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Demand for Money: Implications for the Conduct of Monetary Policy in Kenya

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Abstract

The paper analyses demand for different monetary aggregates (M0, M1, M2 and M3) in Kenya for the period 1997:4-2011:2. Dynamic frameworks are used to estimate and uncover parsimonious and empirically stable demand for money functions. Price, real GDP, nominal 91-Day Treasury bill rate, nominal interbank rate, nominal deposit rate and foreign interest rate affected the long-run demand for money functions to different degrees. The demand for money functions is found to be unstable over the period for the parameter values, implying that the current monetary targeting policy framework is inappropriate. However, there are challenges in adopting an alternative monetary policy framework.

Keywords: money demand, cointegrated VAR

JEL Classification: C51, E31, E52

1. Introduction

A stable money demand function is generally considered essential for the formulation and conduct of efficient monetary policy as it enables a policy-driven change in monetary aggregates to have a predictable influence on output, interest rates and ultimately price (Sriram, 2001). Consequently, considerable effort has been made in the empirical literature for both industrial and developing countries to determine the factors that affect the long-run demand for money and the stability of the relationship between these factors and various monetary aggregates.

Most of the research on the demand for money up until 1980s was carried out by the so-called partial adjustment models in which demand for real money is formulated as a function of a scale variable and a vector of opportunity cost variables. Demand for money models built under this framework for the United States and industrial countries using post World War II data indicated that the demand for money was unstable in the 1970s, which is commonly referred to as the "missing money episode". The "missing money episode" was due to the assumption of a stable velocity and misspecification of the model. On the policy front, it made most of the industrial countries to abandon the monetary aggregate targeting policy framework in favour of inflation targeting. However, in the recent past, this view has changed, since a number of empirical studies using different data definitions and econometric methodology have been successful in finding stable demand relations. These include among others, Carlson *et al.* (2000) for the US, Hendry and Ericsson (1991) for the UK and Hoffman *et al.* (1995) for the US, Japan, Canada, the UK, and Germany.

Majority of empirical studies on money demand are on developed countries. Research work is limited for developing countries partly because of complacency offered by the International Monetary Fund (IMF) financial programming framework, where demand for money is approximated via a basic quantity theory of money equation. Nonetheless, demand for money in Kenya has received some attention from macroeconomists. Studies on the demand for money include, among others, Pathak (1981), Darrat (1985), Kanga (1985), Killick and Mwega (1990), Adams (1992), Ndung'u (1994) and Kisinguh, Korir and Maana (2004). However, prior to Adams (1992) the work on demand for money turned out disparate findings regarding the determinants and stability of the demand for money. Adams (1992) attributed the differences in reported results to differences in sample size, composition of explanatory variables and the appropriate specification of the dynamic adjustment in the demand for money.

The need to revisit the money demand function in Kenya reflects several considerations. First, Kenya's financial system has undergone reforms under the liberalization process guided by the Bretton Woods institutions (i.e. the World Bank and the IMF) in late 1980s and early 1990s. Second, the shift to a floating exchange rate regime in 1991 and the liberalization of the capital account of the balance of payment in 1995 not only expanded the menu of assets available to economic agents in Kenya but also made exchange rate an indirect instrument of monetary policy, thus exogenizing the money supply process. This regime shift may have introduced some instability in the money demand function. Similarly, a floating exchange rate regime meant that the economy lost a nominal anchor to tie prices down (as the experience after 1992 elections shows). Third, the recent years has seen the Kenyan financial sector being transformed by financial innovations and developments that may have impacted on the monetary aggregates and the stability of money demand. Thus this study attempts to estimate the demand for money functions using recent data and to ascertain the stability of the estimated relationship.

The rest of the paper is organised as follows. Section 2 provides a brief account of the theoretical framework. Section 3 presents the empirical methodology. Section 4, reviews the data while section 5 presents the integration and cointegration analysis. Section 6 presents formal tests of stability of the demand for money. In section 7 we present the concluding remarks and policy recommendations.

2. Theoretical Framework

The theoretical underpinnings of the demand for money emphasize transactions, speculative, precautionary or utility considerations, and are well articulated in the economic literature. These include the classical quantity theory, Keynes (1936) liquidity preference, Baumol (1952) and Tobin (1956) inventory theoretical approach, Friedman's (1956) restatement of the quantity theory, and the Cambridge version. These theories share common elements (variables) such as scale variable. Boorman (1976) argues that what separates them is the specific role assigned to each variable. Sriram (2001) argues that the general consensus in the literature is that the empirical work on the demand for money is motivated by a blend of theories. As pointed out by Nachega (2001), empirical studies on demand for money should converge to a specification in equation 1 where real money balances is a function of a scale variable, opportunity cost of holding money and own rate of return on money.

$$M_t = f\underset{(+)\quad(-)\ (+)}{\left(P_t, scale_t, i_t, i_t^d\right)} \tag{1}$$

Where M_t is the demand for nominal money balances, P_t is the domestic price level (consumer price index or GDP deflator), $scale_t$ is a scale variable (the real income, expenditure, or wealth), i_t is the nominal rate of return on alternative asset, i_t^d is the nominal own rate of return.

