balances, t is time starting from 1981 to 2013, m is nominal money demanded, p is the price level, y is the real GDP-production as a proxy to capture transactions and precautionary demand for money, RM is rate of return on money (the lending interest rate), that is the short-run of interest on money itself, rb is the rate of return on bonds, RS is the rate of return on stocks, RE is the rate of return on equities, $\Delta p_t = \ln(p_t) - \ln(p_{t-1})$ is the rate of inflation, is considered as a proxy to measure the return on holdings of goods (including foreign currencies), and its coefficient should be negative, *i.e.* $\square < 0$, as goods (*e.g.* real estate and other currencies) are an alternative to holding domestic currency and $(m - p)_{t-1}$ is the lagged value of real money balances (Valadkhani and Alauddin, 2003). All variables shown in lowercase (*i.e.* m , y , and p) are in natural logarithms while the remaining variables (*i.e.* RM , RB , RS , and RE) are in levels.

In a more conventional way we may rewrite equation 2 as;

$$\log RMD_t = \gamma_0 + \gamma_1 \log RGDP_t + \gamma_2 \log ROB_t + \gamma_3 \log ROE_t + \gamma_4 \log ROS_t + \gamma_5 \log ROM_t + \gamma_6 \log INF_t + \gamma_7 \log RMD_{t-1} + \varepsilon_t \quad (3)$$

The model above is designed to measure the relationship that exist between the dependent variable; real money demand (RMD) and the independent variables; real gross domestic income (RGDP), return on bonds (ROB), return on equities (ROE), return on stocks (ROS), return on money (ROM) and inflation rate (INF) and the lag value of real money demand (RMD_{t-1}). This is to see how these independent variables influence the money balance or money demand either positively or negatively.

The parameter γ_1 and γ_6 denote the short-run income and inflation elasticities of the demand for money, whereas γ_2 and γ_5 are short-run semi- elasticities of, *ROB*, *ROE*, *ROS* and *ROM* with respect to money demand, respectively. Adopting an adaptive expectations model, one can divide these coefficients by $(1 - \gamma_7)$ to obtain the corresponding long-run elasticities or semi-elasticities.

The a-priori assumptions for the above model based on (equation 3.) are: $\gamma_1 > 0, \gamma_2 < 0, \gamma_3 < 0, \gamma_4 < 0, \gamma_5 < 0, \gamma_6 < 0, \gamma_7 > 0$. The parameters $\gamma_s > 0$ implies a positive relationship between the dependent variable and independent variables. This implies that an increase in these independent variables will lead to an increase in money demand. The parameters $\gamma_s < 0$ means that there is a negative relationship between the dependent variable and the independent variables, This means that an increase in the independent variables will lead to a decrease in money demand. The expectations of the model are quite clear from the a priori signs of the coefficients based on economic literatures.

Money demand is positively related to permanent income. However, permanent income, since it is a long-run average, is more stable than current income, so this will not be the source of a lot of fluctuation in money demand. The other terms in Friedman's money demand function are the expected returns on bonds, stocks and goods relative the expected return on money. These items are negatively related to money demand: the higher the returns of bonds, equity and goods relative the return on money, the lower the quantity of money demanded. Friedman did not assume the return on money to be zero. The return on money depended on the services provided on bank deposits (check cashing, bill paying, etc.) and the interest on some checkable deposits.

So the demand for real money balances, according to Friedman, increases when permanent income increases and declines when the expected returns on bonds, stocks, or goods increases versus the expected returns on money, which includes both the interest paid on deposits and the services banks provide to depositors.

Analytical and Estimation Technique

Generalized linear models are a remarkable synthesis and extension of familiar regression models such as the linear models. Generalized linear models have become so central to effective statistical data analysis, however, that it is worth the additional effort required to acquire a basic understanding of the subject. The GLM approach is attractive because it (1) provides a general theoretical framework for many commonly encountered statistical models; (2) simplifies the implementation of these different models in statistical software, since essentially the same algorithm can be used for estimation, inference and assessing model adequacy for all GLMs.

