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Original Article

Monetary Policy and Demand for Real Cash Balances: Some Theoretical and Empirical Results

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ABSTRACT

Influence of monetary policy is ordinarily studied within Hicksian $IS-LM$ model. This, nonetheless, tolerates only the comparison of positions of static equilibrium making $IS-LM$ model inapt to analyse the path of an economy that is out of equilibrium. In a complex, dynamic economy experiencing incessant structural transformation with technical and institutional rigidities, inertia and contractual obligations, autoregressive model of adjustment mechanism must apply. This paper revealed that it might be disingenuous and cynical to view the real world using Hicksian static formulation particularly in the short run. The objective of this paper was to examine impact of monetary policy on demand for real cash balances by establishing how dynamic considerations could enter monetary economics. This paper ingeniously introduced adjustment-lagged variable in the conventional money demand function and estimated elasticity coefficient of adjustment. Regression analysis on the monetary data from 2000-2022 was conducted. The study found that money demand in Kenya responds diminutively to changes in interest rate. Estimated elasticity coefficients of adjustment revealed that in aggregate, Kenyans adjust their portfolio within a year. If central bank changes money stock, this study established that the smaller the value of interest elasticity coefficient, the greater the necessary change in rate of interest needed to accommodate such a policy. These elegant results set limits to the extent in which the volume of money in circulation could be raised in an exogenous manner at the behest of monetary policy committee. The study concluded that the less the demand for real balances vary with interest rates, the greater will be the efficacy of monetary policy. Thus, effectiveness of monetary policy is directly correlated with low interest elasticity of money demand. Violent rise in interest rate might precipitate a failure of the banking system.

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INTRODUCTION

Changes in money supply by central bank impacts an economy by two distinct mechanisms. Firstly, they could alter the level of real wealth held by society. Through this influence of the level of real wealth on aggregate demand, there could be changes in the level of output, employment, and prices. Secondly, the level of real wealth could remain unaltered albeit changes in money supply (Geromichalos *et al.,* 2023). Customarily, this is presumed when dealing with an economy where money is essentially the liability of privately owned banking system. Nevertheless, these changes alter the composition of portfolios and, subsequently, the rates of returns at which investors hold existing stocks of assets. The level of aggregate demand, in this case, is influenced by changes in these rates of return (Carlson *et al*., 2022; Pesek & Saving, 1967; Feige, 1964).

Monetary policy works primarily through either wealth effect or substitution effect. Even so, various preconditions must be satisfied before central bank could influence predictably, the behaviour of the economy by manipulating the supply of money. Amongst the most significant necessary (not sufficient) conditions are that central bank should be able to control the volume of that set of assets which most closely corresponds money stock (Coibion *et al*., 2022; Laidler, 1966). At the same time, the demand function for this stock of assets (demand for real cash balances) must be stable enough for the consequences of changing its volume to be predictable with a high degree of consistency (Hamburger, 1968; Feige, 1964).

An extensively held view by economists that the demand for real cash balances would be greatly unstable owing to the vicissitudes of speculative behaviour is hardly stressed to a great extent in recent literature (Ng'ang'a, 2022). Nevertheless, the question as to whether central bank's monetary authority has control over the relevant stock of assets is one that has come in for a good deal of attention, both at the theoretical and at the empirical level (Geromichalos *et al*., 2023).

This paper recognizes three expansive views of what constitute money stock. Firstly, the traditional concept of currency in the hands of the public and demand deposits at commercial banks. Secondly, the time deposits at commercial banks are close substitute for demand deposits. This view advocates for their inclusion in the quantity of money, which the central bank must manipulate in its endeavour to influence the level of economic activity. Thirdly, but contentious view reasons that, liabilities of non-bank financial intermediaries (NBFI) are close substitutes for commercial bank liabilities and should therefore be included as part of money stock. This view espouses that before central bank can expect useful results from monetary policy, NBFIs must be brought under the control of monetary authorities (Hamburger, 1968; Friedman, 1959).

The understanding at inception of the distinction between the determinants of real money stock and nominal money stock is important. Nominal stock of money is determined in the virtuously fiduciary currency issued by central bank at its discretion. Nominal number of units of money is therefore whatever amount of money the central bank creates. This amount of money cannot be altered directly by its holders (Choi *et al*., 2023). Nevertheless, individual economic agents can make the real amount of money anything that in aggregate they want. Suppose money holders prefer to hold just a relatively small quantity of

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real cash balances? Individually, they will pursue a reduction of their nominal cash balances. They accomplish this by raising expenditures on goods and services. This will not the least bit, alter nominal money stock held in case some individuals become successful in decreasing their nominal cash balances. This, only leads to transfer of nominal money amongst its holders. Nevertheless, this will raise the flow of expenditures, money income and prices. Subsequently, real quantity of money decreases to the desired level. Equally, suppose money holders would like to hold rather larger real quantity of money. They will individually, pursue to raise their nominal cash balances. In aggregate, they will be unsuccessful. Nonetheless, in the effort, they will decrease nominal flow of expenditures on goods and services. This will lead to a decrease in money income, and prices. The consequence is an increase in the real quantity of money (Cooper *at al*., 2021; Motley, 1967; Gurley & Shaw, 1960; Bronfenbrenner & Mayer, 1960).

