Turkish Economic Review
www.kspjournals.org
Volume 4 June 2017 Issue 2

An Econometric Analysis of Demand for Money and its Stability in Tanzania

By Manamba EPAPHRA [†]

Abstract. This paper examines the determinants of demand for money and its stability in Tanzania using annual time series data spanning from 1966 to 2015. Economic analysis of the money demand function is facilitated by the Johansen cointegration, vector autoregressive-vector error correction model (VAR-VECM) and variance decomposition with the main objective of analyzing the factors which, in both short run and long run, influence its movements. The study is thought to be significant because the demand for real money balances serves as the core link between the monetary policy and the real sector of the economy. Based on the annual data under the period of study, cointegration results reveal that there is a long-run relationship between real money balances and the explanatory variables namely, real GDP, deposit interest rate, real exchange rate and inflation rate. Consistent with money demand theory, the VECM results show that the demand for real money balances is positively related with scale variable (real GDP) but it responds inversely to opportunity cost of holding money (deposit interest rate and inflation rate). Moreover, results provide evidence that the demand for real money balances and real exchange rate are positively associated. Furthermore, after incorporating the stability tests, the empirical results show that real money demand function is stable over the 1966-2015 period, suggesting that it is possible to use the narrow money aggregate as target of monetary policy in Tanzania.
Keywords. Money demand, VAR-VECM model, Stability.
JEL. C32, E41, E52.

1. Introduction

Studies on the demand for money and its stability remain in the domain of rigorous investigation because demand for money plays a major role in macroeconomic analysis, especially in selecting appropriate monetary policy actions. Markedly, the relationship 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). Thus, understanding the robust determinants of demand for money and its stability can inform the setting of monetary policy. Conventionally, a good understanding of the stability and robust determinants of the demand for real money balances forms the core in the conduct of monetary policy as it enables a policy-driven change in monetary aggregates to have predictable influences on output, interest rate, and ultimately price through transmission mechanism (see also Sriram, 1999; Nachega, 2011; Halicioglu & Ugur, 2005). The central argument here is that the relationship between real money balances and the scale variable (real GDP) that measures the level of economic activity and opportunity cost (of holding money) variables (deposit interest rate and inflation rate) plays an important role in macroeconomic analysis of a country.

[†] Department of Accounting and Finance, Institute of Accountancy Arusha, Tanzania.
☎. +255 754 399 775
✉. emanamba@iaa.ac.tz

The specification of an appropriate money demand function is vital in determining the optimal quantity of money to be supplied in the economy. Moreover, deducing from the estimations of money demand equations, the monetary authority can implement the best monetary policy under the current economic conditions (Dritsaki & Dritsaki, 2012). Chiefly, effective monetary policy implicitly assumes a stable money demand function. However, if the relationship is not stable, money supply targeting might not be an effective policy option for controlling factors such as inflation. Thus, examining the robust determinants and stability of money demand in the economy such as Tanzania which suffers a number of economic problems such as high and persistent inflation, wide use of foreign currency and shallow and volatile domestic financial market is crucial, mainly for understanding the transmission mechanism of monetary policy in the economy.

It is worth noting that determining the significant relationship between the demand for real money balances, scale variable and opportunity cost variables is not straight forward. Even the distinguishable works of Keynes (1936) and Friedman (1956) do not go unchallenged. Keynes (1936) develops the liquidity preference theory of money demand which explicitly shows that people demand money for transaction, precautionary and speculative motives. He argues that money demand depends on both income and interest rate. In particular, the Keynesian speculative theory suggests that relationship between money demand and the rate of interest is negative. By the same token, the fact that the stability or instability of money demand is a major determinant of liquidity preference, Poole (1970) argues that the rate of interest should be targeted if liquidity preference is unstable while the money supply should be targeted if the investment-savings relationship is unstable and the demand for money is stable. However, as Laidler (1977) points out, the most important innovation in the analysis of Keynes (1936) is on speculative demand for money but not on the demand for money arising from the transactions and precautionary motives as technically fixed in their relationships with the level of income. Significantly, Friedman (1956) opposes the Keynesian view that money does not matter and presents the quantity theory as a theory of money demand. Still, the quantity theory of money has been criticized on its assumptions of permanent and transitory incomes.

Undoubtedly, because the demand for money serves as the core link between the monetary policy and the real sector of an economy, the level and stability of the demand for money have received enormous attention by economists, researchers and policy makers in developed and developing countries. As a result, modeling, estimating and examining the stability of money demand function in the economy has become a fertile area for research (See for example Arango & Nadiri, 1981; McNown & Wallace, 1992; Hoffman *et al*., 1995; Teriba, 1974; Darrat, 1986; Arize *et al*., 1990; Adam, 1992; Kallon, 1992; Simmons, 1992; Kumar, *et al*., 2013; Fielding, 1994; Ghartey, 1998; Nachega, 2001; Anoruo, 2002; Nwaobi, 2002; Nell, 2003; Bohl, 2000; Gerlach & Svensson; 2004; Weliwita & Ekanayake, 1998; Arize *et al*., 1999; Bahmani-Oskooee & Tanku, 2006; Bahmani- Oskooee, & Gelan, 2009; Akinlo, 2006; Nwafor *et al*., 2007; Owoye & Onafowora, 2007 and Sterken, 2004). Nevertheless, controversies remain in the literature with the robust determinants and the stability of the demand for real money balances across the countries using both velocity and conventional approaches. Despite the fact that theoretical and empirical evidences suggest that variables such as real income, interest rate, exchange rate and inflation rate affect the demand for real Money balances, there are seem to be mixed conclusions about the direction of their relationships and the stability of the function of demand for money. The mixed conclusions on the determinants and stability of money demand in different economies might be attributed to the fact that the factors that affect money demand vary in accordance to the realities of different economies.

The lack of consensus regarding the stability of money demand function is evident. Central banks in many developing economies have switched towards monetary policies directed at the interest rate (Kumar, *et al.*, 2013). According to Kumar *et al.* (2013), this policy switching is mainly grounded on the view that financial market reforms and liberalization might have contributed to the instability in money demand functions. However, other studies raise concern about the validity and strength of central bank interest rate targeting in developing economies (see for example Bahmani-Oskooee & Rehman, 2005; Rao *et al.*, 2009; Rao & Kumar, 2009a and 2009b). Notable, Darrat (1986) and Adam (1992) show that monetary aggregates are stable in African countries and hence support the perspective favouring monetary targeting by central banks.

These important controversies in the findings call forth a further investigation with recent data and methods, to explore the stability of money demand function and the extent to which variables such as real GDP, inflation rate, deposit interest rate and real exchange rate as discussed in the theoretical and empirical literature determine the demand for real money balances. In this perspective, it is important to examine the robust determinants and stability of the real money demand in a low income country like Tanzania covering a large sample, spanning from 1966 to 2015. The empirical results of this paper are expected to contribute to the ongoing debate on the robust determinants and stability of money demand and optimal monetary policies.

2. Theoretical Framework

Money demand theories have evolved overtime. Fisher (1911) provides the earliest quantity theory of money demand through the equation of exchange. Fisher (1911) argues that the demand for money is solely a function of income. However, it is worth noting that the concept of money holdings started to take a formal shape in the quantity theory by Pigou (1917). In another development, Keynes (1936) develops the liquidity preference theory of money demand. The general argument under liquidity preference is that people demand money for transaction, precautionary and speculative motives and that, money demand depends on income and interest rate. Similarly, inventory theories of money demand hypothesize that transaction demand for money is positively associated with income but it has a negative relationship with nominal interest rate earned on alternative assets. The Baumol-Tobin model is a good example of the most well-known inventory theory of money demand. In other theories, for example portfolio theories of money demand, money is treated like any other asset and therefore assets' demand theory is used to derive the money demand theory. Because money offers different combination of risk and return than other assets, people hold money as part of their portfolio of assets. This section briefly discusses the theories and models of demand for money.

2.1. Classical Economics

The four major functions of money-medium of exchange, store of value, unit of account, and source of deferred payment provide the basis to formulate theories of money. In the classical theory, money is held for transaction purposes or as a medium of exchange. Here, money is a commodity whose unit is used to express the prices and values, but whose own value remains unaffected by its role. In this theory, the role of money as a store of value is limited of perfect information and negligible transaction costs. The quantity theory of money is based on the assumptions that money supply, M^S is exogenous and the income velocity of money, V^T is constant as a results, the demand for money is stable. According to this theory, the economy is always in full employement levels except for the transitory deviations as a result of real balances so that income, y in the equation of exchange could be treated as constant in the short run (Equation 1)

$$P^T = \frac{M^S \overline{V}^T}{\overline{y}} \quad (1)$$

This also suggests that changes in the quantity of money lead to proportional changes of the price level, P^T. The most important feature of this theory is that, it suggests that interest rates have no effect on the demand for money. In the long run, the price level depends upon the quantity of money in the economy. Notable, in this theory demand for money is not mentioned, instead what is stressed is transactions velocity of circulation of money, V^T.

2.2. Quantity Theory of Money Demand

As reported above, the quantity theory provides a direct and proportional relationship between the quantity of money and the price level. This relationship is developed in the classical equilibrium framework by two alternative but equivalent expressions: Fisher's equation of exchange (Fisher, 1911) and Cambridge approach (Pigou, 1917). Both versions yield models of the transaction demand for money because they are primarily concerned with money as a means of exchange and hence, they yield models of the transaction demand for money (Sriram, 1999).

The Fisher (1911) approach is based upon the exchange equation. In this theory, the demand for money is solely a function of the volume of transaction in the economy. The relationship between money in circulation, M^S and the volume of transactions, T is expressed as

$$M^S V^T = P^T T \quad (2)$$

Equation (2) is not an identity rather an equilibrium condition. Money is held simply to facilitate transactions and has no intrinsic utility. The velocity variable incorporates the technological factors and institutional arrangements of the monetary system governed by non-monetary factors and it is assumed to be stable in the short run (Sriram, 1999). The theory suggests that the demand for money is inelastic to interest rate changes because people demand money only for transaction purpose.