GLMs offer a common framework in which we may place all of these specification, facilitating development of broadly applicable tools for estimation and inference. In addition, the GLM framework encourages the relaxation of distributional assumptions associated with these models, motivating development of robust quasi-maximum likelihood (QML) estimators and robust covariance estimators for use in these settings. A wide range of familiar models may be cast in the form of a GLM by choosing an appropriate distribution and link function.

The Structure of Generalized Linear Models

The canonical treatment of GLMs is Nelder and Wedderburn (1972), and this review closely follows their notation and approach. Begin by considering the familiar linear regression model, $Y_i = X_i'\beta + \varepsilon_i$, where $i = 1, \dots, N$, Y_i is a dependent variable, X_i is a vector of k explanatory variables or predictors, β is a k -by-1 vector of unknown parameters and the ε_i are zero-mean stochastic disturbances. Typically, the ε_i are assumed to be independent across observations with constant variance σ^2 , and distributed normal. That is, the normal linear regression model is characterized by the following features:

a) A *random component* or stochastic component: specifying the conditional distribution of the response variable, Y_i (for the i th of n independently sampled observations), given the values of the explanatory variables in the model. The Y_i are usually assumed to have independent normal distributions with $E(Y_i) = \mu_i$, with constant variance σ^2 , or $Y_i \sim^{iid} N(\mu_i, \sigma^2)$

b) A linear predictor or systematic component: the covariates X_i combine linearly with the coefficients to form the linear predictor $\eta_i = X_i'\beta$. That is a linear function of regressors

$$\eta_i = \alpha + \beta_1 X_{i1} + \beta_2 X_{i2} + \dots + \beta_k X_{ik} \tag{4}$$

c) A smooth and invertible linearizing link function $g(\cdot)$, which transforms the expectation of the response variable, $\mu_i \equiv E(Y_i)$ to the linear predictor. That is the link between the random and systematic components: the linear predictor $X_i'\beta = \eta_i$ is a function of the mean parameter μ_i via a *link* function, $g(\mu_i)$. Note that for the normal linear model, g is an identity.

$$g(\mu_i) = \eta_i = \alpha + \beta_1 X_{i1} + \beta_2 X_{i2} + \dots + \beta_k X_{ik} \tag{5}$$

The corresponding density functions for the normal distribution from the exponential family is given by:

$$f(y_i, u_i, \sigma^2, w_i) = \left(\frac{2\pi\sigma^2}{w_i}\right)^{-\frac{1}{2}} \exp\left(\frac{-(y_i^2 - 2y_i u_i + u_i^2)}{2\sigma^2 / w_i}\right) \text{ for } -\infty < y_i < \infty \tag{6}$$

Recall that the main aim of this study is to empirically investigate whether their relationship exists between certain combinations of Milton Friedman’s factors for money demand and the real money balances in relation to Nigerian economy. As such an appropriate estimation procedure will be adopted. With the formulated models in equation 3, we carried out the model estimations.

The first step is the unit root test which involves the determination of the order of integration, using the ADF - Fisher Chi-square and Phillips-Perron test statistic. The second aspect is to test for cointegration, using the Engle-Granger single-equation cointegration test. The third aspect is the impact relationship between the dependent and the independent variables which is run over the sample period 1981-2013, using the Generalized Linear Model (GLM) (IRLS - Fisher Scoring) method. IRLS, which stands for Iterated Reweighted Least Squares, is a commonly used algorithm for estimating GLM models. IRLS is equivalent to Fisher Scoring, a Newton-method variant that employs the Fisher Information (negative of the expected Hessian matrix) as the update weighting matrix in place of the negative of the observed Hessian matrix used in standard Newton-Raphson. The fourth and final test is for Specification Errors which is carried out by Ramsey Regression Equation Specification Error Test (RESET).