Conventionally, the level of real income, the ratio of income to money stock, or income velocity is distinctively determined by the real stock of money. These explanations also apply to income velocity. It is determined by holders of money, or, phrasing it contrarily, it is a reflection of their decisions about the real quantity of money that they desire to hold (Brunner & Meltzer, 1963). Economists speak interchangeably about decisions of holders of money to change either their real stock of money or to change the ratio of the flow of income to the stock of money. It appears suitable to allude in this paper that nominal quantity of money is determined predominantly by conditions of supply. Whereas real quantity of money and income velocity of money are determined primarily by conditions of demand (Carlson *et al*., 2022; Feige, 1964).

This paper identifies two broad ways of thinking how central bank implements monetary policy and therefore about the pragmatism of $IS-LM$ analysis. Firstly, central bank is modelled as effecting monetary policy through its control of the level or growth of money supply. To tackle this approach, LM curve is used. Secondly, this study sees the central bank as setting the rate of interest to stabilize the economy and then controlling it meticulously toward a set inflation target. Ostensibly, this is the monetary rule (MR) approach.

In monetary policymaking, there is a growing prevalence of monetary rule. Consequently, one may want to know why this paper would be troubled presenting the $IS-LM$ model at all. Firstly, to comprehend why central banks have opted the use of monetary rules, it would be valuable to have thorough understanding of the $IS-LM$ approach as a reference point. Besides, even though central bank is using MR approach, LM still occurs because it signifies equilibrium in the money market. Secondly, LM approach becomes very expedient in examining problems of deflation. Suppose that central bank utilizes monetary rule to regulate the rate of interest in order to attain inflation target. There is still a need to comprehend situations under which this may turn out to be ineffective. The case of liquidity trap that had befallen Japan for almost a decade is an excellent example. During this period, nominal interest rate declined close to zero and the economy experienced decreasing price level. Thirdly, open economy macroeconomic analysis is extensively conducted using $IS-LM$ model (Coibion *et al*., 2022; Leijonhufunds, 1987; Hicks, 1937; Keynes, 1936).

The three elucidations exemplify that, even though $IS-LM$ model is less applicable in policy analysis than formerly understood, still, it is a valuable tool. The influence of changes, such as, in the supply of money, is customarily analysed within the Hicksian $IS-LM$ model. This though, allows only the comparison of positions of static equilibrium and is, as a result, impractical in analysing the path of an economy out of equilibrium.

The objective of this study was to explore the implication of monetary policy on demand for real cash balance by demonstrating ingeniously how techniques of estimating dynamic analysis could enter monetary economics. Section 2 offers

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literature review while Section 3 provides the main theoretical underpinnings for the empirical studies reported in Sections 4. Section 5 provides a summary of the results and offers policy and conclusion that suggests some implications of the results.

LITERATURE REVIEW

According to Choi *et al*., (2023) monetary theory recognizes two sets of arguments that are pertinent to the problem of what constitutes money stock. Firstly, there is the argument that the theory of demand for money is the theory of the demand for an asset whose value is determined by its general acceptability attribute in exchange of goods and services. Additionally, it should have the function of storing value (wealth) (Gurley & Shaw, 1960). This argument reasons that, unlike demand deposits that are swiftly transferable by *cheque*, time deposits, and savings deposits for instance are not means of exchange. Building from these premises, it inexorably follows that demand deposits are money. Those other assets are not. Secondly, Pesek and Saving (1967) argue that demand deposits, being in actuality liabilities of commercial banks, whose owners are individual economic agents, represent net wealth to society. Certainly, time deposits and liabilities of NBFIs do not represent net worth (Geromichalos *et al*., 2023).

From inferences of monetary theory, monetary policy works principally by means of wealth effect. The suitable empirical definition of money therefore is confined to currency plus the demand deposit because it is only changes in the real quantity of these assets that represent changes in the society's wealth (Choi *et al*., 2023; Meltzer, 1963; Tobin, 1956).