This equation is modified by the Cambridge School also known as neoclassical economists, Pigou (1917) in particular and Marshall (1923), among others. The modification is based on individual choice rather than on market, that is the focus changes from a model where V^T is determined by payments mechanism to one where people have a desired demand for money (Cuthbertson & Barlow, 1991). Also, in the cash balance approach, money is held not only as a medium of exchange, but also a store of value. Moreover, the cash balances postulate the role of wealth and the interest rate in determining the demand for money. With this modification, the equation of exchange becomes

$$M^S V^T = P^T y \quad (3)$$

Output, y is used as a proxy for transaction because the more an economy produces, the more goods and services are bought and sold. Equation (3) can be transformed into the quantity theory of money demand by solving for the real money balances, $(M/P)^S$. Thus, equation (3) becomes

$$m^s = \left(\frac{M}{P}\right)^S = \left(\frac{1}{V}\right) \bullet y \quad (4)$$

Equilibrium in the money market is achieved where the quantity of real money supplied $m^s = (M/P)^S$ is equal to the demand for real money balance, $m^d = (M/P)^d$. Since the income velocity of circulation, V is fixed or stable, it follows that $1/V = k$

reflecting institutional and technological features of the economy which are stable in the short run. Hence, the quantity theory of money demand can be expressed as

$$m^d = \left(\frac{M}{P}\right)^d = k \bullet y \tag{5}$$

Since k is fixed, the level of transactions generated by a fixed level of income determines the quantity of money that individuals demand. In this regard, equation (5) suggests that the demand for real money balances is solely determined by real income, with interest rates having no effect.

2.3. Liquidity Preference

As has been noted, Keynes (1936) theorizes that individuals hold money with three motives: transactions, precautionary, and speculative. According to Keynes (1936) transactions demand for money depends on the level of income. If the level of income increases, the demand for real money balances for transactions also increases. The precautionary demand depends on the level of income as well, because money serves as a medium of exchange in this motive. The precautionary motive provides a contingency plan for unforeseen expenditure. The speculative demand for money is what Keynes (1936) calls as liquidity preference. The store of value function of money is emphasized in the speculative demand for money (Sriram, 1999). Individuals can hold wealth into either money or bonds. It is expected that individuals will hold more assets into bonds and less into money if the interest rate or the rate of return on bonds, i increases. Contrary, a decrease in the interest rate should induce individuals to shift some assets out of bond and into money. In this case, money demand for speculative motives is interest rate elastic because interest rate is the opportunity cost of holding money. Thus, the Keynesian money demand function is expressed as

$$m^d = \left(\frac{M}{P}\right)^d = f(y, i) \tag{6}$$

where the demand for real money balances, m^d is a function of real income, y and nominal interest rate, i. As explained above, money demand is positively related with income and inversely related with interest rate. It is assumed in this model, that the income velocity of money is not stable. Further, implicitly, the liquidity preference function captures the effect of inflation on the demand for money. Fisher (1930), hypothesizes that the nominal interest rate, i in any period is equal to the sum of the real interest rate, r and the expected rate of inflation, π^e. This refers to the Fisher Effect. The Fisher effect is presented as

$$i = r + \pi^e \tag{7}$$

The Fisher equation (7) states that there is a one-to-one relationship between expected inflation and nominal interest rates, with real interest rates being unrelated to the expected rate of inflation and determined entirely by the real factors in the economy, such as the productivity of capital and investor time preference. Incorporating the Fisher effect (7) into the Keynesian money demand function (6), we obtain the Keynesian money demand function (8) that captures the effect of inflation on real money demand.

$$m^d = \left(\frac{M}{P}\right)^d = f\left(y, r + \pi^e\right) \tag{8}$$

Both inflation rate and interest rate are cost of holding money. In this case, the demand for real money balances also depends negatively on the expected rate of inflation. Henceforth, demand for real money balances is an increasing function of income and a decreasing function of both interest rate and expected rate of inflation. However, a problem arises due to lack of any direct measure of the expected rate of inflation. For this reason, a proxy variable for inflationary expectations is employed. Some studies use form of distributed lag on past inflation rates to proxy for inflationary expectations (see for example Cagan, 1956; Meiselman, 1962; Sargent, 1969 and Gibson, 1970).

2.4. Inventory Theoretic Approach

Inventory theories of money demand consider the money demand for transactions motive. Baumol (1952) and Tobin (1956) use inventory theoretic approach to develop a theory of money demand in which money is viewed as an inventory held for transactions purpose by analyzing the costs and benefits of money holding. To enumerate, the inventory models assume the presence of stores of value i.e. money and an interest bearing assets. The benefit of holding money is liquidity and the cost of holding money is the forgone interest, r. These models also assume that there is a fixed cost of making transfers between money and alternative assets. All the payments are made with money. One of the most appealing insights of these models is that the income and interest elasticity of money demand are constant and both equal to 0.5. This suggests that average money demand should increase by 0.5 percent if real income increases by 1 percent and that average money demand should decline by 0.5 percent if interest rate increases by 1 percent. Thus, income elasticity and interest elasticity are the key parameters for determining the demand for money. Because a brokerage fee or a fixed transaction cost, b is involved per money withdrawal, individuals hold inventories of cash and make currency conversion only infrequently (see also Li, 2007). This leads to the famous square-root formula with average cash holdings expressed as

$$m^{d*} = \left(\frac{M}{P}\right)^{d*} = \sqrt{\frac{by}{2r}} \tag{9}$$

where as defined above, b is the cost of converting interest-bearing assets into money, r is interest rate, P is the price level and y is real income. Model (9) is obtained by minimizing the sum of interest forgone on total money holdings and total transaction costs. The model postulates that optimal demand for real money balances, m^{d*} is directly proportional to transactions costs, b and real income, y and inversely proportional to the interest rate, r earned on alternative assets.

2.5. Portfolio Theories of Money Demand

Friedman (1956) and Tobin (1958) develop the portfolio theoretic approach models while treating money like any other asset yielding a flow of services and use the assets' demand theory to derive the money demand theory. According to Friedman (1956) velocity of money is highly predictable and that the demand for money function is highly stable and insensitive to interest rates. This implies that the quantity of money demanded can be predicted accurately by the money demand function (Kumar *et al.*, 2013). Portfolio theories of demand for money emphasize that individuals hold money as part of their portfolio of assets. At a lower rate of interest or rate of return on bonds individuals will hold more money and fewer bonds in their portfolio. On the other hand, the increase in the rate of interest or rate of return on bonds, wealth holders will be generally attracted to hold a greater fraction of their wealth in bonds and thus reduce their holding of money. That is to say, the demand for money is a function of the risk and return offered by money and by the alternative assets that individuals can hold instead of money. In addition, since the size of wealth determines the amount of the portfolio to be allotted between money and the alternative assets demand for money is also a function of wealth (see also Jammeh, 2012). Incorporating, wealth (permanent income), y_P, expected rate of inflation, π^e, expected return on bond r_b, expected returns on stock or equity, r_s and expected return on money r_m, This version of demand for real money balances can be presented as

$$m^{d*} = \left(\frac{M}{P}\right)^{d*} = f\left(y_p, \pi^e, r_b, r_s, r_m\right) \tag{10}$$

According to Friedman (1956), money demand function assumes that there is a stationary long-run equilibrium relationship between money balances, real income, and the opportunity cost of holding real money balances that formulate the demand for money function (10). The explanation of model (10) is that the demand for real money balances is positively related with permanent income. Higher wealth implies larger portfolio. Equally important, the incentive to hold money depends on the attractiveness of bonds, stocks and goods assets comparing to holding money. These assets measure the opportunity cost of holding money. Thus, expected returns on these assets are negatively related with demand for real money balances. Similarly, an increase in expected inflation tends to reduce demand for real money balances.

3. Methodology

3.1. Model Specification

As discussed above, there are various theories concerning the money demand function. By and large, there is a consensus among the money demand theories that the main determinants of the quantity of money demand are the scale variable, which can be real income, wealth, or permanent income and opportunity cost variables including inflation rate and interest rate. Keynes (1936) argues that both transactions motive and precautionary motive depends on the scale variable (i.e., output) and the speculative motive depends on the opportunity cost variable (i.e., interest rate). The money demand for real balances is summarized as

$$m_t^d = \left(\frac{M_t}{P_t}\right) = f\left(y_t, R\right) \quad f_y > 0,\ f_R < 0 \tag{11}$$

where

m_t^d	Demand for real money balances
P_t	The price level
y_t	Scale variable (income, wealth or expenditure, in real terms)
R	Vector of expected rate of return (within and outside money)

Model specification (11) represents the long run real money function and assumes a long run unitary elasticity of nominal cash balances with respect to the prices level. This assumption of price homogeneity can be tested empirically (see also Nachega, 2001). The function f is hypothesized to be increasing in y, decreasing in those elements of R representing rates of return on alternative assets, and increasing in rates of return associated with assets included in M. For the purpose of this paper, the definition of money which is considered for estimation of real money demand function is $M1$. $M1$ includes currency in circulation and demand deposits as defined by the Bank of Tanzania. The main argument here is that the analytical work on $M1$ is more amenable to control by the monetary authorities. Also, a number of studies on developing countries indicate that the models using narrow definition of money are better than those employing broad money reflecting the weak banking system and low level of financial sector development (see for example Moosa, 1992; Simmons, 1992; Kallon, 1992; Hossain, 1994; Metin, 1994; Pradhan & Subramanian, 1997; Suliman & Dafaalla, 2011; Maravić & Palić, 2005).

Either wealth or income or expenditure can be used as a scale variable which measures the level of economic activity. In this paper real GDP is used as a scale variable. It is worthy to note that the holding of money and thus the demand for money are related to the volume of the transactions. Also, the amount of the transactions is proportional to the level of income (see also Suliman & Dafaalla, 2011). Real GDP captures transactions and precautionary demand for money. *A prior,* it is expected that the sign of real income is positive. This is because as real income increases, people demand more money for transactions and precautionary motives. Opportunity cost of holding money in a demand for money function measures the yield on money against other assets that might be held. In this paper, the deposit interest rate and the rate of inflation are included to take account of the asset-substitution hypothesis. The relationship between the demand for real money balances, and interest rate and the rate of inflation has been empirically studied (see for example Khan & Sajjid, 2005; Maravić & Palić, 2005, Valadkhani, 2008 and Kjosevski, 2013). The demand for real money balances is expected to have an inverse relationship with deposit interest rate and the rate of inflation, since an increase in deposit rate and the rate of inflation increases the cost of holding money.