An increase in the general level of prices leads to a rise in the transactions demand for money since economic agents need to hold more money to undertake the same amount of real expenditures. With absence of money illusion, an increase in the general level of prices will induce a proportionate increase in the nominal demand for money, leaving the level of real money balances unchanged. This is the price homogeneity assumption that underlies demand for real money balances.

The scale variable is used to capture the transactions motive since the higher the level of scale variable the greater the demand for real money balances. The quantity theory of money demand posits a one-for-one relationship between money demand and income.

The opportunity cost of holding money has three considerations: the own-rate of return, rate of return on assets alternative to money and expected rate of inflation. Tobin (1958) argues in favour of including both rates. Ericsson (1998) points out that omission of own-rate of money leads to break down of the estimated money demand especially when financial innovations occur in the economy. Friedman (1956) argues that the expected rate of inflation should be included in the demand for money.

In an open economy like Kenya, the choice of assets for portfolio diversification is wider as foreign currency denominated assets are available in addition to the domestic financial and real assets. Thus as suggested by Bahmani-Oskooeee (2001), the domestic money demand could be sensitive to the external monetary and financial factors. An increase in rates of returns in foreign securities may potentially induce domestic residents to increase their foreign asset holdings financed by drawing down the domestic money holdings. Similarly, if the domestic currency is expected to depreciate, the domestic investors would be encouraged to readjust their portfolios in favour of foreign assets. This implies the possibility of the uncovered interest parity (UIP) relationship. UIP states that if domestic interest rates are higher than similar foreign interest rates, then investors

will shift their investment portfolios to the domestic assets leading to nominal exchange rate appreciation. UIP can be expressed algebraically as

$$i_t^m = i_t^{m*} + \Delta e_{t+1}^e + u_t \quad (2)$$

Where e_t is the expectation on the basis of all information available at time t, i_t^m is the yield on domestic assets with maturity m at time t, i_t^{m*} is an equivalent foreign interest rate and u_t is the risk premium associated with domestic assets.

3. Empirical Methodology

The definition of money varies across countries due to either institutional characteristics or arbitrary decisions. Ericsson and Sharma (1996) argue that although it is easy to control narrowly defined aggregates, they are less useful in policy analysis because their relationship with price and output is subject to considerable variability. Broader monetary aggregates appear more stable relative to nominal income but less amenable to control. For the purpose of this study, the assets considered are Kenya shilling money as measured by money stock (M0, M1, M2 and M3). It is however important to note that money (M3) is the intermediate target under the current monetary policy framework in Kenya.

Money demand functions have moved from traditional specification to include more variables to the specification and from use of simple regression time series econometrics to use more sophisticated methodologies such as Vector error Correction methodologies. Sanvi et al (2011), study's the money demand functions for the Euro area and add equity price to the traditional money demand specification. Using the VECM methodology they find money demand to be stable with equity price and less stable without equity prices. AL-Abdulrazag and Abdullah (2011), add exchange rate depreciation variable to the traditional specification of money demand function for the Jordian economy. Using Johansen Juselius Cointegration test they find the cointegration exists between the variables of income, interest rates and exchange rate with a positive relationship between money aggregates and the level of income and a negative relationship between monetary aggregates and interest rate and exchange rate depreciation. The money demand function was however found to be unstable.

In line with other studies on demand for money, the real GDP is used as a scale variable. The choice of the real GDP is also informed by the availability of data for the sample period in quarterly frequency.

There are different measures of the return on assets alternative to money: yields on short-term government securities, commercial paper, return on equities, yields on long-term government securities. The study uses the interest rate on 91-day Treasury bills as the return on assets alternative to money since it is the benchmark interest rate used in the financial market during the period of study.

The study uses average deposit rate as own return to money. This is motivated by the fact that demand deposits for corporate customers, all savings and time deposits are paid interest in Kenya.

The external influence is captured by the US three months Treasury bill rate adjusted for the expected depreciation/appreciation of the nominal Kenya Shilling US exchange rate.

The study uses cointegrated vector autoregression (VAR) analysis as presented in Johansen (1996) and Juselius (2006). The basic p-dimensional reduced-form VAR model with Gausian errors is specified as follows;

$$x_t = A_1 x_{t-1} + ... + A_k x_{t-k} + \Phi D_t + \varepsilon_t, t = 1,..,T \quad (3)$$

Where the vector of variables (Note 1), x_t is:

$$x_t = \left(m_t^i, p_t, y_t, i_t^{tb}, i_t^{ib}, i_t^d, i_t^{*k}, atm\right), i = 0,1,2,3 \quad (4)$$

$x_0,...x_{-k+1}$ are fixed, $\varepsilon_1,...\varepsilon_T$ are $iid \sim N_P(0,\Omega)$, D_t is a vector of deterministic variables such as constant, linear trend, centred seasonal and intervention dummies.