The data for this study consists of annual time series, they are generated in line with the period covered by the study which is 1981-2013, a period of 34. This choice is predicated by the research method adopted for this work and following the purposes and objectives of the study. The data used for this study are obtained from the publications of the Central Bank of Nigeria (CBN, 2010, 2013) Statistical Bulletin and Annual Reports on major economic indicators.

4. Empirical Results

Unit Root Test

Table 1 shows Augmented Dickey-Fuller (ADF) - Fisher Chi-square and Phillips-Perron Test Statistic test of unit root conducted on all the variables to test for stationarity of the variables (Raza, 2015). From the A(ADF) - Fisher Chi-square and PP test statistics, the results show that LOGRMD is integrated at order two, that is I(2) or it was stationary at second difference, while LOGROB, LOGROE, LOGROS, ROM and INF were all integrated at order one, that is I(1) or they were stationary at first difference. This position is further reinforced by the values of the various probabilities. All the variables (except for INF that was statistically significant at 5% and 10% critical values) were statistically significant at 1%, 5% and 10% critical values in first difference.

Table 1: Stationarity Test Result

Null Hypothesis: Unit root (individual unit root process)								
Series: LOGRMD, LOGRGDP, LOGROB, LOGROE, LOGROS, ROM, INF								
Method:	ADF - Fisher Chi-square				Phillips-Perron Test Statistic			
Series	t-Stat	Prob.	Order of integration	Maximum Lag	Adj. t-Stat	Prob.	Order of integration	Maximum Lag
D(LOGRMD,2)	-4.5781	0.0058	I(2)	1	-14.17752	0.0000	I(2)	1
D(LOGRGDP)	-6.5396	0.0000	I(1)	1	-5.404977	0.0006	I(1)	1
D(LOGROB)	-8.3304	0.0000	I(1)	1	-8.902424	0.0000	I(1)	1
D(LOGROE)	-7.2245	0.0000	I(1)	1	-7.715138	0.0000	I(1)	1
D(LOGROS)	-3.7775	0.0316*	I(1)	1	-3.945394	0.0218*	I(1)	1
D(ROM)	-6.3565	0.0001	I(1)	1	-7.287776	0.0000	I(1)	1
D(INF)	-5.7545	0.0003	I(1)	1	-8.376755	0.0000	I(1)	1
	1% level	-4.339330			1% level	-4.284580		
	5% level	-3.587527			5% level	-3.562882		
	10% level	-3.229230			10% level	-3.215267		

Notes: * indicate statistical significance at the 5% and 10%
 Source: Authors' Computation

Single-Equation Cointegration Test

The Engle-Granger tau-statistic (t-statistic) and normalized auto-correlation coefficient (which we term the z-statistic) both reject the null hypothesis of no cointegration at the 5% significance level. The probability values are derived from the MacKinnon response surface simulation results. Given the small sample size of the probabilities and critical values there is evidence of four cointegrating equation at the 10% level of significance using the tau-statistic (t-statistic) and evidence of five cointegrating equation at the 10% level of significance using the z-statistic This implies that the both did not rejected the null hypothesis of no cointegration among the variables at the 10 per cent level of significance. On balance, using the tau-statistic (t-statistic) the evidence clearly suggests that LOGRGDP, LOGROB, LOGROE and ROM are cointegrated, while, LOGRMD, LOGRGDP, LOGROB, ROM and INF are cointegrated using the z-statistic. This implies that there exists a long-run relationship or cointegration between real money demand and its determinants.