Moreover, taking the currency substitution hypothesis into account, many studies on the demand for money in developing countries often include exchange rate variable in money demand function. The inclusion of exchange rate variable in the standard function of money demand to take account of the currency substitution phenomenon is suggested by Mundell (1963). A similar approach is used by Sriram (2009) and Bahmani-Oskooee & Ng (2002). In addition, Bahmani-Oskooee & Malixi (1991), Simmons (1992), Akinlo (2006), Suliman & Dafaalla (2011) and Adam *et al.* (2012) include exchange rate in the model of demand for real money balances. Apparently, the relationship between real money demand and exchange rate is a matter of empirical investigation. According to Bahmani-Oskooee & Ng (2002), variation in the foreign exchange rate has wealth and the currency-substitution effects. Specifically, Bahmani-Oskooee & Ng (2002) argue that first, exchange rate depreciation may be perceived as an increase in wealth by wealth holders in foreign economies leading to an increase in the demand for money. Second, exchange rate depreciation may cause expectation of further depreciation leading to a reduction in domestic demand of money. Thus, the sign of the coefficient on exchange rate will eventually be determined by the predominant effect.

Accordingly, the specification of demand for real money balances takes the following semi-log linear functional form:

$$\ln\left(m_t^d\right)=\lambda_c+\lambda_y\ln\left(y_t\right)+\lambda_r r_t+\lambda_{ex}\ln\left(ex_t\right)+\lambda_\pi\pi_t+u_t \tag{12}$$

where m_t^d Real money demand

y_t Real GDP (scale variable)

r_t Deposit interest rate (opportunity cost variable)

ex_t Real exchange rate to capture currency substitute effect

π_t	Inflation rate (opportunity cost variable)
u_t	white noise error term, i.e. $u_t \sim N(0,\sigma^2)$

The vector autoregressive (VAR) model is expressed as

$$\Delta \ln(m_t^d) = \sum_{j=1}^{q}\lambda_{mj}\Delta\ln(m_{t-j}^d) + \sum_{j=1}^{q}\lambda_{yj}\Delta\ln(y_{t-j}) + \sum_{j=1}^{q}\lambda_{rj}\Delta r_{t-j} + \sum_{j=1}^{q}\lambda_{exj}\Delta\ln(ex_{t-j}) + \sum_{j=1}^{q}\lambda_{\pi j}\Delta\pi_{t-j} + u_t \quad (13)$$

and the vector error correction model (VECM)[1] for all the endogenous variables is specified as

$$\Delta \ln(m_t^d) = \sum_{j=1}^{q}\lambda_{mj}\Delta\ln(m_{t-j}^d) + \sum_{j=1}^{q}\lambda_{yj}\Delta\ln(y_{t-j}) + \sum_{j=1}^{q}\lambda_{rj}\Delta r_{t-j} + \sum_{j=1}^{q}\lambda_{exj}\Delta\ln(ex_{t-j}) + \sum_{j=1}^{q}\lambda_{\pi j}\Delta\pi_{t-j} + \lambda_c C_t + \lambda_m \ln(m_{t-j}^d) + \lambda_y \ln(y_{t-j}) + \lambda_r r_{t-j} + \lambda_{ex}\ln(ex_{t-j}) + \lambda_\pi \pi_{t-j} + u_t \quad (14)$$

where Δ is the difference operator and $\lambda_6 C_t$ is a vector of exogenous variable (intercept). The VECM is estimated for all the endogenous variables in the model. Also, the variance decomposition tests are carried out to further understand the interactions of the variables.

3.2. Unit Roots and Cointegration Tests

The unit root and cointegration tests are very important pre-estimation tests that are often used to examine the properties of the time series used in model in order to avoid spurious regression. The Augmented Dickey Fuller (ADF) (Dickey & Fuller, 1979; 1981) is used to determine the presence of unit roots in the data sets in this paper. Specifically, ADF test is employed to test whether the variables used in the estimation are stationarity or not. The test is estimated with the following regressions

$$\Delta z_t = \beta_1 + \beta_2 t + \delta z_{t-1} + \sum_{i=1}^{q}\alpha_i \Delta z_{t-i} + u_t \quad (15)$$

$$\Delta z_t = \beta_1 + \delta z_{t-1} + \sum_{i=1}^{q}\alpha_i \Delta z_{t-i} + u_t \quad (16)$$

where z_t is the individual variable at time t, $\Delta z_t = z_{t-1} - z_t$, u_t is a pure white noise error term, β_1 is the constant, q is the number of lags which should be large enough to ensure that the error terms are white noise and small enough to save degree of freedom, t is the trend variable in quarters and $\delta = \rho - 1$. The equations above are the ADF with a constant and time trend, and ADF with only a constant. In each case, the *null hypothesis* is that $\delta = 0$; which means that there is unit root or the time series is nonstationary. The *alternative hypothesis* is that $\delta < 0$; this means that the variable is stationary, using tau (τ) statistics. At 95 percent confidence level, if the p-value is less than or equals to 0.05, we reject the null hypothesis that the variable in equation is non stationary or it has a unit root.

The presence of long run equilibrium relationship between dependent and independent variables is referred to as cointegration. The two common tests for cointegration are the procedure of Engle & Granger (1987) and the procedure of Johansen and Juselius (Johansen & Juselius, 1990; Johansen, 1992). In this paper

[1] VECM allows causality to emerge even if the coefficients of the lagged differences of the explanatory variables are not jointly significant.

both Engle-Granger two step method and the Johansen cointegration technique are used to examine the existence of an equilibrium relationship between money demand and its determinants. The Johansen cointegration model is a VAR-based test and it is presented as

$$\Delta z_t = \Pi z_{t-1} \sum_{i=1}^{k-1} \Gamma_i \Delta z_{t-i} + \mu + \Phi t + u_t \tag{17}$$

Model (17) is an *(n x 1)* vector of endogenous variables and is also an *(n x 1)* vector of white noise error term, where *n* is the number of all the variables used in this paper. The rank of the matrix coefficient Π indicates the long run relationship among the variables. Full rank $r = n$ means that the variables are cointegrated. Rank $r = 0$ means that the variables are not cointegrated and reduced rank where *r* lies between zero and *n* means that there are *r* cointegrating vector among the variables.

3.3. Dataset and Sources of Data

Empirical analysis is based on annual time series data spanning from 1966 to 2015. As presented earlier, the basic estimation model has five main variables namely, real money demand $(M1/P)$, real GDP (y), deposit interest rate (r), real exchange rate (ex) and inflation rate (π). The data on $M1$, real GDP, deposit interest rate, and the rate inflation were obtained from publications of the Bank of Tanzania "Tanzania Mainland's 50 Years of Independence: A Review of the Role and Functions of the Bank of Tanzania (1961-2011) and Annual Report (*various issues*). $M1$ is considered in this paper as a proxy for the demand for money because the Central Bank is able to control this aggregate more accurately than broader aggregates such as M2 and M3. Real exchange rate data were obtained from the International Financial Statistics of the International Monetary Fund. Real exchange rates are derived by multiplying the nominal exchange rate by the ratio of the U.S. to local currency Consumer Price Index. Data on consumer price index (CPI) was obtained from the Federal Reserve Bank of St. Louis. Nominal $M1$ was deflated by a weighted average of prices of consumer goods and services (CPI) in order to compute its real value.

Figure 1 (1.1-1.5) and Figure 2 (2.1-2.5), respectively, give visual information about the data generating process in levels and in first difference. In Figure 1 it can be inferred that real money demand and real GDP have upward trends. Hence, they have no constant means and have a long memory in their increasing trend. Deposit interest rate and inflation rate are above their means for the 1980-2000 period. There is a very sharp increase in both deposit interest rate and inflation rate in the 1980s but during the second half of 1990s both variables declined drastically. In the last 15 years deposit interest rate, inflation rate, and real exchange rate seem to be stable. In general, however, all the variables seem to have unit root. The overall implication at this elementary stage is that all variables might be integrated of order one to make them stationary. Trends of variables may be affected by economic crisis of 1980s and financial liberalization of 1990s. Accordingly, it becomes inevitable to test the stability of the money demand equations in this analysis.