In an I(1) framework equation 3 can be reparameterised as a vector error correction model (VECM) as follows;

$$\Delta x_t = \Pi x_{t-1} + \Gamma_1 \Delta x_{t-1} ... + \Gamma_{k-1} \Delta x_{t-k+} + \Phi D_t + \varepsilon_t, t = 1,..,T \quad (5)$$

Where $\Pi = \sum_{i=1}^{k} A_i - I_P$ and $\Gamma_i = -\sum_{i=i+1}^{k} A_i$

Presence of unit roots in the unrestricted VAR model corresponds to nonstationary stochastic behaviour which can be accounted for by reduced rank ($r < p$) restrictions of the long-run levels matrix, $\Pi = \alpha\beta'$. The matrix α is the loading/speed of adjustment coefficients while β is the cointegrating vector so that $\beta' x_{t-1}$ is $r \times 1$ vector of stationary cointegrating relations.

4. A Look at the Data

In this section we use graphs to show the character of the data and give some intuition why cointegration holds. Figure 1 shows the components of the broad money (M3), which is the dependent variable in the analysis. Consequently, the analysis attempts to incorporate the factors that are likely to impact on these components. All variables in the demand for money functions are graphically analysed and several characteristics emerge.

First, some of the variables show a strong presence of a deterministic trend. This is apparent in figure 1 of the nominal money stock (M1, M2 and M3) and from graphical analysis of overall CPI, real GDP, 91-Day Treasury bill rate and nominal deposit rate. The presence of the deterministic trend in the data calls for the need to incorporate deterministic trend in the cointegrated VAR.

Second, there are structural breaks during the period of analysis. The structural breaks reflect the changes in monetary and fiscal regime in 2003 following the end of the Kenya African National Union (KANU) leadership in 2002 and the coming to power of the National Rainbow Coalition (NARC) government at the beginning of 2003; impact of the reduction in cash ratio requirement which caused substantial liquidity surplus in the market in 2003/2004; drought conditions in the year 2006 and effects of the post-election violence in 2008 which adversely affected the food supply chains causing a rise in inflation.

Finally, there is a strong component of seasonality for the variables. The analysis thus takes seasonality into consideration.

5. Integration and Cointegration Analysis

In testing for the level of integration and cointegration, we first carry out unit roots for the variables of interest. We then proceed to perform cointegration analysis with a view to finding out if the data support the models.

Traditionally, Augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) tests are used to assess the order of integration of variables. In view of the fact that ADF and PP unit root tests take structural breaks in the series as evidence in favour of non-stationarity, the study uses the Perron-Vogelsang (1992) and Clemente-Montanes-Reyes (1998) tests are preferable. Both these tests offer two models: an additive outlier model (OA) and an innovative outlier model (IO). The OA model captures sudden change in the mean of a series while (IO) allows for a gradual shift in the mean of the series of the model. Since these tests can identify the date of the structural break, they can facilitate the analysis of whether a structural break on a certain variable is associated with a particular event in the economic calendar.

The ADF and Clemente-Montanes-Reyes (1998) test results are not presented due to space limitations (Note 2). The starting point is to use the ADF test for the variables in levels and then apply the Clemente-Montanes-Reyes test to take into account existence of structural breaks. Generally, all variables have unit roots since the null hypothesis of non-stationarity is not rejected. However, the Clemente-Montanes-Reyes (1998) tests for the broad money (M3) suggest that it is an I(2) process. We, however, took a conservative view and used the ADF result which suggest that it is I(1) process. We then proceed under the assumption that no variable contains more than one unit root and that the first difference of each series is stationary.

Several issues emerge from the unit root tests. First, since overall CPI is I(1), inflation, which is I(0), cannot be included in the long-run demand for money. Second, since no variable is I(2), there is no possibility of existence of polynomially cointegrated relationships. The analysis therefore does not use I(2) analysis framework. Finally, existence of double structural breaks in most variables implies a need to incorporate structural breaks in the VAR analysis.

For each monetary aggregate the first step in the estimation process entailed specification and estimation of a reduced-form VAR model. The second step is the conduct of diagnostic tests on the reduced form VAR in terms of appropriate lag length (Schwarz criterion, Hannan-Quinn criterion and LM-test for autocorrelation at that particular lag), multivariate normality, autocorrelation, autoregressive conditional heteroscedasticity (ARCH) effects and modulus of largest root of the companion matrix. The VAR diagnostic test results are not reported due to space limitations (Note 3). Generally, the models for the different demand for money pass the diagnostic tests, with the exception of the ARCH effects for the money (M2).

Having performed diagnostic statistics for each of the reduced form VAR, the final specification of the VAR is settled upon. For money M0, time trend plus dummy variables for year 2003 change of government and 2008 post-election violence are added to the variables in equation 4. For money M1, time trend plus dummy variables for year 2000 drought, 2003 change of government, 2008 post-election violence and 2010 economic recovery are added to the variables in equation 4. For money M2, the specification is the same as M1 except that the ATM and nominal interbank rate are excluded from equation. For money M3, the additional variables are as in M0, with the exception that ATM is excluded. In effect the ATM is excluded in M2 and M3 while nominal interbank rate is included in M3 only.