Table 2: Engle-Granger Cointegration Test Results

Dependent	tau-statistic	Prob.*	z-statistic	Prob.*	Long-run residual variance
LOGRMD	-4.466544	0.5308	-35.53556	0.0508	0.029949
LOGRGDP	-7.204665	0.0130	-156.1938	0.0000	1.431572
LOGROB	-6.216376	0.0628	-35.43690	0.0611	0.293798
LOGROE	-6.195943	0.0648	-33.20388	0.1151	0.048434
LOGROS	-4.036102	0.7065	-22.25107	0.6954	0.355552
ROM	-6.120327	0.0727	-34.36095	0.0840	11.52781
INF	-5.101482	0.2893	-53.75279	0.0000	510.8279

Source: Authors' Computation

Long-run residual variance" is the estimate of the long-run variance of the residual based on the estimated parametric model. The estimator is obtained by taking the residual variance and dividing it by the square of 1 minus the sum of the lag difference coefficients. These residual variance and long-run variances are used to obtain the denominator of the z-statistic.

Interpretation of Estimated Coefficients

Table 3: Coefficients impacts Estimate

Dependent Variable: LOGRMD				
Method: Generalized Linear Model (IRLS - Fisher Scoring)				
Family: Normal				
Link: Identity				
Dispersion computed using Pearson Chi-Square				
Coefficient covariance computed using expected Hessian				
Variable	Coefficient	Std. Error	z-Statistic	Prob.
C	2.801478	0.654871	4.277909	0.0000
LOGRGDP	0.167506	0.080573	2.078944	0.0376
LOGROB	-0.132574	0.200384	-0.661599	0.5082
LOGROE	-0.107980	0.470783	-0.229361	0.8186
LOGROS	-0.109635	0.106883	-1.025755	0.3050
ROM	-0.120867	0.226335	-0.534018	0.5933
INF	0.138001	0.045604	3.026048	0.0025
LOG(RMD(-1))	0.909942	0.070166	12.96834	0.0000
Mean dependent var	12.94679	S.D. dependent var	2.341817	
Sum squared resid	1.732654	Log likelihood	1.364323	
Akaike info criterion	0.341556	Schwarz criterion	0.658997	
Hannan-Quinn criter.	0.448365	Deviance	1.732654	
Deviance statistic	0.066641	Restr. deviance	175.4915	
LR statistic	2607.404	Prob(LR statistic)	0.000000	
Pearson SSR	1.732654	Pearson statistic	0.066641	
Dispersion	0.066641			

Source: Authors' Computation

Friedman's work on the demand for money began with "The Quantity Theory of Money: A Restatement" (1956) published as the lead essay in Studies in the Quantity Theory of Money (Friedman, Ed, 1956). These items in our result in Table 3 that are in Friedman's money demand function are negatively

related to money demand: the higher the returns of bonds, equity, stock and goods relative the return on money, the lower the quantity of money demanded.

Although, LOGROB, LOGROE, LOGROS and ROM are negatively related to the level of money demand in Nigeria, the p-values statistics shows that they were not statistically significant. Elasticity, which is the measure of opportunity cost of holding money are found to be -0.133, -0.108, -0.110 and -0.121 respectively. This not significant relationship provides evidence in support of opportunity cost of holding money in Nigeria.

These are consistent with most empirical studies on the determinants of real money balances. An increase in the interest rate will lead to a reduction in the demand for money. So, an investor will decide to allocate its portfolio between money and bonds. An increase in the interest rate will lead to a reduction in the demand for money a proportional increase in the nominal demand for money: in fact, if prices of all. If bond prices decrease, then the: interest rate decreases and transactions demand for money will increase. An increase in the interest rate will lead to a reduction in the demand for money because higher interest rates will lead investors to put less of their portfolio in money (that has a zero interest rate return) and more of their portfolio in interest rate bearing assets (Treasury bills). Friedman did not assume the return on money to be zero. The return on money depended on the services provided on bank deposits (check cashing, bill paying, etc) and the interest on some checkable deposits.

Other important variables estimated in this model are real GDP, rate of inflation and past value of real money demand. The estimated regression line shows that real GDP (LOGRGDP), rate of inflation (INF) and past value of real money demand (LOG(RMD(-1))), have positive relationship with real money demand in Nigeria. The regression coefficient of LOGRGDP, INF and LOG(RMD(-1)) are 0.1675, 0.1380 and 0.9099, respectively which implies that 16.75%, 13.80% and 90.99% of the increase in the real money demand in the period under review are accounted for by a 100% increase in real GDP, rate of inflation and past value of real money demand, respectively. The p-values statistics shows that they were statistically significant. This impact implies that these variables are the major contributor to money demand in Nigeria.