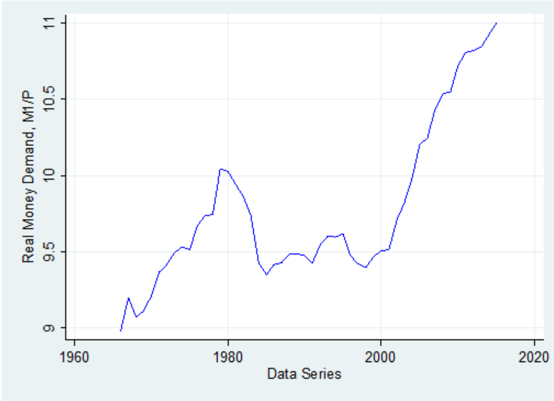


Figure 1.1. *Real Money Demand,* $\ln(M1/P)_t^d$

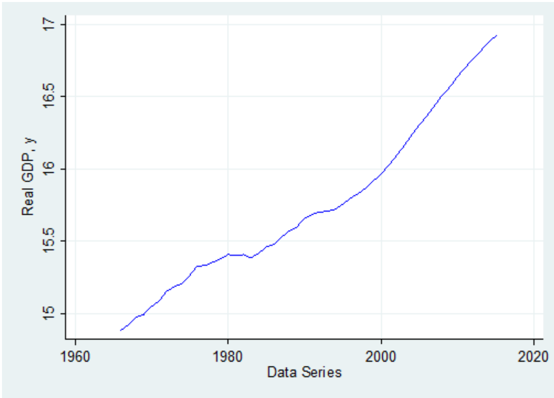


Figure 1.2. *Real GDP,* $\ln(y_t)$

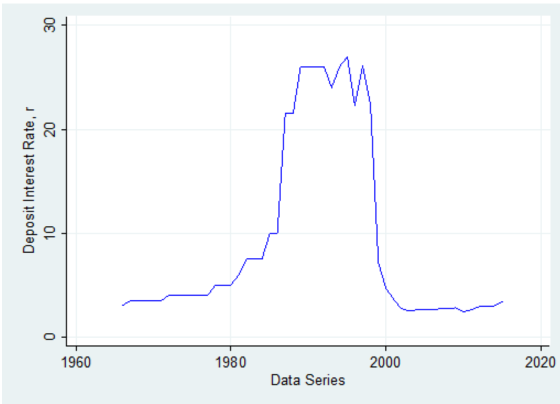


Figure 1.3. *Deposit Interest Rate,* r_t

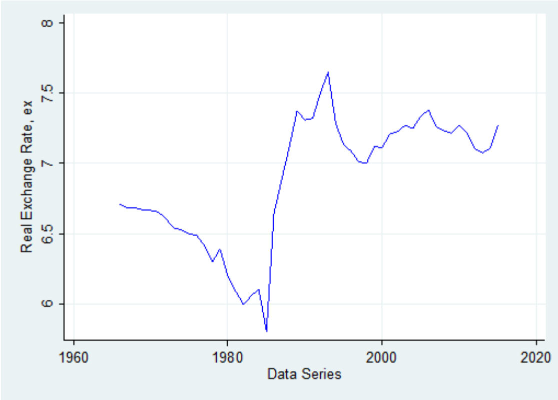


Figure 1.4. *Real Exchange Rate,* $\ln(ex_t)$

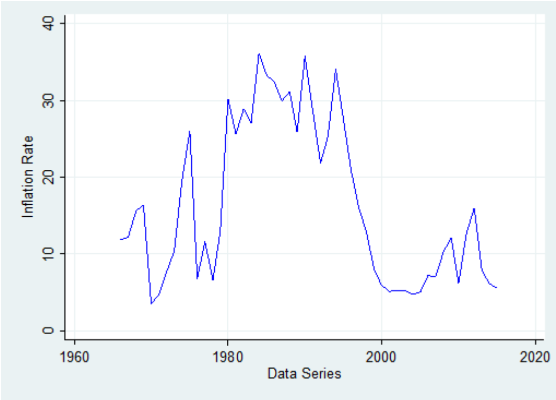


Figure 1.5. *Rate of Inflation,* π_t

As presented above, graphs of the levels of the real $M1$ variable, real GDP, deposit interest rate, real exchange rate and inflation rate appear to have non-constant mean, and give some information about the non-stationarity. Instead, the time series in first differences as displayed graphically in Figure 2 show no evidence of changing means.

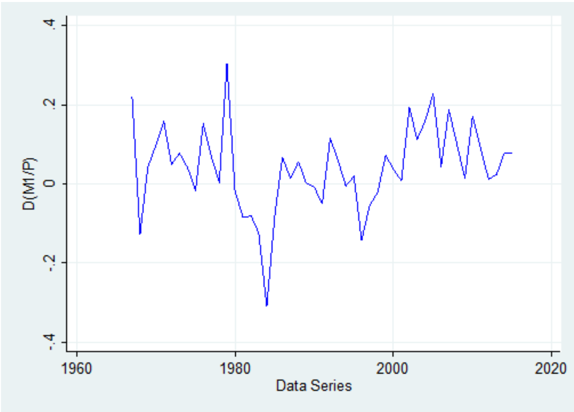


Figure 2.1. *Real Money Demand,* $D.\ln(M1/P)_t^d$

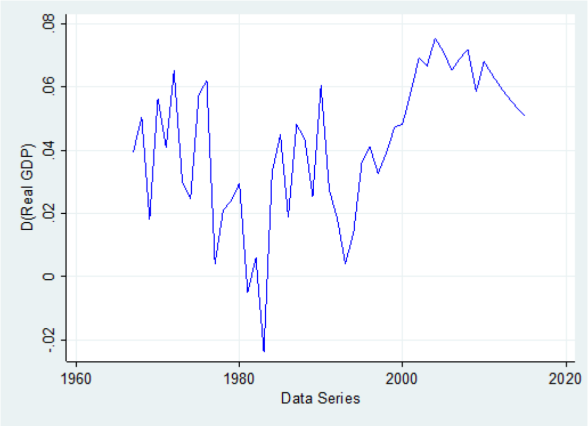


Figure 2.2. *Real GDP,* $D.\ln(y_t)$

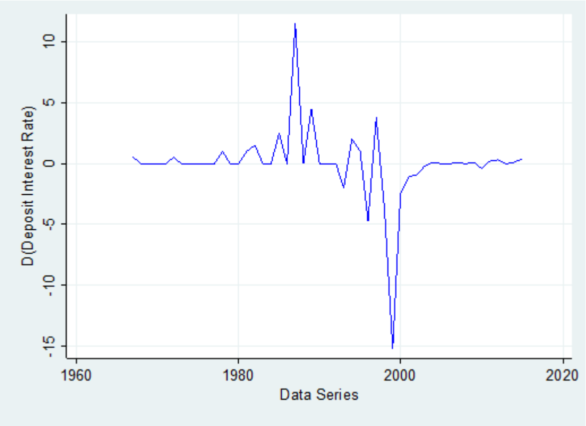


Figure 2.3. *Deposit Interest Rate,* $D.(r_t)$

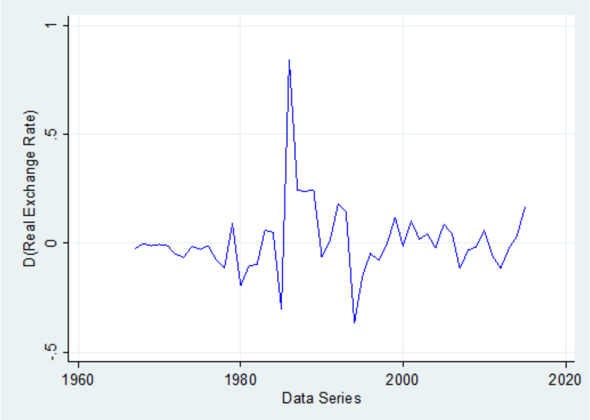


Figure 2.4. *Real Exchange Rate,* $D.\ln(ex_t)$

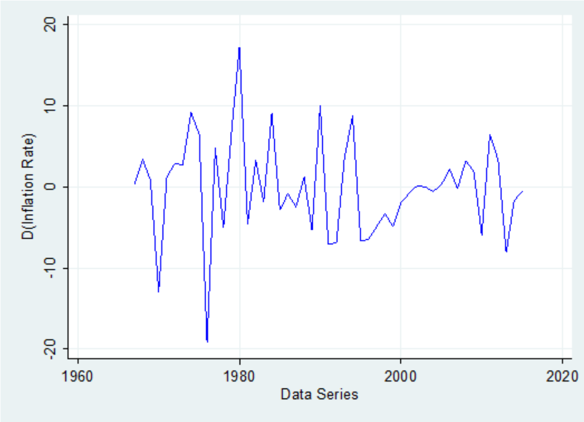


Figure 2.5. *Rate of Inflation,* $D.(\pi_t)$
Source: Author's Estimations

Furthermore, descriptive analysis is conducted to ascertain the statistical properties of the variables. Table 1 reports the descriptive statistics of the variables. Based on the skewness, the descriptive statistics suggest that real GDP, real exchange and rate of inflation are approximately normally distributed because their respective skewness is equal or less than 0.5 in absolute values. In addition, the probabilities of these variables fail to reject the null hypothesis of normal distribution at 5 percent level of significance. Also, based on kurtosis, real money demand and deposit interest rate tend to be mesokurtic because their values are approximately equal to 3. Overall, it can be concluded that there is evidence that there are no outliers in these respective time series causing the data sets to become relatively symmetrical.

Table 2 shows the correlation and covariance matrices for the system variables. The correlation matrix clarifies the direction and the degree of the relationships between variables in the system. Real $M1$ is highly and positively correlated with real GDP. Thus an increase in the rate of growth of real GDP is expected to increase the demand for real money balances. Real $M1$ seems to have a negative correlation with deposit interest rate and inflation rate. However, the degree of association seems to be low. In addition, money demand and real exchange seem to be positively associated.

Table 1. *Descriptive Statistics of the Variables*

	$\ln(m_t^d)$	$\ln(y_t)$	r_t	$\ln(ex_t)$	π_t
Mean	4.270	6.843	9.130	2.986	16.408
Median	4.173	6.806	4.000	3.073	12.745
Maximum	4.811	7.350	27.000	3.264	36.146
Minimum	3.977	6.464	2.400	2.521	3.493
Std. Dev.	0.230	0.247	8.984	0.201	10.414
Skewness	1.037	0.513	1.141	-0.536	0.473
Kurtosis	2.909	2.229	2.500	2.089	1.757
Jarque-Bera	8.978	3.429	11.365	4.301	5.082
Probability	0.011	0.180	0.003	0.116	0.079
Observations	50	50	50	50	50

Source: Author's computations

Table 2. *Correlation Matrix*

	$\ln(m_t^d)$	$\ln(y_t)$	r_t	$\ln(ex_t)$	π_t
$\ln(m_t^d)$	1				
$\ln(y_t)$	0.866	1			
r_t	-0.378	-0.126	1		
$\ln(ex_t)$	0.341	0.648	-0.327	1	
π_t	-0.352	-0.339	0.623	-0.246	1

Source: Author's computations

3.4. Testing Stability of the Demand for Money

Testing for stability of money demand is important as money supply is one of the key instruments of monetary policy. Money supply is the most suitable monetary policy instrument if money demand function in the economy is stable. If the money demand happens to be unstable over the medium to long term, then the Central Bank should shift its targeting into another workable framework such as interest rate targeting as the most appropriate instrument for the conduct of monetary policy. Hence, parameter constancy is a critical issue for money demand function. In particular, to be able to interpret the estimated money demand function, it is necessary to assure that the parameters are stable over the estimation period. To examine the structural stability real money demand function, this paper applies the cumulative sum (CUSUM) and cumulative sum of squares (CUSUMQ) of recursive residuals tests. These are conventional methods for the test of stability of the money demand function. They are proposed by Brown *et al.* (1975) and are commonly used by authors who examine the demand for money (see for example Payne, 2000; Bahmani-Oskooee & Shin, 2002; Owoye & Onafowora, 2007; Dritsaki & Dritsaki, 2012; Gaurisankar & Kwie-Jurgens, 2012 and Kjosevski, 2013). The CUSUM test which is based on the cumulative recursive sum of recursive residuals, is useful for detecting systematic changes in the regression coefficients whereas the cumulative sum of squares test that is based on the cumulative sum of squares of recursive residuals, is useful in a situation where the departure from the constancy of regression coefficients is abrupt and sudden. It should be noted that both the CUSUM and CUSUMSQ test statistics are updated recursively and plotted against break points in the data and for stable real money demand function's short-run dynamics and long-run parameters, the CUSUM and CUSUMSQ statistics stay within the 5 percent critical bound.