The next step is to determine the cointegration rank using Johansen's maximum likelihood procedure. As pointed out by Juselius (2006), the determination of the cointegration rank is a crucial step in the empirical analysis and yet quite difficult since the distinction between stationary and non-stationary directions of the vector process is not straight forward.

Table 1 presents the results for the trace test of the cointegrating rank. The test is a sequential in nature beginning from the null hypothesis that there is no cointegration (i.e. $r = 0$). If the null of no cointegration is rejected, we continue until first failure to reject the null.

Table 1. Cointegration test results for the demand for money

Null	Small sample(Bartlett-corrected) trace test(λ^*_{trace})			
	M0	**M1**	**M2**	**M3**
$r = 0$	143.665 (0.005)***	136.448 (0.019)**	110.382(0.045)**	168.102(0.024)**
$r = 1$	88.936 (0.192)	84.831 (0.304)	64.050(0.469)	123.338(0.112)
$r = 2$	57.678 (0.393)	54.586 (0.532)	27.960(0.949)	85.278(0.283)
$r = 3$	27.491 (0.847)	25.610 (0.903)	7.299(0.999)	55.012(0.509)
$r = 4$	10.293 (0.961)	11.492 (0.926)	4.498(0.910)	32.053(0.651)
$r = 5$	2.682 (0.945)	NA	NA	13.911(0.832)
$r = 6$	NA	NA	NA	5.036(0.751)

Notes: p-values in brackets. * and ** show rejection of null at 10% and 5% level of significance,

Respectively. NA means the order of the VAR could not allow the trace test to be computed.

On the basis of this criterion, we conclude that there is one cointegrating vector for M0, M1 and M2. However, for M3, the null hypothesis of two cointegrating vectors is barely accepted at 10%. We therefore conclude that there are two cointegrating vectors.

The estimated unrestricted cointegrating vectors may or may not make economic sense. They are uniquely defined based on the ordering of the λ_i and the choice of the eigenvector normalisation. For each of the four VAR models systems, we need at least r^2 long-run restrictions to ensure exact identification. This was easy for M0, M1, and M2 since the trace test returned a verdict of one cointegrating vector (i.e. $r = 1$), which implied that exact identification could be achieved by one restriction i.e. the eigenvector normalisation. For M3 with two cointegrating vectors, four ($2^2 = 4$) restrictions must be imposed for exact identification. We chose to identify demand for money (M3) and uncovered interest parity (UIP) equations.

Table 2 presents the final long-run parameters. Prior to the imposition of the unit price elasticity (long-run price homogeneity), the coefficient for price differed substantially for the different monetary aggregates. Specifically, the coefficients were 0.568, 0.722, 0.843, 1 360 for M0, M1, M2 and M3 respectively. The difference from unit price elasticity may be attributed to two factors. First, as the economy grows, the basket of goods and services in the CPI may become less relevant for firms and households that are increasing their broad money holding. Indeed, the new CPI basket, based on the Kenya Integrated Household Survey done in 2005/2006, has 234 compared to 216 items in the old CPI basket based on 1997 Household Survey. Second, technological progress may have changed the relationship between nominal broad money supply and price. Long-run price homogeneity is imposed in line with earlier demand for money studies in Kenya such as Killick and Mwega (1990), Adams (1992), Ndungú (1994), and Kisinguh *et.al.* (2004).

Table 2. Long-run coefficients ($\hat{\beta}$)

	m_t^0	m_t^1	m_t^2	m_t^3	**UIP**
p_t	1.000	1.000	1.000	1.000	0.000
y_t	1.381	1.822	1.977	1.459	0.000
	(7.648)	(18.582)	(11.609)	(13.794)	
i_t^{tb}	-5.896	-3.291	-5.420	-2.737	-0.676
	(-8.902)	(-9.189)	(-7.809)	(-4.309)	(-3.207)
i_t^d	8.710	4.474	8.693	7.085	0.000
	(8.564)	(8.165)	(8.110)	(11.224)	
i_t^{ib}	0.000	0.000	0.000	-2.024	0.000
				(-3.962)	
i_t^{*k}	0.000	0.000	-0.847	0.000	1.000
			(-2.663)		
atm	0.000	0.000	0.000	0.000	0.000
t	0.000	0.000	0.000	0.000	0.000

The income elasticity of demand is greater than unity and varies substantially. The finding of greater than unity income elasticity suggests that over the sample period changes in real income have induced, on average, more than proportionate increase in the demand for real money balances. A test imposing unitary income elasticity is rejected for most monetary aggregates with the exception of M0. This finding is in line with earlier works of Ndele (1991), who found income elasticity for M3 of 1.92 and Ndung'u (1994) who found an elasticity of 1.7. The greater than unitary income elasticity may be attributed to economic development and monetization in the Kenyan economy. It also means that money is considered a luxury or it indicates neglected wealth effects. The results are, however, contrary to the works of Killick and Mwega (1990) who found income elasticity of 0.56 for money M3 and Kisinguh *et al.*(2004) who found income elasticity for money supply with foreign currency deposits (M3) of 0.977.