Speculative demand for money theory, initially in its Keynesian form and its later manifestations in Tobin (1958) is a theory of demand for an asset whose capital value does not fluctuate with the rate of interest. Viewed this way, time deposits are fairly, as good as demand deposit. An enquiry on the definition of money overlaps profoundly with an alternative significant problem in monetary economics: explicitly whether transactions motives alone are sufficient to allow one to model an acceptable theory of demand for money. One can straightforwardly cognize that, it is expedient to hold an asset to bridge the gap between receipt and making of payments (Geromichalos *et al*., 2023; Bronfenbrenner & Mayer, 1960). Consequently, this paper asserts that transactions demand for money arises from lack of synchronization of receipts and disbursements. Niftily, there exists an extensive variety of assets for this purpose (Choi *et al*., 2023). Authoritatively, this paper defines money as the stock of assets best accustomed for this purpose in the sense that it is easy to store and relatively riskless insofar as its market value is concerned. Evidently, neither time deposits and demand deposits nor currency and demand deposits are perfect substitutes in these respects. The implicit question is whether the cost involved in the transformation of a time deposit into demand deposit before making transfer of funds is sufficiently high to make the former unsuitable for use as a temporary abode of purchasing power (Garomichalos *et al*., 2023; Carlson *et al*., 2022; Teigen, 1964; Meltzer, 1963; Laidler, 1966).

According to Pesek and Saving (1967) individual economic agents desire demand deposits because of stream of conveniences they yield. In contrast, an economic agent holds time deposits solely for the interest they bear. This interest on time deposits is the liability that must be paid by banks. Flow of amenities from demand deposits is not at the expense of banks except in as much as they may hold reserves as a guarantee that they may accomplish their obligations. This paper argues that the gains from the public for holding time deposits is offset by the loss bankers incur in having them outstanding. Such offsetting does not prevail in as far as demand deposits are concerned (Motley, 1967). Clearly, demand deposits represent net wealth to the society.

According to Ng'ang'a (2022), determination and measurement of a stable function of aggregate demand for money is the most imperative issue insofar as splendid monetary policy is concerned. Knowledge about aggregate money demand

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function supports central banks in influencing economic activity by controlling money supply. A more stable aggregate demand function for money permits outcomes of manipulating money supply to be easily and accurately predicted with great precision. The stable function is typically one that involves knowledge of smaller number of exogenous variables and their slope coefficients appropriate to forecast demand for money with a given degree of accuracy. A necessary but not sufficient condition is for central banks to embrace time deposits as suitable substitute for demand deposits because money concept that includes them is more stable than a narrower definition. This broader definition is empirically more stable to numerous rates of interests, including some appropriate regressors like permanent income (Geromichalos, *et al*., 2023; Carlson, *et al*., 2022; Friedman, 1959; Laidler, 1966; Feige, 1964).

Friedman (1959) found an elasticity of demand for money with respect to permanent income of roughly 1.8. Regrettably, he was empirically not capable of providing evidence that the rate of interest was a significant regressor in demand for money function. These inaccurate outcomes were anomalous. Friedman's inclusion of time deposits in his aggregate money demand function was essentially held responsible, though not solely. Employment of time deposits were largely to blame for the high elasticity of demand for money with respect to permanent income (1.8). Baumol (1952) in his inventory approach predicted that demand for money would increase less than in proportion to income.

Numerous research have overtly found that interest rate has a negative effect on the real demand for money. According to Laidler (1966), the inclusion of time deposits in the definition of money tends to improve the stability of this correlation. Testing techniques applied by Friedman made it difficult for him to get close correlation between interest rate and real demand for money. Friedman's income elasticity of money demand of 1.8 emanates from omission of the rate of interest in his functional fitting. The importance of rates of interest is now unchallenged. All the evidence suggests that a highly stable demand for money function can be identified whether time deposits are included in the definition of money or not (Ng'ang'a, 2022).

According to Monetary theorists, investors respond quickly to changes in their economic environment (Carlson *at al*., 2022; Tobin, 1958). Money market certainly, moves rapidly toward equilibrium in its flow and stock aspects. Thus, investors' actual money holdings are quickly adjusted to desired levels. In recent empirical studies on the function of aggregate demand for money, it was established that equilibrium in the money market was taken to be the stock of money in the hands of the public. Numerous studies fit the demand for money functions to quarterly or annual data. These functions estimate income and interest elasticities by assuming that investors react within a quarter or a year to slight divergence between their actual and desired money holdings (Choi *et al*., 2023; Cooper *at al*., 2021; Feige, 1967).

The concept of rapid adjustment cannot be unreasonable as security traders do react swiftly to environmental changes provided the theory of money demand is truly the theory for securities in organized markets. Keynes innovative work on speculative consideration took the view that the primary alternative to holding money is holding bonds (Keynes, 1939). Investors adjust their portfolios comprising of money and bonds rapidly as conditions in the economy vary. "Modern quantity theory" to demand for assets, sees demand for and supply of money as the most stable macro-relation and the one most fitting for evaluating economic performance (Friedman, 1959). Quantity theory views changes in the economy caused by policy variables or variations in desired asset structure as working essentially, not entirely, by generating divergences between desired and actual holding of money. In turn, these activate adjustment of several other assets in the final wealth holders' portfolio.