5. Empirical Results

5.1. Unit Root and Cointegration Tests

The ADF unit root test is applied to test for the stationarity of the variables. The test is applied to both the series in levels and in the first differences. The 5 percent critical value is used for making a decision on whether to reject the null hypothesis or not. Results of both tests which are reported in Table 3, indicate that all the series are non-stationary in their level, $I(0)$, when the model includes constant only and also when includes constant and trend. The variables become stationary in their first differences, $I(1)$. Thus, we conclude that all series are integrated of order one, $I(1)$ at the 5 percent level of significance. These results suggest that the model meets the requirement to proceed with the cointegration test. As it has been discussed in this paper, Johansen & Juselius's (1990) cointegration and Engle-Granger two step methods are used for the cointegration analysis. The order of lag-length is determined by Sequential modified LR test statistic (LR) and Final prediction error (FPE) (Table 4). Based on LR and FPE, the appropriate lag length is 2. The results of the Johansen cointegration analysis with 2 lags order are presented in Table 5. The test statistics reject the null hypothesis of no cointegrating relation at the 5 percent significance level. Both the trace test and the maximal-eigen value statistics for cointegration test indicate two cointegrating equations at the 5 percent significance level. In addition, cointegration test results based on Engle-Granger two step method suggests existence of equilibrium in the estimating model. The ADF test applied to the error term of the cointegrating equation is integrated of order zero $I(0)$ (see Table 6). Figure 3 also confirms the existence of cointegration between variables. According to Thomas (1993), if an equilibrium relationship exists, then the disequilibrium error should fluctuate about zero (Figure 3). This implies that there is a long run relationship between real money demand, real GDP, deposit interest rate, real exchange rate and inflation rate over the sample period under investigation.

Table 3. *ADF Unit Root Test*

	Levels		First Difference, Δ	
Optimal Lag = 1	Constant $\beta_1 = 0$	Constant and Trend $\beta_1 = \beta_2 = 0$	Constant $\beta_1 = 0$	Constant & Trend $\beta_1 = \beta_2 = 0$
Ln(M1)	-0.198	-0.882	-4.656	-4.798
Ln(Y)	-1.937	-0.116	-3.574	-4.135
R	-1.208	-1.167	-5.947	-5.981
Ln(RER)	-1.187	-1.789	-6.200	-6.134
π	-2.019	-2.225	-7.904	-7.894
5% Critical Value	-2.924	-3.506	-2.924	-3.506

Note: Null Hypothesis: *there is a unit root*
Source*: Authors computations*

Table 4. *VAR Lag Order Selection Criteria*

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-239.01	NA	0.03	10.61	10.81	10.68
1	81.16	556.82	7.50e-08	-2.22	-1.03*	-1.78*
2	108.03	40.88*	7.19e-08*	-2.31	-0.12	-1.48
3	131.64	30.79	8.48e-08	-2.25	0.94	-1.05
4	161.64	32.62	8.44e-08	-2.46*	1.71	-0.89

Notes: *indicates lag order selected by the criterion
LR: Sequential modified LR test statistic (each test at 5% level)
FPE: Final prediction error
AIC: Akaike information criterion
SC: Schwarz information criterion
HQ: Hannan-Quinn information criterion

Table 5. *Johansen Tests for Cointegration*

Trend: Constant — Number of obs = 48
Sample: 1968-2015 — Lags = 2

Maximum rank	eigenvalue	trace statistics	5 percent critical value
0		99.0023	68.52
1	0.56218	59.3563	47.21
2	0.46617	29.2281*	29.68
3	0.35687	8.0403	15.41
4	0.12555	1.6007	3.76
5	0.03280		

Maximum rank	eigenvalue	max statistics	5 percent critical value
0		39.6460	33.46
1	0.56218	30.1282	27.07
2	0.46617	21.1879	20.97
3	0.35687	6.4396	14.07
4	0.12555	1.6007	3.76
5	0.03280		

Source: Author's Estimations

Table 6. *Table Static model: Tests for Cointegration between M1/P and Explanatory Variables*

	Levels		Levels	
Optimal Lag = 1	Constant $\alpha_1 = 0$	Probability 0.000	Constant & Trend $\alpha_1 = \alpha_2 = 0$	Probability 0.000
M1/P Residual*s*	-7.810***		-7.818***	
1% Critical value	-3.588		-4.181	
5% Critical value	-2.930		-3.516	

Notes: Null Hypothesis: *Residuals are non-stationary*
****denote rejection of the null hypothesis at 1% critical value*

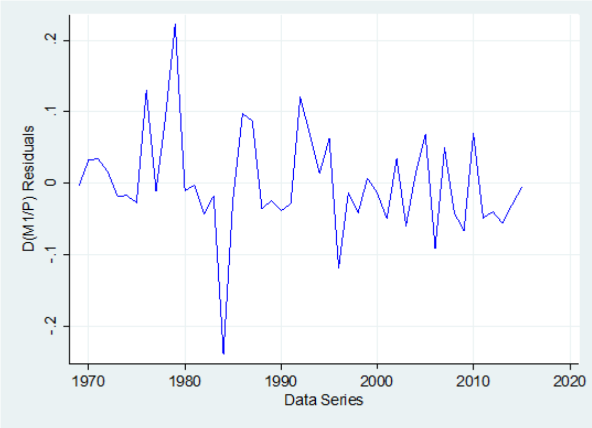


Figure 3. *Long Run Cointegrating Vector*
Source: Author's Estimation

5.2. Regression Results

Table 7 reports the results of the vector error correction model for real money demand. The t-statistics are in brackets. Overall, the coefficients of the estimated money demand model are consistent with a prior expectation and theoretical postulations regarding signs, and they are statistically significant. Real GDP has a positive sign. This suggests that the transaction and precautionary motives of money demand hold in Tanzania. Empirical results show that a percentage increase in real income may increase real money demand by more than two percent. Interestingly, income elasticity of money demand for real balances implies that money can be considered as a luxury good in the Tanzania consistent with Valadkhani (2008) for Asian-Pacific countries and Jammeh (2012) for Gambia. Interest rate has a negative sign implying that an increase in the deposit rate may lead to a decline in money demand for real balances. This also suggests that individuals hold money for speculative purposes. Similarly, the coefficient of inflation rate is negative, which suggests that a percentage increase in inflation rate may lead to a decline in money demand in Tanzania. These results also suggest that assets substitution is likely to be between money and physical assets rather than between money and financial assets (see also Nachega, 2001). As inflation rate increases, individuals tend to shift from money holding to asset holding. In fact, demand for money seems to have implications for portfolio decisions in Tanzania.

Table 7. *Vector Error Correction Estimates*

Error Correction:	$\Delta\ln(m_t^d)$	$\Delta\ln(y_t)$	Δr_t	$\Delta\ln(ex_t)$	$\Delta\pi_t$
CointEq1	-4.065589	0.292121	-0.755967	3.889257	-2.0631
	[- 4.01364]	[1.23706]	[-3.96622]	[-2.44058]	[-2.31098]
CointEq2	-1.054775	1.966879	-0.769256	1.966879	7.9431
	(-4.38433)	[5.19677]	[-3.09673]	[5.19677]	[2.47679]
$\Delta\ln(m^d)_{t-1}$	0.071587	-0.033801	-1.38812	2.123569	-6.99187
	[0.29271]	[-0.59286]	[-1.03161]	[5.51932]	[-0.60924]
$\Delta\ln(m^d)_{t-2}$	-0.060055	-0.042894	-8.028154	1.134494	-2.69004
	[-0.32205]	[-0.98669]	[-0.50784]	[3.86712]	[-0.61247]
$\Delta\ln(y)_{t-1}$	2.482864	-0.182754	7.12152	5.072869	2.7858
	[2.24933]	[-0.71020]	[0.83484]	[2.92123]	[1.13914]
$\Delta\ln(y)_{t-2}$	2.080551	0.007919	7.55123	-1.360844	8.47624
	[2.35662]	[0.03848]	[0.94265]	[-0.97979]	[0.50319]
Δr_{t-1}	-0.004876	0.001128	0.231649	0.001105	0.224314
	[-1.97813]	[2.12955]	[1.41743]	[0.28047]	[0.57850]
Δr_{t-2}	-0.002273	0.000118	-0.204684	0.002391	-0.315699
	[-1.34993]	[0.30171]	[-1.43390]	[0.90274]	[-1.03497]
$\Delta\ln(ex)_{t-1}$	0.009854	0.035136	-8.260228	-0.499780	9.160893
	[0.08283]	[1.26690]	[-0.81903]	[-2.67033]	[0.42507]
$\Delta\ln(ex)_{t-2}$	0.326690	0.018800	-12.93115	-0.236707	5.685530
	[2.71484]	[0.90340]	[-1.70874]	[-1.68550]	[0.35158]
$\Delta\pi_{t-1}$	-0.001805	0.000455	-0.172384	-0.002391	0.278676
	[-1.14746]	[1.23957]	[-1.29231]	[-0.96601]	[0.97766]
$\Delta\pi_{t-2}$	-0.002065	0.000344	-0.145830	0.001601	0.136143
	[-2.21448]	[1.58191]	[-1.84446]	[1.09115]	[0.80582]
C	0.001740	0.000447	-0.019248	-0.002428	0.027559
	[0.34444]	[0.37919]	[-0.04495]	[-0.30548]	[0.03012]
R-sq.	0.690261	0.475727	0.676416	0.787807	0.720518
Adj. R-sq.	0.550378	0.238958	0.530281	0.691978	0.594300
S.E. eq.	0.034171	0.007966	2.896871	0.053759	6.190309
F-statistic	4.934580	2.009250	4.628709	8.220950	5.708526

Source: Author's estimations

Moreover, empirical results show that real exchange rate have a positive impact on demand for real money balances in Tanzania. The positive estimated coefficient on exchange rate is consistent with the fact that depreciation of domestic currency raises the domestic currency value of an individual's foreign assets, and if this is perceived as an increase in wealth, then money demand would increase (see also Arango & Nadiri, 1981). The implication here is that the wealth-effect of currency depreciation dominates the currency substitution-effect of currency depreciation in Tanzania postulating that money demand increases as domestic currency depreciates. A depreciation of the domestic currency may be perceived as an increase in wealth because it raises the domestic value of dollar inflows which would increase money demand in Tanzania (see also Jammeh, 2012). An adjusted R-squared of 0.55, used to measure the goodness-of-fit of the estimated model, indicates that the model explains about 55 per cent of the behavior of money demand.