The coefficient for the nominal 91-Day Treasury bill rate is negative as expected for all the monetary aggregates. This is in line with theory since the higher the return on the alternative asset (The 91-Day Treasury bills), the lower the incentive to hold money (Ceteris Paribus). Most studies on demand for broad money in Kenya have found significant negative effects for Treasury bill rates for M3. Ndung'u (1994) found an interest elasticity of -1.97, Killick and Mwega (1990) found -0.250 and Kisinguh et al. (2004) found an elasticity of -0.01.

The nominal deposit rate (own-return on money) has a positive effect on the demand for all the real money balances. This is in line with economic theory since the higher the own-return on money, the less the incentive to hold assets alternative to money.

The nominal interbank rate has a negative effect on the demand for real broad money (M3) balances. This is in line with economic theory since the higher the interbank rate, the less the incentive to hold money.

Foreign interest rate adjusted with nominal exchange rate depreciation (i_t^{*k}) has a negative effect for the demand for real money (M2) and M3). This can be explained by the fact that an increase in foreign interest rate as it potentially induces domestic residents to increase their holdings of foreign assets which are financed by drawing down domestic money holding. Similarly, the expected depreciation implies that the expected returns from holding foreign money increases and hence agents would substitute the domestic currency for foreign currency. The results are fairly close to those found in Killick and Mwega (1990) and Kisinguh et al. (2004). Finally, financial innovations as proxied by the number of ATMs do not seem to have affected the demand for real money balances with the exception of M1. Table 3 presents the corresponding loading matrices.

Table 3. Loading matrices ($\hat{\alpha}$)

Variables	m_t^0	m_t^1	m_t^2	m_t^3	UIP
Δm_t^i	-0.173***	-0.294***	-0.096***	-0.103***	-0.052
	(-5.316)	(-3.508)	(-3.832)	(-3.502)	(-1.835)
Δp_t	0.087***	0.262***	0.047	0.135***	0.054
	(2.755)	(5.081)	(1.230)	(2.557)	(1.057)
Δy_t	-0.058	-0.023	0.014	-0.007	0.050
	(-1.947)	(-0.385)	(0.394)	(-0.130)	(1.010)
Δi_t^{tb}	-0.068***	-0.037	-0.136***	-0.102***	0.113***
	(-2.151)	(-0.637)	(-4.932)	(-2.189)	(2.509)
Δi_t^{ib}	0.000	0.000	0.000	-0.144***	0.074
				(-3.101)	(1.648)
Δi_t^d	0.015	0.035***	-0.012	0.015	0.017
	(1.691)	(2.119)	(-1.260)	(1.229)	(1.493)
Δi_t^{*k}	0.000	0.000	0.000	-0.099	-0.899***
				(-0.694)	(-6.521)
Δatm_t	-0.019	-0.041	0.000	0.000	0.000
	(-0.236)	(-0.272)			
Restrictions: $\chi^2(v)$	3.979	5.44	0.869	9.240	9.240
	(0.264)	(0.142)	(0.648)	(0.236)	(0.236)

The long-run restrictions are not rejected in the Kenyan data as shown by the Chi-square test in table 3. Several issues can be noted from Table 3, which are useful for monetary policy making. First, the speed of adjustments in the second row shows a slow adjustment process, which reflects structural rigidities in the Kenyan financial market. Second, the fact that the speed of adjustment relating to inflation (Δp_t in the third row) is positive implies that when supply for real money balances deviate from the long-run demand for real money, it leads to inflationary pressures in the case of M0, M1 and M3. Finally, the loading matrices provide information regarding variables which are weakly exogenous in a particular money demand equation. Those variables whose adjustment coefficients are statistically significant (indicated by ***) are endogenous. For instance, for the money demand (M0), there is a two-way Granger causality between M0 and price and nominal Treasury bill rate. Contrariwise, those variables whose adjustment coefficients are statistically insignificant are weakly exogenous (one-way Granger causality).

6. Stability of Demand for Money Tests

As pointed out by Judd and Scadding (1982) stability of the demand for money refers to a set of necessary conditions for money to exert a predictable influence on the economy so that the central bank can control reserve (base) money as an instrument of monetary policy. Judd and Scadding add that there are three key elements of the stability of the demand for money. First, the demand for money function should be predictable in a statistical sense. In other words the demand for money function must forecast accurately out of sample. Second, the demand for money should have relatively few determinants. They argue that a demand for money relationship that requires knowledge about a large number of variables in order to pin it down is not predictable. Finally, the variables in the demand function should represent significant links to spending and economic activity in the real sector. Juselius (2006) argues that stability of a function relates to a constant parameter regime.