The demand for money ought to be part of the theory of asset selections. However, the exact specification of the regressors on the real money

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balance remains a gamble (Meltzer, 1963). Dissimilarities in specification of regressors in the function of money demand have yielded significant differences in inferences or results. Tobin (1956) and Baumol (1952) individually modelled the demand for transactions balances as an issue in capital theory. They each found a function of the demand for real cash balances that depends on yields and costs. From their models, they inferred the existence of economies of scale in holding transaction real balances. To ascertain this insinuation a wealth or income elasticity of less than unity is computed (Choi, *et al*., 2023; Geromichalos, *et al*., 2023).

In his theory of asset choice, Tobin (1958) offers rates of return on nonfinancial and financial assets a vital role. Friedman's paper on the quantity theory emphasizes the view of the quantity theory as a theory of the demand for money and uses bond and equity yields as regressors in the money demand function. His empirical conclusions suggest the significance of per capital permanent income. Friedman neglects rates of interest as regressors in the function and probably accords them inferior roles. Bronfenbrenner and Mayer (1960), assessed separately the impacts of wealth, rate of interest, income, and lagged money balances on real money demand. Their conclusions are that the rate of interest, income, and the lagged money regressors are statistically significant by the standard ordinary least square (OLS) tests. However, the wealth exogenous variable is statistically insignificant (see also Cooper & Peek, 2021).

A modest principle of Monetarist counter-revolution exemplified by Friedman's version of the quantity theory is the supposition that, there exists a steady demand function for money that indicates only little response to vicissitudes in the rate of interest. Thus, effectiveness of monetary policy by central banks is directly related to low interest elasticity of demand for money. Whether this elasticity coefficient is small or large has been one of the focal points of discussion and accounts for major difference between Monetarism and of Keynesianism. The less the fluctuation of demand for real balances with interest rate, the greater the efficacy of monetary policy (Coibion *et al*., 2022; Cooper *et al*., 2021; Laidler, 1966; Teigen, 1964; Friedman, 1959).

Monetary theorists hypothesize that income-earners trace an equilibrium between the convenience and security that cash balances offer and the loss of income resulting from holding cash balances (Geromichalos, *et al*., 2023; Motley, 1967). These individual economic agents hold only a certain percentage of their money income for transaction purposes.

Monetary theorists hypothesize the following Cambridge equation:

$$M^d = \hbar Py.$$

Where M^d denotes the aggregate quantity of nominal money balances which all economic agents desire to hold, P is the aggregate price level in the economy, y is total real income and $\hbar$ is a fraction anywhere between zero and one of money income held as currency and bank deposits. Multiplying P and y produces nominal income. Therefore, Cambridge equation establishes a hypothesis that households hold a fraction of their nominal income as money. The term $\hbar$ is the "$Cambridge\ \hbar$" and Py is the money value of real income. Monetarists hold that $\hbar$ is fairly stable.

Supposing that money supply is given by central bank, this paper argues that the importance attached to interest elasticity coefficient emanates exclusively from its influence on the demand for real balances, $Cambridge\ \hbar$. From this vantage point, a lower interest elasticity necessarily infers more effective monetary policy. This coefficient is imperative with respect to monetary policy transmission mechanism, i.e., the channel through which a change in money stock is brought about to impact the economy. In context of its association with transmission mechanism, the smaller the elasticity coefficient the more difficult it gets to "implement" monetary policy via open-market operations (Keynes, 1936).

The aforementioned analysis recapitulates illustrious theoretical background and ample

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empirical evidence. Furnished with this knowledge becomes possible to deduce the set of assets central bank should endeavour to manipulate in conducting sound monetary policy. Regarding liabilities of commercial banks, whether central bank control the volume of demand deposit or demand deposit plus time deposits does not matter. Money's demand function, notwithstanding its definition, appears stable. Thus, central bank's manipulation of the supply of suitable assets should produce predictable results on the regressor variables appearing in the demand function, $ceteris\ paribus$.

MODEL SPECIFICATION AND METHODOLOGY

To cognize implications of instantaneous adjustment, consider the following identities:

$$Y_t^d \equiv C_t^S + \delta A_t \qquad (1)$$

Meaning that disposable income $\left(Y_t^d\right)$ is either spent on consumption (C_t^S) or added to net assets δA_t.

Where,

$$C_t^S \equiv P_t^C + T_t^C + T_t^r \qquad (2)$$

Consumption spending (C_t^S) comprises of: Permanent consumption P_t^C, transitory consumption T_t^C, and transfer payments T_t^r., and,

$$\delta A_t \equiv \delta M_t + \delta S_t + \delta D_t - \delta L_t \qquad (3)$$

Identity (3) tells us the balance-sheet position and states that net purchases of assets encompass additions to, stocks of money (δM_t), securities (δS_t), durable goods (δD_t), and less additions to net liabilities (δL_t).

Combining these three identities yields:

$$Y_t^d \equiv P_t^C + T_t^C + T_t^r + \delta M_t + \delta S_t + \delta D_t - \delta L_t \qquad (4)$$

Equation (4) is the budget constraint identity.