Also, we found the results consistent with most empirical studies except for inflation which most considered to be negatively related to money demand. According to most empirical studies, an increase in the income of the investor will lead to an increase in the demand for money. In fact, if income is higher consumer will need to hold more cash balances to make transactions (buy goods and services). In the case of inflation we explained that, an increase in the price level (inflation) will lead to a proportional increase in the nominal demand for money: in fact, if prices of all goods double, we need twice as much money to make the same amount of real transactions. Since the nominal money demand is proportional to the price level, we can write the real demand for money as the ratio between money demand and the price level. Then, the real demand for money depends only on the level of transactions and the opportunity cost of money (the nominal interest rate):

Regression Specification Error Test

In this study, we use the Ramsey's (1969) Regression Specification Error Test (RESET) as a General Test for Functional Form Misspecification for the linear regression model. RESET has proven to be useful in this regard that is detecting neglected nonlinearities in estimated models. More specifically, it tests whether non-linear combinations of the fitted values help explain the response variable. The intuition behind the test is that if non-linear combinations of the explanatory variables have any power in explaining the response variable, the model is mis-specified. Ramsey's suggestion is to include powers of the predicted values of the dependent variable (which are, of course, linear combinations of powers and cross-product terms of the explanatory variables).

In our study, we used the RESET test as a general test for the following types of specification errors: (1) Omitted variables; the explanatory variables (LOGRGDP LOGROB LOGROE LOGROS ROM INF (LOGRMD(-1))) do not include all relevant variables. (2) Incorrect functional form; some or all of the

variables in model should be transformed to logs, powers, reciprocals, or in some other way. (3) Correlation between explanatory variables and the error term, which may be caused, among other things, by measurement error in explanatory variables, simultaneity, or the presence of lagged RMD values and serially correlated disturbances.

Table 4: Regression Specification Error Test Result

Ramsey RESET Test			
Specification: LOGRMD C LOGRGDP LOGROB LOGROE LOGROS ROM INF (LOGRMD(-1))			
Omitted Variables: Powers of fitted values from 2 to 3			
	Value	DF	Probability
F-statistic	14.39301	(2, 24)	0.0001
Likelihood ratio	28.78602	2	0.0000
F-test summary:			
	Sum of Sq.	DF	Mean Squares
Test Deviance	0.938248	2	0.469124
Restricted Deviance	1.720500	26	0.066173
Unrestricted Deviance	0.782253	24	0.032594
Dispersion SSR	0.782253	24	0.032594
LR TEST SUMMARY:			
	VALUE	DF	
Restricted Deviance	1.720500	26	
Unrestricted Deviance	0.782253	24	
Dispersion	0.032594		

Source: Authors' Computation

The result in Table 4 shows that the Ramsey RESET test used the powers of the fitted values of real money demand (RMD) as we assumed that all explanatory variables are exogenous and the test are likelihood ratio based tests. The top portion of the output shows the test settings, and the test summaries. Looking at the F-statistic, likelihood and probability value, the results show evidence of linearity with no case of omitted variables, incorrect functional form and correlation between explanatory variables and the error term.

5. Recommendations and Conclusions

The purpose of this study is to investigate the demand for money in the Nigeria. The results obtained were in tandem with a priori expectation in terms of signs and magnitude. Income and inflation turned out to be positive and significant in affecting the demand for real money balances while, other variables in the specification such as returns on stock, return on equity and return on money were negative and significant conforming to a priori expectations. This indicates that the demand for real money balance in Nigeria possesses a predictable monetary aggregate. The stability of money demand is crucial in assessing the longer-term relationship between money and prices

To understand the economic mechanism that leads to this adjustment, the investor must decide how much to invest in money and how much to invest in bonds. Since the demand for money is a negative function of the interest rate, the demand for bonds will be a positive function of the interest rate: as interest rates become higher, the investor would like to put more of her wealth in bonds and less of her wealth in cash.