In this section, a battery of tests suggested by Hansen and Johansen (2002) for testing stability for a cointegrated VAR model is utilized. There are two versions of the tests: forward recursive tests and backward recursive tests. The idea behind the forward recursive tests is to choose a baseline sample from the first part of the sample, estimate a first model, and then recursively test whether the more recent observations have followed the same model. The backward recursive tests provide information about the possibility of non-constant parameters in the beginning of the sample. The recursion is performed by adding more and more distant observations.

The results are presented for two versions of the model: the full model version (X-form) and the concentrated model version (R-form). The X-form is a function of the short-run dynamics and deterministic components and hence the degrees of freedom are fewer leading to increased volatility in the graphs. The R-from is corrected for these effects and generally looks stable than the X-form over time. The study reports mainly the R-form due to space limitations.

The results are summarised in table 4 and cover recursive estimates of $\hat{\beta}$ coefficients for the demand for money and UIP equation, recursive tests of the full model, recursive tests based on eigenvalues, recursive tests based on the constancy of the cointegrating space and recursive tests of predictive failure both for the full system and for individual series. First, the recursive graphs of $\hat{\beta}$ coefficients are generally unstable even after correcting for short-run dynamics. Second, the recursive tests of the full model, which check whether the model is approximately acceptable or not, rejects constancy of the demand for M0, M1, M2 and M3. Third, the recursive tests based on the eigenvalues, λ_i ,as well as transformation of them, rejects stability of the demand for M2 and M3. However, the demand for money (M0 and M1) is found to be stable. Fourth, the max test of constant β , suggested by Nyblom (1989) and referred to as the Nyblom Q test, focuses on testing whether β has changed with time or not. This test shows that the demand for money M0, M1,M2 and M3 are stable. Fifth, the test of β being equal to "known" β fails shows that the demand for money M0 and M1 are stable while the demand for M2 and M3 are unstable. Finally, the recursively calculated prediction tests show predictive failure in all the four monetary aggregates.

Table 4. Summary of Stability of demand for money for the R-form (concentrated version)

Test	**M0**	**M1**	**M2**	**M3**
A. Visual inspection of recursive $\hat{\beta}$				
Recursive $\hat{\beta}$	Unstable	Unstable	Unstable	Unstable
B. Recursive tests of the full model				
Test of constancy of log-likelihood	Unstable	Unstable	Unstable	Unstable
C. Recursive tests based on the eigenvalues, λ_i *as well as transformation of them*				
Eigenvalue fluctuation test	Stable	Stable	Unstable	Unstable
D. Recursive tests of the constancy of the cointegrating space, $\beta' x$				
1.Nyblom Q Test of β constancy	Stable	Stable	Stable	Stable
2. Test of β equal to "known" β	Stable	Stable	Unstable	Unstable
E. Recursively calculated prediction tests				
1-Step prediction test	Unstable	Unstable	Unstable	Unstable

Notes: A verdict of instability is returned once stability is rejected by at least one criterion

In summary the stability tests show that the demand for different monetary aggregates is unstable over the period 1997:4 to 2011:2. This is consistent with the work of Killick and Mwega (1990) and Kisinguh *et.al.* (2004). The instability of the demand for money may be attributed to a number of factors. First, there is substantial financial innovations within the financial markets that have introduced a number of quasi-money products. Second, the removal of the capital and financial regulations in the 1990s removed a key factor that contributed to the stability of the money multiplier and the money demand in the 1980s.

Finding unstable demand for money means that the current monetary policy framework, guided by the assumption of a stable demand for broad money (M3), is inconsistent with monetary theory. It means that the

central bank does not have control of the money supply process. This makes it difficult to steer the reserve money (operating target) with a view to creating monetary conditions that are consistent with the ultimate objectives of price stability.

Several alternatives of monetary policy frameworks exist: Net domestic Assets (NDA) targeting, interest rate targeting and inflation targeting. The NDA targeting suffers the same problems as the monetary aggregate targeting since it assumes a stable demand for money and velocity. The interest rate targeting and inflation targeting assume that the money markets are efficient and fully developed so that monetary policy impulses are transmitted through the interest rate. Additionally, they assume that clear patterns between changes in the short-term interest rates and inflation have been observed.

7. Concluding Remarks and Policy Recommendations

The study set out to analyse the demand for different monetary aggregates (M0, M1, M2 and M3) in Kenya using quarterly data for the period 1997:4-2011:2. The resulting models are parsimonious but empirically unstable.

Our key finding is that demand for the different monetary aggregates are affected to varying degrees by changes in real GDP, nominal Treasury bill rate, nominal exchange rates and nominal foreign interest rate.

We find that the demand for the different monetary aggregates is unstable implying that the the current monetary policy framework based on stable and predictable demand for money is inappropriate. However, there are challenges in moving to alternative monetary policy frameworks. The NDA targeting is dependent on stable demand for money while the interest rate and inflation targeting frameworks assume fully developed and efficient money and capital markets. Additionally, the interest rate and inflation targeting require that a clear relationship between changes in short-term interest rates and inflation should have been observed.

References

Adams, C. (1992). On the Dynamic Specification of the Money Demand in Kenya. *Journal of African Economies*, *1*, 233-270.