At a particular level of current disposable income, identity (4) fervently reasons that additions to stocks of money can be made only at the expense either of a reduction in current consumption or of a reduction in holdings of other assets. In addition to the opportunity cost of holding money (interest rate), there may also be cost associated with changing one's money stock rapidly. This arises because it involves a large change in current consumption standards. Individuals will presumably balance this "cost" against the benefits of attaining the desired money stock as rapidly as possible. Irrefutably, the rate at which individuals eliminate divergences between desired and actual money stocks is not necessarily rapid and may be a function of other variables. However, the implied postulation fundamental to most recent empirical research is that the economy eradicates any divergence between actual and desired money holdings promptly without regard to the condition of the rest of its balance sheet.

Let;

$$\delta M_t = \widetilde{M}_t - M_{t-1} \qquad (5)$$

where the tilde sign specifies desired money stocks.

This study models the concept that economic agents do not adjust their money holding instantaneously to fluctuations in their economic environment. Firstly, desired money stocks are contingent on the opportunity cost of holding money and individual's income. Precisely, consider the following function.

$$\widetilde{M} = f(y, i) \qquad 6a)$$

In particular, function (6a) translates into the following exponential regression model:

$$\widetilde{M}_t = \varphi y_t^{\alpha_1} i_t^{\alpha_2} e^{\varepsilon_t} \qquad (6b)$$

where $\widetilde{M}_t$ = desired real cash balances, i_t = nominal interest rate, %, y_t = aggregate real income

Secondly, some proportion ϖ of any discrepancy between actual and desired money stocks will be adjusted in a period. Because desired demand variable cannot directly be observable, this paper

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assumes the stock adjustment postulate as follows:

$$M_t = M_{t-1}\left[\frac{\widetilde{M}_t}{M_{t-1}}\right]^{\varpi} \qquad 0 < \varpi \leq 1 \qquad (7a)$$

where ϖ is the elasticity coefficient of adjustment.

Equation 7(a) avers that a constant percentage of discrepancy between actual and desired real cash balances gets eradicated in a single period (yearly in this paper). If, $\varpi = 1$, then, actual money holding is equal to desired money holding. Meaning that actual money holding adjusts to the desired money holding instantaneously in the same period. If, $\varpi = 0$, then, no changes because actual money holding at time t is the same as that observed earlier. Normally, ϖ is likely to lie between these limits because adjustment to the desired money holding is likely to be incomplete.

In log form, 7(a) becomes:

$$\ln(M_t) = \ln(M_{t-1}) + \varpi[\ln(\widetilde{M}_t) - \ln(M_{t-1})] \qquad (7b)$$

If, $\varpi = 1$, then, it follows that:

$$M_t = \widetilde{M}_t = f(y, i) \qquad (7c)$$

The technique chosen will be contingent (empirically) on the form of function f in Equation (6a). This paper argues that the size of ϖ will depend on the length of the period chosen, tending to unity as the long run approaches. Economic agents are likely to correct large imbalances in their portfolios more rapidly than small ones; hence ϖ is a function of the difference between actual and desired money holdings. Moreover, this paper enunciates strongly that the demand for money function should be estimated as part of a dynamic system in which holdings of all types of assets are determined simultaneously.

For econometrics estimation, if the form of Equation (6a) is linear in the logarithms of the variables the equations to be fitted are derived from Equation (6b) and expressed expediently in logarithmic form as:

$$ln(\widetilde{M}_t) = ln(\varphi) + \alpha_1 ln(y_t) + \alpha_2 ln(i_t) + \varepsilon_t \qquad (8)$$

Equation (8) is the long-run demand function for money. It hypothesizes that desired money holding is a function of expected (anticipated) interest rate and income. Substituting $ln(\widetilde{M}_t)$ from Equation (8) into Equation (7b), this study obtains the following log-linear model (constant elasticity model):

$$ln(M_t) = (1-\varpi)ln(M_{t-1}) + \varpi[ln(\varphi) + \alpha_1 ln(y_t) + \alpha_2 ln(i_t)] + \xi_t$$

$$= \varpi ln(\varphi) + \varpi\alpha_1 ln(y_t) + \varpi\alpha_2 ln(i_t) + (1-\varpi)ln(M_{t-1}) + \xi_t \qquad (9)$$

Equation (9) is the $short-run\ demand\ function\ for\ money.$

In Equation (8), α_2 measures the elasticity of M with respect to i, viz., the percentage change in M for a given (small) anticipated percentage change in i. This is equilibrium or long-run value of i. In Equation (9) on the other hand, $\varpi\alpha_2$, measures the percentage change in M with respect to a one percentage change in the actual or observed value of i. Responses in Equations (8) and (9) will not be the same unless, of course, $\varpi = 1$, that is, the current and long-run values of i are the same. Practically, this paper estimates Equation (9) first. When an estimate of ϖ if obtained from the coefficient of lagged M, α_2 is straightforwardly computed by basically dividing the coefficient of i_t $(= \varpi\alpha_2)$ by ϖ.