Given the findings above, the following recommendations are hereby proposed for this research study:

First, the monetary authorities should have the political-will to effectively control and accurately predict aggregate monetary variables to achieve macroeconomic objectives which transcends to economic growth in Nigeria. It is encouraged that the monetary authority should be truly independent or autonomous in order to effectively and efficiently discharge her monetary policy obligations to the economy.

Second, the government should free the financial market from the shackles of her manipulations to allow the forces of demand and supply determine what happens in the financial market as this is the case in most developed countries. This would make it easier to achieve the objectives of monetary policy in terms of inflation control, competitive interest rate, appropriate exchange rate and money supply.

Third, the investment habits of the Nigerian people should be improved through carefully planned financial inclusion programmes that are inspired by the monetary authorities. This would stimulate more positive banking habits among the people and enhance decision on the sophisticated choices between investment in securities and holding on to money balances.

Fourth, the monetary authorities should take account of some important variables in the determination of money demand in Nigeria; of particular importance is the lagged value of money demand which played an important role during the period under review in this study. So far, the impact of this variable has not been given much attention in the determination of money demand analysis in Nigeria.

Finally, monetary macroeconomic policy inconsistency and ad-hoc responses to macroeconomic trends should be discontinued forthwith in the management of the country's macroeconomic affairs. Frequent, ill-conceived and reactive changes in monetary macroeconomic policies most often serve to further exacerbate a worsening economic direction for a country. Proper long-term planning with a clear strategic direction for the country's monetary macroeconomic situation is more beneficial for the country's long-term growth objective.

The above recommendations are in conformity to our stated a-priori expectation that there exists a positive relationship between the Real Gross Domestic Product and money demand and Consumer Price Index and money demand in Nigeria and also an inverse relationship between return on stocks, return on equity and interest rate on money demand in Nigeria. The Nigerian situation has shown support for the existing relationship between money and prices over time. The analysis somewhat establishes that the relationship could be essentially independent of the time period considered.

References

- Ajayi S.I (1974): "The Demand for Money in Nigeria: Comments and Extensions" NJESS, 16 (1) Pp. 165-174.
- Anoruo, E. M. (2002): "Stability of the Nigerian M2 Money Demand Function in the SAP Period." Economics Bulletin. Vol. 14, No. 3, P. 179
- Arize, A, 1989, An Econometric Investigation of Money Demand Behaviour in four Asian developing countries, International Economic Journal 3(4), 79-93
- Asogu, J. O and C.N.O Mordi (1987): "An Econometric Model of the Nigerian Monetary Sector: Outline and Preliminary results, Mimeo, Central Bank of Nigeria.
- Audu, M. M. (1988): "Stability of Demand for Money Functions in Selection West African Countries" (1960 – 1987), unpublished M. Sc. Thesis, Department of Economics, University of Lagos.
- Bahmani – Oskooee, M. and Rhee, H.J. (1994), "Long Run Elasticity's of the Demand for Money in Korea: Evidence from Co integration Analysis, International Economic Journal, 8(2).
- Baumol E.J. (1953), "The Transactions Demand for Cash: An Inventory Theoretic Approach" Quarterly Journal of Economics, Vol.66.