In addition, the variance decomposition results are reported in Tables 8-12. The variance decomposition determines the amount that the forecast error variance of each of the variables can be explained by exogenous shocks to the other variables. Empirical results of variance decomposition of demand for real money balances are reported in Table 8. The results reveal that 100 percent of the forecast error variance of real money demand is explained by its own shock in the first year. In the subsequent years however, it declines significantly reaching 28.9 percent after a 10 year period. Real money demand apart, a significant proportion of the real money demand variance is caused by real GDP, which increases from 0.00 percent in the first period to 23.5 percent in the tenth year. Similarly, both the rate of inflation and real exchange rate seem to have a significant influence on the real money demand. In period 10, the inflation rate and real exchange rate, respectively, account for 21.9 percent and 19.8 percent of the real money demand forecast error variance. In the last three periods, deposit interest rate seems to contribute very little to real money demand forecast error. The variance decompositions of real GDP, deposit interest rate, real exchange rate and inflation rate are reported in Tables 9-12 respectively.

Table 8. *Variance Decomposition of Money Demand,* $\ln(m_t^d)$

Period	S.E.	$\ln(m_t^d)$	$\ln(y_t)$	r_t	$\ln(ex_t)$	π_t
1	0.030	100.000	0.000	0.000	0.000	0.000
2	0.041	78.009	3.972	3.950	13.423	0.646
3	0.050	57.540	2.902	5.960	26.602	6.997
4	0.056	47.827	3.958	13.165	27.383	7.667
5	0.061	42.444	11.851	15.366	23.807	6.532
6	0.065	44.148	14.287	14.068	21.332	6.165
7	0.075	41.553	15.441	10.589	22.383	10.033
8	0.095	36.420	18.975	6.961	21.817	15.827
9	0.116	32.137	21.859	6.214	20.723	19.066
10	0.138	28.907	23.532	6.087	19.799	21.675

Table 9. *Variance Decomposition of Real Per capita GDP,* $\ln(y_t)$

Period	S.E.	$\ln(m_t^d)$	$\ln(y_t)$	r_t	$\ln(ex_t)$	π_t
1	0.007	5.684	94.316	0.000	0.000	0.000
2	0.011	11.565	70.867	8.793	8.144	0.631
3	0.014	18.242	55.908	9.716	13.645	2.489
4	0.019	25.445	41.806	8.410	17.959	6.381
5	0.026	29.471	33.388	6.692	20.422	10.027
6	0.033	28.989	30.712	6.809	21.406	12.084
7	0.041	28.532	28.223	7.117	21.645	14.483
8	0.049	28.815	25.995	7.578	21.067	16.545
9	0.057	28.858	25.029	7.639	19.836	18.639
10	0.065	28.729	24.763	7.612	18.619	20.278

Table 10. *Variance Decomposition of Deposit Interest Rate,* r_t

Period	S.E.	$\ln(m_t^d)$	$\ln(y_t)$	r_t	$\ln(ex_t)$	π_t
1	2.012	0.994	2.563	96.443	0.000	0.000
2	3.323	0.447	3.562	69.202	11.270	15.519
3	3.943	4.680	8.845	52.448	8.190	25.837
4	5.045	7.126	14.230	38.100	5.257	35.290
5	6.448	7.402	27.424	24.016	3.606	37.553
6	7.137	8.181	29.511	19.602	3.008	39.698
7	7.545	10.898	30.153	17.545	2.884	38.519
8	7.885	12.755	29.215	16.365	2.992	38.672
9	8.341	15.759	28.763	14.801	3.459	37.218
10	8.814	18.404	27.824	13.896	4.167	35.709

Table 11. *Variance Decomposition of Real Exchange Rate,* $\ln(ex_t)$

Period	S.E.	$\ln(m_t^d)$	$\ln(y_t)$	r_t	$\ln(ex_t)$	π_t
1	0.049	6.590	1.410	20.778	71.222	0.000
2	0.054	13.720	1.561	22.664	59.297	2.758
3	0.067	15.800	2.270	22.657	42.249	17.023
4	0.084	18.418	1.578	20.952	47.382	11.670
5	0.101	19.236	1.951	23.756	46.836	8.221
6	0.121	19.355	1.464	23.702	48.564	6.914
7	0.135	20.101	1.189	22.684	48.999	7.028
8	0.142	18.572	1.089	24.171	48.435	7.733
9	0.145	17.877	1.131	25.001	47.884	8.107
10	0.146	17.997	1.406	25.050	47.531	8.016

Table 12. *Variance Decomposition of Inflation Rate, π_t*

Period	S.E.	$\ln(m_t^d)$	$\ln(y_t)$	r_t	$\ln(ex_t)$	π_t
1	4.774	0.150	7.115	19.320	0.066	73.350
2	7.335	15.044	29.241	11.718	7.205	36.793
3	7.950	20.520	29.314	10.063	6.132	33.971
4	9.005	23.439	27.466	9.578	11.098	28.420
5	9.946	28.135	23.320	10.041	11.933	26.572
6	11.328	29.340	19.134	9.050	15.008	27.467
7	12.644	27.407	18.399	8.707	16.414	29.073
8	13.749	26.421	19.878	11.216	15.867	26.618
9	14.552	25.666	18.606	14.325	16.968	24.435
10	15.249	26.610	17.659	15.637	17.375	22.719

Source: Author's estimations

5.2 Structural and Parameter Stability Tests

Structural and parameter stability tests are used to find out if demand for money is stable in Tanzania during the period under study. Figure 4 and Figure 5, respectively, report the results of the sum of recursive residuals (CUSUM) and cumulative sum of squares of recursive residuals (CUSUM-SQ) tests. The straight lines represent critical bounds at 5 percent significance level. In Figure 4, the plot of the CUSUM is within the critical bounds at 5 percent significance level. The plot deviates with reversion to the zero line, hence confirming structural stability. Similarly, the plot of the CUSUM-SQ is within the critical bounds confirming both structural stability and parameter stability. Thus, real money demand is structurally stable and parameters are also stable over the period under study.

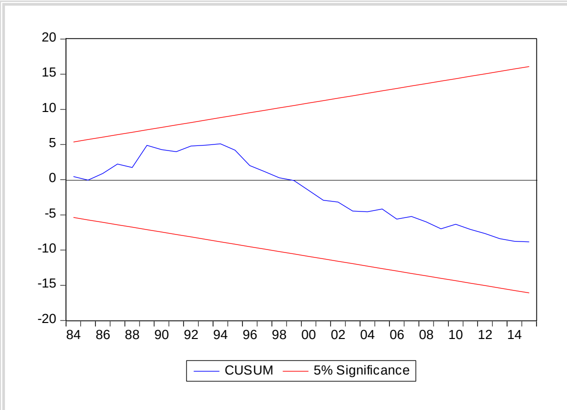


Figure 4. *Plot of Cumulative Sum of Recursive Residuals (CUSUM)*

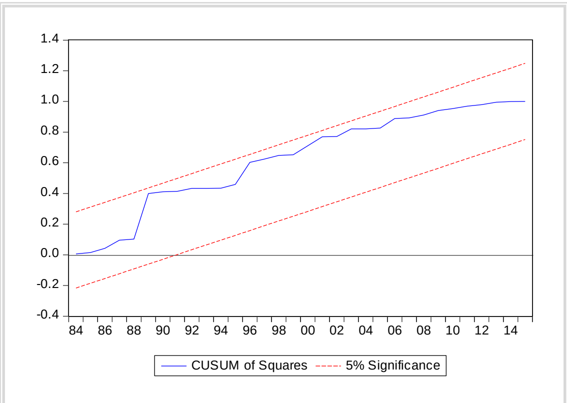


Figure 5. *Plot of Cumulative Sum of Squares of Recursive Residuals (CUSUM-SQ)*

Source: Author's estimations

5.3. Diagnostic Tests

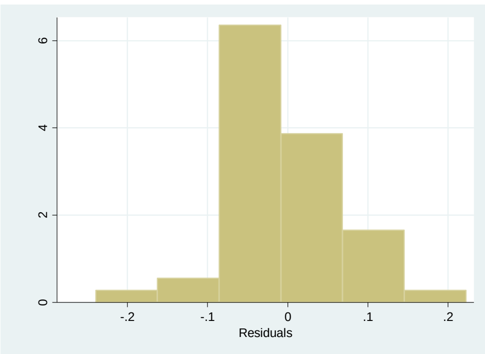
Presence of autocorrelation and heteroscedasticity violates the classical assumptions of the OLS and hence invalidate statistical validity of parameter estimates. Thus, diagnostic analysis is crucial to ascertain if the model is statistically adequate. These tests are focused on the properties of residuals. The results of the diagnostic tests are reported in Table 13 and Figures 6-9. Generally, results show that the model is good because we fail to reject the null hypotheses of no serial correlation and no heteroscedasticity. The Breusch-Godfrey serial correlation Lagrange Multiplier (LM) test confirms that the residual terms in the model are not serially correlated (Table 13). Also, the ARCH LM test strongly suggests that there exists no heteroscedasticity in the residuals of the model. Moreover, the estimated *p*-value for RESET regression errors specification test fails to reject the null hypothesis of no model misspecification error, suggesting that the model is not misspecified (Table 13). Equally important, the diagnostic tests show that the error correction model does not suffer from non-normality. The histogram and Jarque-Bera normality test as reported in Figure 6 suggest that the residuals of the model are normally distributed as we fail to reject the null hypothesis of normality using Jacque-Bera at 5 percent.