Equivalently, equation (8) can also be written as:

$$ln\left(\frac{M_t}{M_{t-1}}\right) = \varpi[ln(\varphi) + \alpha_1 ln(y_t) + \alpha_2 \ln(i_t) - \ln(M_{t-1})] + \xi_t$$

$$= \varpi ln(\varphi) + \varpi\alpha_1 ln(y_t) + \varpi\alpha_2 ln(i_t) - \varpi ln(M_{t-1}) + \xi_t \qquad (10)$$

Where,

$$\xi_t = \varpi\varepsilon_t$$

These equations permit the identification of both elasticity coefficient of adjustment ϖ and the long-run demand elasticities with respect to income α_1, and the rate of interest α_2. Note that

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equations (9) and (10) are identical and least-squares fitting will yield equal values of the parameters. A value of ϖ close to unity, $\varpi > 0.500$, implies that households do in fact respond within a year to divergences between actual and desired money holdings. A very low value, $\varpi < 0.500$, on the other hand, implies that additions to the economic agents' money stock depend on the levels of income and the rate of interest. To support the hypothesis of lagged portfolio adjustment (in terms of annual monetary data) ϖ takes a value significantly different from both zero and unity $(0 < \varpi < 1)$, which would imply that a lag exists.

EMPIRICAL RESULTS

As an illustration of the short-term and long-term demand for real cash balances, consider results in *Table 1*. The paper used yearly monetary data for Kenya from 2000 to 2022. The data was obtained from the World Bank (CD-ROM), 2022. The variables are defined as follows: M_t (as defined by M2 broad money supply, Kenya shillings, billions), P (implicit price deflator, 2016 = 100), $Y_t = GDP$ at constant 2016 prices (Kenya shillings, billions) and i_t (91-day T-bills, 182-day T-bills, 364-day T-bills, 5-year T-notes, and 10-year T-bonds rate of interest, %). $M2$ was deflated by P to get figures for real cash balances. A priori, real money demand was expected to be positively correlated to gross domestic product (GDP) (positive income effect) and negatively related to i_t (the higher the interest rate the higher the opportunity cost of holding money). The dependent variable is the natural logarithm of the real cash balances, ln (M_t/P_t), for the years 2000-2022.

Equation (9) produces result given in *Table 1*. To interpret these equations this paper rewrites them in a form that shows income elasticity, interest elasticity and elasticity coefficient of adjustment.

Equation 1: 91-day T-bills rate.

Short-run demand function for money.

$$\widehat{ln\left(\frac{M_t}{P_t}\right)} = -1.316 + 0.378ln(y_t) - 0.039ln(i)_{91dt} + 0.661ln\left(\frac{M_{t-1}}{P_{t-1}}\right) \quad (11a)$$

In the short run (one quarter), the elasticity of real money demand with respect to real income is 0.378: a 1 percent increase in real income raises demand for real cash balances by 0.378 percent, which is considerably less than proportionately. An increase in 91-day T-bill rates reduces demand for real cash balances. The short run interest responses are small: a 1-percentage point increase in the T-bills rate reduces the demand for real cash balances by 3.9 percent. The elasticity coefficient of adjustment, $\varpi = (1 - 0.661) = 0.339$. This deduces that only about 33.9% (or 8.475% in a quarter) of discrepancy between desired and actual real cash balances is eliminated yearly. A sluggish adjustment.

Long-run demand function for money

To get long-run demand function from equation (11a), this paper divides the short-run demand function through by the speed of adjustment (ϖ) and drops the $ln\left(\frac{M_{t-1}}{P_{t-1}}\right)$ term. The results are:

$$\widehat{ln\left(\frac{M_t}{P_t}\right)} = -3.882 + 1.115ln(y_t) - 0.115ln(i)_{91dt} \quad (11b)$$

The long-run elasticities exceed the short-run elasticities by a factor of 2.94. The long-run real income elasticity is 1.115, meaning that in the long-run the rise in the real cash balances arising as a consequence of a given rise in real income is 1.115 percent as large as the proportional rise in real income. Real cash balances thus rise more than proportionately to the rise in real income. If the rise in interest rate is sustained, a 1-percentage point increase in the T-bill rate reduces real cash balances by, $\alpha_2 = \varpi\alpha_2/\varpi = -0.039/0.339 = -0.115$: when holders of real cash balances have had time to adjust to the 1 percent variation in the rate of interest, they will reduce their real cash holding by about 11.5 percent.

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Table 1: Regression estimates of real income, interest rate and adjustment-lagged variable in the demand for real cash balances.