- Carpenter, S.B and J. Lange (2002), "Money Demand and Equity Markets" Board of Governors of the Federal Reserve System and Cornerstone Research, October.
- Central Bank of Nigeria (2011), Statistical Bulletin, Vol. 21, December, Abuja, Nigeria
- Essien, E.A, E.A Onwioduokit and E.T. Osho (1996): "Demand for Money in a Debt Constrained Economy", A Case Study of Nigeria, CBN Economic and Financial Review, 34(2).
- Friedman, M. (1956), "The Quantity Theory of Money – A Restatement in M.Friedman (ed)" Studies in Quantity Theory of Money, (Chicago University Press).
- Goldfeld, S.M. (1994) Demand for Money: empirical Studies in P.Newman, M. Milgrate&J.Eatwel (Eds). The New palgrave Dictionary of Money and Finance (London, Macmillan Press).
- Haug, A. A. (1999) 'Money demand functions: Data span and tests,' conference paper presented at the New Zealand Econometrics Study Group Meeting, available at http://www.econ.canterbury.ac.nz/research/working_papers.shtml
- Ikhide S. I and A.A. Alawode (2001) "Financial sector Reforms, Macroeconomic instability and Order of economic Liberalisation: The Evidence from Nigeria" African Economic Research Consortium, Research paper 112.
- Keynes, J.M. (1936), "The General Theory of Employment, Interest and Money." London and New York Macmillan
- Lungu, M., Simwaka, K., Chiumia, A., Palamuleni, A. & Jombo, W. (2012), Money Demand Function for Malawi: implications for monetary policy conduct, Banks and Bank Systems 7(1), 50-63
- Mankiw, N. G., L. H. Summers, (1986), "Money Demand and the Effects of Fiscal Policies", Journal of Money, Credit, and Banking, 18, 415-429.
- McPhail, K. (1991) 'The Long-Run Demand for Money, Canada savings bonds and treasury bills in Canada', available at <http://www.esri.go.jp/en/archive/dis/discussion-e.html>
- Mishkin, F. S. (2009). The Economics of Money, Banking and Financial Markets. United States of America: Pearson Education, Inc.
- Nelder, J.A. and R.W.M. Wedderburn (1972), "Generalized linear models." Journal of the Royal Statistical Society, Series A 135:370--84
- Nwaobi, G. (2002), "A Vector Error Correction and Non Nested modeling of Money demand Function in Nigeria." Economics Bulletin, Vol.3.
- Odama, J.S (1974), "The Demand for Money in the Nigerian Economy, Some Comments", NJESS 16(1), 178-188.
- Ojo, O. (1974): "The Demand for Money in the Nigerian Economy, Some Comments" Nigerian Journal of Economics and Social studies, Vol.16, No.1 Pp.149-152.
- Patinkin, D., 1969. The Chicago Tradition, the Quantity Theory, and Friedman, Journal of Money, Credit and Banking 1 (1), 46-70
- Ramsey, J. B. (1969), "Tests for Specification Errors in Classical Linear Least Squares Regression Analysis, 'Journal of the Royal Statistical Society, Series B, 31, 350–371
- Rao, B. B and Kumar, S. (2009b) 'Cointegration, structural Breaks and Demand for Money in Bangladesh', Applied Economics 41, 1277-1283
- Rao, B. B. and Kumar, S. (2009a) 'A Panel Data Approach to the Demand for Money and the Effects of Financial Reforms in the Asian Countries', Economic Modeling 26, 1012-1017
- Raza, S. A. (2015). Foreign direct investment, workers' remittances and private saving in Pakistan: an ARDL bound testing approach. Journal of Business Economics and Management, 16(6), 1216-1234.

- Telyukova, I. (2008). Theories of money demand. (UBC Economics Power point slides)
- Teriba, O. (1974): "The Demand for Money in the Nigerian Economy: Some Methodological Issues and Further Evidence", Nigerian Journal of Economic and Social Studies.Vol.16, No.1, Pp 153-164.
- Tobin, J.(1947): "Liquidity Preference and Monetary Policy," Review of Economics and Statistics 29: 124–131.
- Tobin, J. (1969): "A General Equilibrium Approach to Monetary Theory" Journal of Money Credit and Banking, Vol.1.
- Tomori, J. (1972): "The Demand for Money in Nigeria: Nigeria Journal of Economics and social Studies (NESS) 4(3)