In addition, Figure 7 suggests that residuals are normally distributed, they are not correlated and that their mean is zero. Specifically, probability values of Portmanteau test for white noise and Barlett's periodogram-based white noise test fail to reject the hypotheses that residuals are random or independent, there is no serial correlation among residuals and that residuals are stationary. One simple diagnostic test that is applied to know whether the model is a reasonable fit to the data is to obtain residuals and the autocorrelation (AC) and partial autocorrelation (PAC) of these residuals at any different lags. The estimated AC and PAC are shown in Figure 8 and Figure 9. The Figures show that none of the autocorrelations and partial correlations is individually statistically significant at 5 percent level.

Table 13. *Serial Correlation, Heteroskedasticity and Ramsey RESET Tests*

Breusch-Godfrey Serial Correlation LM Test:			
F-statistic	1.150469	Prob.	0.3387
Obs*R-squared	5.100367	Prob. Chi-Square	0.0781
Heteroskedasticity Test: ARCH			
F-statistic	0.529096	Prob.	0.4710
Obs*R-squared	0.547396	Prob. Chi-Square	0.4594
Ramsey RESET Test			
	Value	Probability	
t-statistic	0.437279	0.6641	
F-statistic	0.191213	0.6641	
Likelihood ratio	0.222576	0.6371	

Source: Author's Computations



Skewness	=	-0.507	Jarque-Bera	=	1.935
Kurtosis	=	2.950	Probability	=	0.380

Figure 6. Normality Test of the Residuals

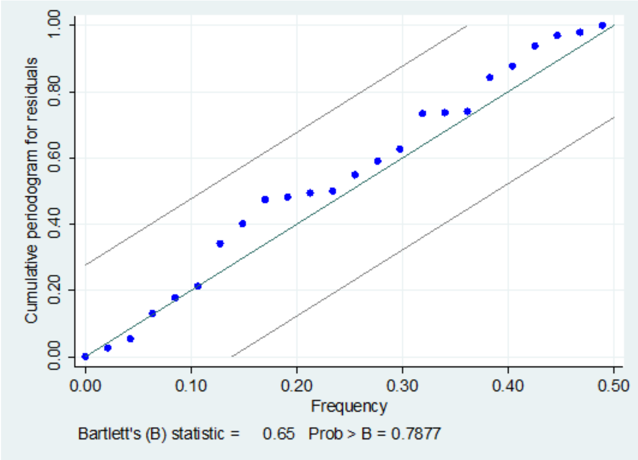
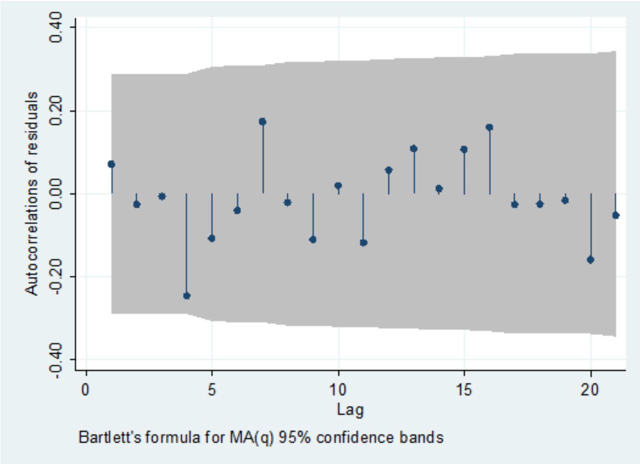
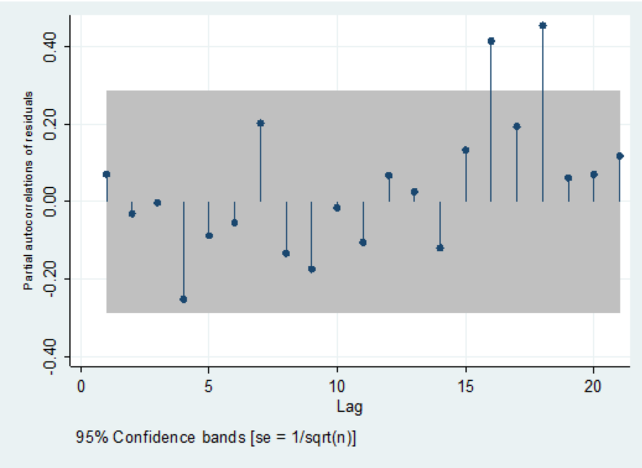


Figure 7. *White noise Test of the Residuals*



H0: There is no serial correlation in the residuals
H1: There is serial correlation in the residuals
Figure 8. *Autocorrelation of residuals*



H0: There is no serial correlation in the residuals;
H1: There is serial correlation in the residuals.
Figure 9. *Partial autocorrelation of residuals*
Source: Author's computations

6. Conclusions

Investigation of the factors and stability of real money demand is very important because a good understanding of the stability and robust determinants of the demand for real money balances forms the core in the conduct of monetary policy as it enables a policy-driven change in monetary aggregates to have predictable influences on output, interest rate, and ultimately price. This paper investigates the main factors that determine demand for real money balances in Tanzania. The paper also examines the stability of the real money demand function over the 1966-2015 period. Both the Johansen Maximum Likelihood procedure and the Engle-Granger two step method show that there is a long-run relationship for real money. The VECM results show that scale variable (real GDP) and the currency substitution variable (real exchange rate) have a positive relationship with demand for real money balances. Moreover, consistent with the economic theory, empirical results suggest that opportunity cost (of holding money) variables (deposit interest rate and inflation rate) have a negative effect on the demand for real money balances. The results of stability tests reveal that demand for real money balances, $M1/P$, in Tanzania is stable over the period of the study. These results suggest that it is possible to use the narrow money aggregate as target of monetary policy in Tanzania. Equally important, monetary policy makers in the Bank of the Tanzania should consider real income, interest rate, inflation rates and real exchange rates as key policy factors.

References

Adam, C. (1992). On the dynamic specification of money demand in Kenya. *Journal of African Economies,* 1(2), 233-270. doi. 10.1093/oxfordjournals.jae.a036750

Adam, C., Kessy, P., Nyella, J.J., & O'Connell, S. A. (2012). The demand for money in Tanzania. *Tanzanian Economic Review*, 2(1), 1-34.

Akinlo, A.E. (2006). The stability of money demand in Nigeria: an autoregressive distributed lag approach. *Journal of Policy Modeling*. 28(4), 445-452. doi. 10.1016/j.jpolmod.2005.09.001

Anoruo, E. (2002). Stability of the Nigerian M2 money demand function in the SAP period. *Economics Bulletin*, 14(3), 1-9.

Arango, S., & Nadiri, M.I. (1981). The demand for money in open economy. *Journal of Monetary Economics,* 7(1),69-83. doi. 10.1016/0304-3932(81)90052-0

Arize, A.C., Malindretos, J., & Shwiff, S.S. (1999). Structural breaks, cointegration, and speed of adjustment evidence from 12 LDCs money demand. *International Review of Economics & Finance,* 8(4), 399-420. doi. 10.1016/S1059-0560(99)00025-8

Arize, A.C., Darrat, A.F., & Meyer, D.J. (1990). Capital mobility, monetization and money demand: evidence from Africa. *The American Economist,* 34(1), 69-75. doi. 10.1177/056943459003400108

Bahmani-Oskooee, M., & Rehman, H. (2005). Stability of the money demand function in Asian developing countries. *Applied Economics*, 37(7), 773-792. doi. 10.1080/0003684042000337424

Bahmani-Oskooee, M., & Gelan, A. (2009). How stable is the demand for money in African countries? *Journal of Economic Studies,* 36(3), 216-235. doi. 10.1108/01443580910983825.

Bahmani-Oskooee, M., & Malixi, M. (1991). Exchange rate sensitivity of the demand for money in developing countries. *Applied Economics*, 23(8), 1377-1384. doi. 10.1080/00036849100000060

Bahmani-Oskooee, M., & Shin, S. (2002). Stability of the demand for money in Korea. *International Economic Journal,* 16(2), 85-95. doi. 10.1080/10168730200000015

Bahmani-Oskooee, M., & Tanku, A. (2006). Black market exchange rate, currency substitution and the demand for money in LDCs. *Economic Systems*, 30(3), 249-263. doi. 10.1016/j.ecosys.2006.04.001

Bahmani-Oskooee, M., & Ng, R.C.W. (2002). Long-run demand for money in Hong Kong: an application of the ARDL model. *International Journal of Business and Economics*, 1(2), 147-155.

Baumol, W.J. (1952). The transactions demand for cash: an inventory theoretic approach. *Quarterly Journal of Economics*, 66(4), 545-556. doi. 10.2307/1882104

Bohl, M.T. (2000). Nonstationary stochastic seasonality and the German M2 money demand function. *European Economic Review*, 44(1), 61-70. doi. 10.1016/S0014-2921(98)00068-3

Brown, R.L., Durbin, J., & Evans, J.M. (1975). Techniques for testing the constancy of regression relations over time. *Journal of the Royal Statistical Society*, *Series B*, 37(2), 149-163.

Cagan, P. (1956). The monetary dynamics of hyper-inflation, in M. Friedman (ed.), *Studies in the Quantity Theory of Money*, University of Chicago Press, Chicago.

Cuthbertson, K., & Barlow, D. (1991). Money Demand Analysis: An Outline, in Taylor, M.P. (ed.) *Money and financial markets*, Cambridge MA: Basil Blackwell Inc.