Regressors	Results of the Partial Regression Coefficients from the Log-Linear Model				
	Eq. (1)	**Eq. (2)**	**Eq. (3)**	**Eq. (4)**	**Eq. (5)**
Intercept	-1.316[c] (-1.89)	-1.265[c] (-1.74)	-1.017 (-0.61)	-0.917 (-0.76)	-1.574 (-1.67)
$ln(y_t)$	0.378[a] (3.23)	0.362[a] (3.02)	0.437[b] (2.29)	0.304[c] (1.91)	0.329[b] (2.78)
91-day T-bills rate: $ln(i)_{91\_days}$	-0.039[b] (-2.10)				
182-day T-bills rate: $ln(i)_{182\_days}$		-0.043[c] (-1.82)			
364-day T-bills rate: $ln(i)_{364\_days}$			-0.083[b] (-2.52)		
5-year T-notes rate: $ln(i)_{5\_years}$				-0.089 (-1.37)	
10-year T-bonds rate: $ln(i)_{10\_years}$					-0.204[b] (-2.41)
$ln\left(\frac{M_{t-1}}{P_{t-1}}\right)$	0.661[a] (6.10)	0.675[a] (6.07)	0.576[c] (3.88)	0.727[a] (5.07)	0.735[a] (6.60)
Partial elasticity of real cash balances with respect to real income elasticity	0.572	0.536	0.759	0.418	0.448
Partial elasticity of real cash balances with respect to interest elasticity	-0.059	-0.064	-0.144	-0.122	-0.278
Elasticity coefficient of adjustment (ω)	0.339	0.325	0.424	0.273	0.265
Number of observations	23	22	14	17	18
Adjusted R^2	0.992	0.991	0.992	0.983	0.989

Notes: Superscripts indicate levels of significance as follows: a1%, b5%, c10%. The t-Statistics are reported in parentheses.

Equation 2: 182-day T-bill rate.

Short-run demand function for money.

$$\widehat{ln\left(\frac{M_t}{P_t}\right)} = -1.265 + 0.362ln(y_t) - 0.043ln(i)_{182dt} + 0.675ln\left(\frac{M_{t-1}}{P_{t-1}}\right) \quad (12a)$$

The short-run demand function produces income elasticity of 0.362 and interest elasticity of -0.043. They have the right sign and are statistically significant. The elasticity coefficient of adjustment (speed of adjustment) is $\varpi = (1 - 0.675) = 0.325$. Meaning that only about 32.5% (or 8.125% in a quarter) of discrepancy between desired and actual real cash balances is eliminated yearly.

Long-run demand function for money

Long-run demand function is derived from equation (12a):

The results are:

$$\widehat{ln\left(\frac{M_t}{P_t}\right)} = -3.8923 + 1.1138ln(y_t) - 0.1323ln(i)_{182dt} \quad (12b)$$

Both long-run income elasticity and interest elasticity of demand for money are greater (in absolute term in the case of interest elasticity) than the corresponding short-run elasticities.

Equation 3: 364-day T-bills rate.

Short-run demand function for money.

$$\widehat{ln\left(\frac{M_t}{P_t}\right)} = -1.017 + 0.437ln(y_t) - 0.083ln(i)_{364dt} + 0.576ln\left(\frac{M_{t-1}}{P_{t-1}}\right) \quad (13a)$$

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The short-run interest elasticity (-0.083) has the right sign and is statistically significant. The elasticity coefficient of adjustment, $\varpi = (1 - 0.576) = 0.424$. This Means that only about 42.4% (or 10.6% in a quarter) of discrepancy between desired and actual real cash balances is eliminated within a year. This is a reasonably enthusiastic adjustment. The elimination of discrepancy is highest at 364-day T-bills rate.

Long-run demand function for money

Long-run demand function derived from equation (13a) is:

$$\widehat{ln\left(\frac{M_t}{P_t}\right)} = -2.399 + 1.031ln(y_t) - 0.1958ln(i)_{364dt} \quad (13b)$$

Evidently, the long-run interest elasticity of demand for money is considerably greater (in absolute terms) than the corresponding short-run elasticity. This also is true of the income elasticity coefficient. A 1 percent rise in current or observed nominal interest rate would decrease average holding of real cash balance by about 8.3 percent. However, if the increase in nominal interest rate is sustained, then eventually, the interest elasticity out of long-term interest rate will be $\alpha_2 = \varpi\alpha_2/\varpi = 0.083/0.424 = 0.1958$. In other words, when holders of real cash balances have had time to adjust to the 1 percent change in interest rate, they will decrease their money holding ultimately by about 19.58 percent.

Equation 4: 5-year T-notes rate.

The short-run coefficient for the interest elasticity of demand for money at 5-year T-note rate $(ln(i)_{5\_years})$ is statistically not different from zero.

Equation 5: 10-year T-bonds rate.