AL-Abdulrazag Bashier, & Abdullah Dahlan. (2011). The Money Demand Function for Jordan: An Empirical Investigation. *International Journal of Business and Social Science, 2*, 77.

Bahmani-Oskooee, M. (2001). How stable is M2 money demand function in Japan? *Japan and the World Economy, 13*(4), 455-461. Elsevier. http://dx.doi.org/10.1016/S0922-1425(01)00064-0

Baumol, W. J. (1952). The Transactions Demand for Cash: An Inventory Theoretic Approach. *Quarterly Journal of Economics*, *66*, 545-556. http://dx.doi.org/10.2307/1882104

Boorman, J. T. (1976). The Evidence on the Demand for Money: Theoretical and Empirical Results. *Current Issues in Monetary Theory and Policy*. (ed), By Thomas M. Havrilesky and Johan T.Boorman. Arlington Heights, Illinois: AHM Public Corporation, 315-360.

Carlson, J. B., Hoffman, D. L., Keen, B. D., & Rasche, R. H. (2000), Results of a study of the stability of cointegrating relations comprised of broad monetary aggregates. *Journal of Monetary Economics*, *46*, 345-383. http://dx.doi.org/10.1016/S0304-3932(00)00029-5

Clemente, J., Montañés, A., & Reyes, M. (1998), Testing for a Unit Root in Variables With a Double Change in Mean. *Economic Letters*, *59*(2), 175-182. http://dx.doi.org/10.1016/S0165-1765(98)00052-4

Darrat, A. F. (1985). Demand for Money in a Developing Country: The Case of Kenya. *World Development*, *13*, 1163-1170. http://dx.doi.org/10.1016/0305-750X(85)90034-8

Ericsson, N. R. (1998). Empirical Modelling of Money Demand. *Empirical Economics*, *23*(3), 295-315.

Ericsson, N. R., & Sharma, S. (1996). Broad Money Demand and Financial Liberalisation in Greece, IMF Working Paper No.WP/96/62. Washington: International Monetary Fund. http://dx.doi.org/10.1007/BF01294409

For The Euro Area: Some Empirical Evidence. *Bulletin of Economic Research*. http://dx.doi.org/10.1111/j.1467-8586.2010.00388.x

Friedman, B. M. (1956). The Quantity Theory of Money-A Restatement, *Studies in the Quantity Theory of Money*. (ed.) by Milton Friedman. Chicago: University of Chicago Press.

Friedman, M. (1956). The Quantity Theory of Money: A Restatement. *Studies in the Quantity Theory of Money*. (ed.) by Milton Friedman, Chicago: University of Chicago Press, 3-21.

Hansen, H., & Johansen, S. (2002). Some tests of Parameter Constancy in Cointegrated VAR Model, *The Econometrics Journal*, *2*(2), 306-333. http://dx.doi.org/ 10.1111/1368-423X.00035

Hendry, D. F., & N. E. Ericsson. (1991). Modeling the demand for narrow money I the United Kingdom and United States. *European Economic Review, 35,* 833-81. http://dx.doi.org/10.1016/0014-2921(91)90039-L

Hoffman, D. L., H. Raasche, & M. A. Tieslau. (1995). The stability of long run money demand in five industrial countries. *Journal of Monetary Economics, 35*, 319-39. http://dx.doi.org/10.1016/0304-3932(95)01189-U

James Tobin. (1958). Liquidity Preference as Behaviour Towards Risk. *The Review of Economics Studies*, *25*(67), 65-86.

Johansen, S. (1996). *Likelihood-Based Inference in Cointegrated Vector Autoregression Models*, Oxford University Press.

Judd, J. P., & Scadding, J. L. (1982). The Search for a Stable Money Demand Function: A Survey of the Post-1973 Literature. *Journal of Economic Literature*, *20*(3), 993-1023.

Juselius, K. (2006). *The Cointegrated VAR* Model. Oxford University Press: Oxford.

Kanga, M. J. P. (1985). Reserve Ratios as Monetary Policy Instruments in Kenya, University of Nairobi, unpublished M.A Research Paper.

Keynes, J. M. (1936). *The General Theory of Employment, Interest and Money*, 7. JMK. London: Macmillan.

Killick, T., & Mwega, F. M. (1990). Monetary Policy in Kenya, 1967-1988. Working Paper no.39, Overseas Development Institute, London.

Kisingu, K., N. B. A. Korir, & Maana, I. (2004). A Demand for Money Function for Kenya, Working Paper Series No.1 of 2004, Central Bank of Kenya.

Nachega, J. (2001). A Cointegration Analysis of Broad Money Demand in Cameroon, IMF Working Paper Series, WP/01/26.

Ndele, S. M. (1991). The Effects of Non-Bank Financial Intermediaries on the Demand for Money in Kenya, African Economic Research Consortium Research Paper No.5.