Darrat, A. (1986). The demand for money in some major OPEC members: regression estimates and stability results. *Applied Economics*, 18(2), 127-142. doi. 10.1080/00036848600000019

Dickey, D.A., & Fuller, W.A. (1981). Likelihood ratio statistics for auto-regressive time series with a unit root. *Econometrica*, 49(4), 1057-1072. doi. 10.2307/1912517

Dickey, D.A., & Fuller, W.A. (1979). Distribution of the estimators for autoregressive time series with unit root. *Journal of the American Statistical Association,* 74(366a), 427-431. doi. 10.1080/01621459.1979.10482531

Dritsaki, C., & Dritsaki, M. (2012). The stability of money demand: some evidence from Turkey. *The IUP Journal of Bank Management,* 10(4), 7-28.

Engle, R.F., & Granger, C.W.J. (1987). Cointegration and error correction: representation, estimation, and testing. *Econometrica*, 55(2), 251-276. doi. 10.2307/1913236

Fielding, D. (1994). Money demand in four African countries. *Journal of Economic Studies*, 21(2), 3-37. doi. 10.1108/01443589410062968

Fisher, I. (1911). *The Purchasing Power of Money: Its Determination and Relation to Credit, Interest and Crisis*. New York: Macmillan.

Fisher, I. (1930). *The theory of interest*. New York: Macmillan

Friedman, M. (1956). The quantity theory of money-a restatement. (pp.3-21), In: M. Friedman, (Ed.), *Studies in the Quantity Theory of Money*. University of Chicago Press, Chicago.

Gaurisankar, S., & Kwie-Jurgens, N.O. (2012). The money demand function in Suriname. Presented at the 44th Annual Monetary Studies Conference, November 7-9.

Gerlach, S., & Svensson, L. (2004). Money and inflation in the Euro area: a case for monetary indicators. *Journal of Monetary Economics,* 50(8), 1649-1672. doi. 10.1016/j.jmoneco.2003.02.002

Ghartey, E.E. (1998). Monetary dynamics in Ghana: evidence from cointegration, error correction modelling, and exogeneity. *Journal of Development Economics,* 57(2), 473-486. doi. 10.1016/S0304-3878(98)00096-0

Gibson, W.E. (1970). Price-expectations effects on interest rates. *Journal of Finance* 25(1), 19-34. doi. 10.1111/j.1540-6261.1970.tb00410

Goldfeld, S.M. (1994). Demand for money: empirical studies, in P. Newman, M. Milgrate & J. Eatwell (Eds) *The New Palgrave Dictionary of Money & Finance*, Macmillan Press: London.

Halicioglu, F., & Ugur, M. (2005). On stability of the demand for money in a developing OECD country: the case of Turkey, *Global Business and Economics Review,* 7(2/3), 203-213. doi. 10.1504/GBER.2005.007616

Hoffman, D., Rasche, R.H., & Tieslau, M.A. (1995). The stability of long-run money demand in five industrial countries. *Journal of Monetary Economics*, 35(2), 317–339. doi. 10.1016/0304-3932(95)01189-U

Hossain, A. (1994). The search for a stable money demand function for Pakistan: an application of the method of co-integration. *The Pakistan Development Review*, 33(4), 969-983.

Jammeh, K. (2012). Long-run and short-run determinants of demand for money and its stability in the Gambia: an empirical investigation. B.Sc. Research Project, Department of Economics and Management Science, University of the Gambia.

Johansen, S. (1992). Determination of cointegration rank in the presence of a linear trend. *Oxford Bulletin of Economics and Statistics*, 54(3), 383-397. doi. 10.1111/j.1468-0084.1992.tb00008.x

Johansen, S., & Juselies, K. (1990). Maximum likelihood estimation and inferences on co-integration. *Oxford Bulletin of Economics and Statistics*, 52(2), 169-210. doi. 10.1111/j.1468-0084.1990.mp52002003.x

Kallon, K. (1992). An econometric analysis of money demand in Ghana. *Journal of Developing Areas,* 26(4), 475-488.

Keynes, J.M. (1936). *The General Theory of Employment, Interest and Money*. Volume VII, Cambridge: MacMillan.

Khan, M.A., & Sajjid, M.Z. (2005). The exchange rate and monetary dynamics in Pakistan: An autoregressive distributed lag model (ARDL) approach. *The Lahore Journal of Economics*, 10(2), 87-99.

Kjosevski, J. (2013). The determinants and stability of money demand in republic of Macedonia. *Zbornik Radova Ekonomskog Fakulteta u Rijeci*, 31(1), 35-54.

Kumar, S., Don, J.W., & Fargher, S. (2013). Money demand stability: a case study of Nigeria. *Journal of Policy Modeling*, 35(6), 978-991. doi. 10.1016/j.jpolmod.2013.03.012

Laidler, D.E.W. (1977). *The demand for money: theories and evidence.* 2nd ed. London: Harper & Row.

Li, C. (2007). Essays on the inventory theory of money demand. Ph.D. Thesis, Faculty of Graduate Studies (Economics), The University of British Columbia.

MacKinnon, J.G., Haug, G.A., & Michelis, L. (1999). Numerical distribution functions of likelihood ratio tests for cointegration. *Journal of Applied Econometrics*, 14(5), 563-577. doi. 10.1002/(SICI)1099-1255(199909/10)14:5<563::AID-JAE530>3.0.CO;2-R

Maravić, J., & Palić, M. (2005). Econometric analysis of money demand in Serbia, Belgrade: National Bank of Serbia Research Department.

Marshall, A. (1923). *Money, Credit and Commerce*. London, Macmillan.

McNown, R., & Wallace, M. S. (1992). Cointegration tests of a long-run relation between money demand & the effective exchange rate. *Journal of International Money and Finance,* 11(1), 107-114. doi. 10.1016/0261-5606(92)90024-R

Meiselman, D. (1962). *The term structure of interest rates*. Prentice-Hall Inc, N.J

Metin, K. (1994). Modelling the demand for narrow money in Turkey, *METU Studies in Development*, 21(2), 231-256.

Moosa, I. (1992). The demand for money in India: a cointegration approach. *The Indian Economic Journal*, 40(1), 101-115.

Mundell, A.R. (1963). Capital mobility and stabilization policy under fixed and flexible exchange rates. *Canadian Journal of Economics and Political Science,* 29(4), 475-485. doi. 10.2307/139336

Nachega, J.C. (2001). A cointegration analysis of broad money demand in Cameroon, International Monetary Fund, WP/01/26, 1-39. doi. 10.5089/9781451844382.001

Nell, K.S. (2003). The stability of M3 money demand and monetary growth targets: the case of South Africa. *Journal of Development Studies,* 39(3), 155-180. doi. 10.1080/00220380412331322861

Nwafor, F., Nwakanma, H., Nkansah, P., & Thompson, F. (2007). The quantity theory of money in a developing economy: empirical evidence from Nigeria. *African Economic and Business Review,* 5(1), 1-9.

Nwaobi, G. (2002). A vector error correction and nonnested modeling of money demand function in Nigeria. *Economics Bulletin*, 3(4), 1-8.

Owoye, O., & Onafowora, O.A. (2007). M2 targeting, money demand, and real GDP growth in Nigeria: Do rules apply?. *Journal of Business and Public Affairs,* 1(2), 1-20.

Payne, J.E. (2000). Post stabilization estimates of money demand in Croatia: the role of exchange rate and currency substitution. *Ekonomski Pregled*, 51(11-12), 1352-1368.

Pigou, A.C. (1917). The value of money. *The Quarterly Journal of Economics*, 32(1), 38-65. doi. 10.2307/1885078

Poole, W. (1970). The optimal choice of monetary policy instruments in a simple macro model. *Quarterly Journal of Economics,* 84 (2), 197-216. doi. 10.2307/1883009.

Pradhan, B.K., & Subramanian, A. (1997). On the stability of the demand for money in India. *The Indian Economic Journal*, 45(1), 106-117.

Rao, B.B. & Kumar, S. (2009a). A panel data approach to the demand for money and the effects of financial reforms in the Asian countries. *Economic Modelling,* 26(5), 1012-1017. doi. 10.1016/j.econmod.2009.03.008

Rao, B.B., & Kumar, S. (2009b). Cointegration, structural breaks and demand for money in Bangladesh. *Applied Economics,* 41(10), 1277-1283. doi. 10.1080/00036840701367671

Rao, B.B., Tamazian, A. & Singh, P. (2009). Demand for money in the Asian countries: a systems GMM panel data approach and structural breaks. [Retrieved from].

Sargent, T.J. (1969). Commodity price expectations and the interest rate, In: W.E. Gibson, & G.G. Kaufman, (ed.). *Monetary economics: readings on current issues*, Mc Graw Hill Book Co, NY.

Simmons, R. (1992). An error-correction approach to demand for money in five African developing countries. *Journal of Economic Studies*, 19(1), 29-48. doi. 10.1108/01443589210015935

Sriram, S.S. (1999). Demand for M2 in an emerging-market economy: an error-correction model for Malaysia. *International Monetary Fund*, WP/99/173, 1-49. doi. 10.5089/9781451858617.001

Sterken, E. (2004). Demand for money and shortages in Ethiopia. *Applied Economics Letters,* 11(12), 759-769. doi. 10.1080/1350485042000245511

Suliman, S.Z. & Dafaalla, H.A. (2011). An econometric analysis of money demand function in Sudan: 1960-2010. *Journal of Economics and International Finance*, 3 (16), 793-800. doi. 10.5897/JEIF11.122

Teriba, O. (1974). The demand for money in the Nigerian economy: some methodological issues and further evidence. *Nigeria Journal of Economic and Social Studies,* 16(1), 153-164.

Thomas, R.L. (1993). *Introductory Econometrics: Theory and Applications.* 2nd ed. Longman.

Tobin, J. (1956). Interest elasticity of the transactions demand for cash. *Review of Economics and Statistics*, 38(3), 241-247.

Tobin, J. (1958). Liquidity preference as behavior towards risks. The *Review of Economic Studies*, 25(2), 65-86. doi. 10.2307/2296205

Valadkhani, A. (2008). Long- and short-run determinants of the demand for money in the Asian-Pacific countries: an empirical panel investigation. *Annals of Economics and Finance*, 9(1), 47-60.

Weliwita, A., & Ekanayake, E.M. (1998). Demand for money in Sri Lanka during the post-1977 period: a cointegration and error correction analysis. *Applied Economics*, 30(9), 1219-1229. doi. 10.1080/000368498325101