Short-run demand function for money.

$$\widehat{ln\left(\frac{M_t}{P_t}\right)} = -1.574 + 0.329ln(y_t) - 0.204ln(i)_{10t} + 0.735ln\left(\frac{M_{t-1}}{P_{t-1}}\right) \quad (14a)$$

The short-run interest elasticity (-0.204) has the right sign and is statistically significant. The elasticity coefficient of adjustment, $\varpi = (1 - 0.735) = 0.265$. This implies that only about 26.5% (or 6.625% in a quarter) of discrepancy between desired and actual real cash balances is eliminated yearly. Again, a slothful adjustment. This yields the slowest adjustment of all. This very low value of $\varpi = 0.265 < 0.500$, implies that additions to the economic agents' money stock depend on the levels of income and the rate of interest.

Long-run demand function for money

Long-run demand function from equation (14a):

$$\widehat{ln\left(\frac{M_t}{P_t}\right)} = -5.94 + 1.2415ln(y_t) - 0.77ln(i)_{10t} \quad (14b)$$

The long-run interest elasticity of demand for money is considerably greater (in absolute terms) than the corresponding short-run elasticity. This also is true of the income elasticity coefficient, even though in the current case, its economic and statistical significance is dubious.

It appears from the above aggregate money demand equations that, on average, the economy eliminated close to one-half of divergence between desired and actual money stocks within one year (see Equations 13a and 13b). The coefficients attached to real income and the interest rate in equations 11(a), 12(a), 13(a), and 14(a) represent the elasticities of desired money holdings with respect to these variables in the short-run. By using the respective elasticity coefficient of adjustment long-run equation 11(b), 12(b), 13(b), and 14(b) are derived. The long-run elasticities apply if sufficient time elapses for individual economic agents to reach portfolio equilibrium. Results presented suggest that the hypothesis put forward in this paper is substantially correct and that, the observed elasticities are of expected order of magnitude.

The interest-elasticity of demand for money concerns the influence of central bank to vary the money supply in an exogenous manner. The public might be unwilling to absorb more cash balances as central bank lowers interest rate or to release more cash balances as interest rate rises.

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Implementation of monetary policy by central bank via open market operation (OMO) is the channel through which low interest-elasticity coefficient inversely affects the efficacy of monetary policy. The relative efficacy of monetary policy is allied to two specific relationships: the effect of low interest-elasticity coefficient on the $Cambridge\ k$ will increase the potency of monetary policy while the effect of low interest-elasticity coefficient on the transmission mechanism will inhibit its implementation.

These inhibiting effects exist whenever the change in money supply is accomplished through open market operations, or by changing the central bank rate (CBR). Keynes (1936) unambiguously thought up the essential proposition of the above evaluation, as he deliberated on his inventive liquidity preference theory:

> *"… the banking system is in fact always able to purchase (or sell) bonds in exchange for cash by bidding the price of bonds up (or down) in the market by a modest amount…"*

By manipulation of speculative-motive, an economy's monetary management is brought to bear on the economic system. If not, OMO would be unrealizable. Nonetheless, one cannot anticipate that an interest-elasticity bigger than zero will guarantee a change in money demand of any chosen magnitude can be attained by appropriate change in bond prices (Ng'ang'a, 2022).

In modern financial setting, liquidity generated by commercial banks are borrowed from depositors. Holders of such deposits regard them as liquid assets. If central banks were to create violent movement in the rates of interest, colossal withdrawals from deposits accounts would ensue (Geromichalos *et al*., 2023; Baron *et al*., 2021). This could precipitate a collapse of the banking system. However, banks can avert this by correspondingly manipulating rates paid on these deposits. Besides, these deposits are matched in part by longer-term instruments yielding a relatively fixed income. If deemed necessary by central bank to change money supply, then, the smaller the interest elasticity coefficient, the bigger is the necessary change in the rate of interest required to accommodate such a policy. This sets limits the extent to which the volume of money in circulation can be raised in an exogenous manner at the behest of the monetary authorities. Relatively, small changes in the stock of money, properly timed and correct in magnitude, may be adequate to offset other changes making for instability. On the other hand, relatively small changes in the stock of money, randomly timed and sized, may equally be an important source of instability (Carlson *et al*., 2022; Baron *et al*., 2021).

CONCLUSION AND POLICY IMPLICATION

This paper found that, the smaller the value of interest elasticity coefficient, the greater is the necessary change in the rate of interest needed to accommodate such a policy. The study also found that the demand function for money in Kenya shows only little response to changes in the interest rate. Additionally, the estimated response coefficients revealed that in aggregate, economic agents adjust their portfolio within a year. These elegant outcomes establish bounds that limits how the volume of money in circulation can be raised in an exogenous manner at the behest of central bank. This paper concludes that, the less the demand for real balances vary with interest rate, the greater the efficacy of monetary policy. Accordingly, effectiveness of monetary policy is directly correlated to the low interest elasticity of demand for money. Ferocious rise in interest rate structure might precipitate a collapse of the banking system.

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