Ndungú, N. S. (1994). Monetary Model of Inflation: Kenyan Case. *African Development Review*, *6*(2), 109-136. http://dx.doi.org/10.1111/j.1467-8268.1994.tb00062.x

Nyblom, J. (1989). Testing for Constancy of Parameters Over Time, *Journal of the American Statistical Association*, *55*, 324-330.

Pathak, D. S. (1981). Demand for Money in Developing Kenya: An Econometric Study 1968-78, *Indian Economic Journal*, *29*, 10-16.

Perron, P., & Vogelsang, T. J. (1992). Nonstationarity and level shifts with an application to purchasing power parity. *Journal of Business and Economic Statistics*, *10*(3), 301-320. http://dx.doi.org/10.2307/1391544

Sanvi Avouyi-Dovi, Françoise Drumetz, & Jean-Guillaume Sahuc. (2011). The Money Demand Function

Sriram, S. S. (2001). Survey of recent empirical money demand studies. IMF Staff Papers Vol. 47, No. 3

Tobin, J. (1956). The Interest Elasticity of the Transactions Demand for Cash. *Review of Economics and Statistics*, *38*, 241-247. http://dx.doi.org/10.2307/1925776

Notes

Note 1. m_t^i is the log of nominal money (M0,M1,M2 and M3), p_t is the log of overall CPI, y_t is the log of real GDP, i_t^{tb} is the nominal 91-Day Treasury bill rate, i_t^d is the nominal deposit rate, i_t^{ib} is the nominal interbank rate, i_t^{*k} is the nominal three months US Treasury bill rate adjusted for expected nominal exchange rate appreciation/depreciation and atm is the log of the number of ATMs.

Note 2. The unit root test results are available from the authors upon request.

Note 3. The VAR diagnostic test results are available from the authors upon request.

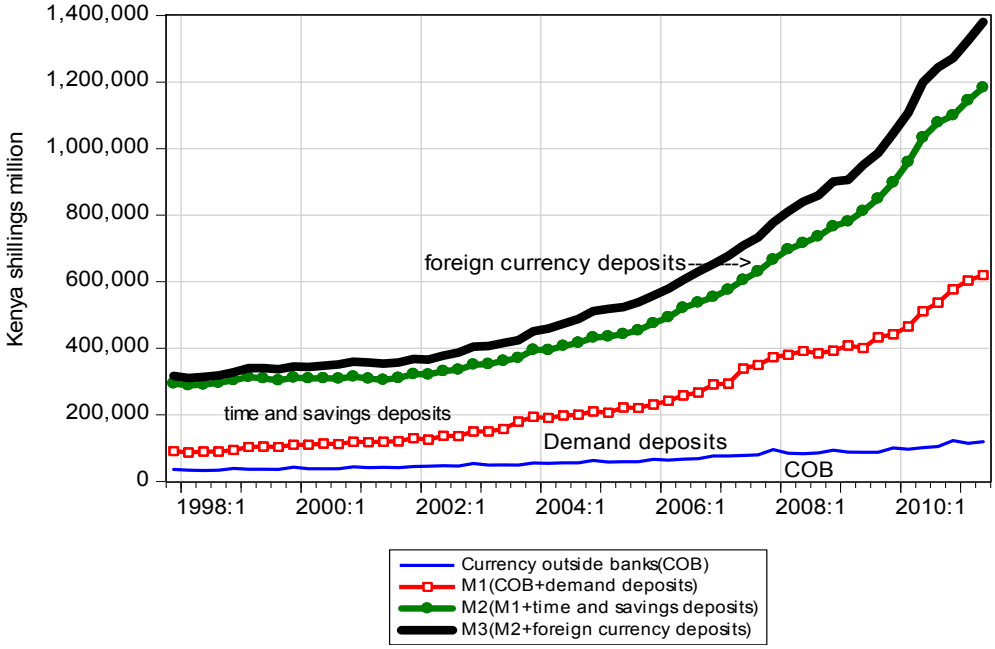

Figure 1. Components of the Broad Money – 1997:4 to 2011:2

Appendix: Data Description

Nominal money M0, M1, M2 and M3 (M_t): This is collected from CBK.

Quarterly real GDP data (Y_t): In view of the fact that real quarterly GDP data reported from the Kenyan National Bureau of Statistics (KNBS) start from 2000 (with October 2001 as base year), temporal disaggregation of data is done using the seasonalities in the post 2000 period.

Price level data (P_t): Use KNBS CPI based on new methodology and basket. This is then rebased to 2001 to agree with the real GDP base.

Nominal Treasury bill rate (i_t^{tb}): Nominal 91-Day Treasury bill rate from the CBK. This is divided by 100.

Nominal interbank rate (i_t^{ib}): Nominal interbank rate from the CBK. This is divided by 100.

Nominal deposit rate(i_t^d): Nominal Average deposit rate from CBK. This is divided 100.

Three months US Treasury bill rate: Collected from the US Federal system. This is adjusted using expected depreciation. $i_t^{*k} = i_t^* + \Delta e_t^e$.

ATMs: This refers to the number of ATMS in Kenya. This is collected from the CBK.