A MONETARY POLICY REACTION FUNCTION FOR KENYA

Henry Rotich, Musa Kathanje and Isaya Maana

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Henry Rotich
Ministry of Finance

Musa Kathanje
Central Bank of Kenya

Isaya Maana
Central Bank of Kenya

Abstract

The paper reviews the recent conduct of monetary policy and the Central Bank rule-based behaviour in Kenya. Using both backward and forward-looking policy rules with appropriate modification to take into account the characteristics in developing countries, we test whether the Central Bank of Kenya (CBK) reacts to changes in inflation, GDP growth and the exchange rate in a consistent and predictable fashion. Our results indicate that during the period after liberalization (1997-2006), CBK has used monetary aggregates as a main policy instrument in conducting monetary policy. The estimate of the coefficient on the inflation gap implies that a rise in expected annual inflation of one percent induces the CBK to lower the expansion of broad money (M3) by 4.2 percent. Similarly, the coefficient of inflation with respect to repo rate is 2.4 which is consistent with Taylor's non-accommodative policy. The results indicate that CBK followed a rule to target inflation with some allowance for output stabilization. We also find a statistically significant reaction to exchange rate, perhaps explaining the relative stability of exchange rate during the greater part of the sample period.

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Authors' E-Mail Addresses: hrotich@treasury.go.ke kathanjem@centralbank.go.ke maanai@centralbank.go.ke

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1. Introduction

Over a decade or so, researchers have investigated the interest rate setting behaviour of the central banks in developed countries using the simple Taylor rule first proposed in 1993. Their results indicate that central banks react mostly in a way to stabilize deviations either from a target level inflation or GDP growth, as predicted by the Taylor rule. More recently, similar works have been undertaken in emerging economies following appropriate modifications of the standard Taylor specification to take into account the realities of underdeveloped financial markets and vulnerability to external shocks typical in these countries. While the results seem inconsistent, there is, nevertheless, evidence that the central banks in these economies also follow some rule-like policy.

Despite the encouraging results in emerging economies, it is surprising that there has been very limited work done to extend similar work to less developed financial settings such as those in Africa, even with some evidence that the central banks in this region are also guided by some rule based behaviour when setting monetary policy. The need to extend the estimation of policy rule work to less developed countries in Africa has even become particularly important as these countries consider adopting inflation targeting frameworks in conducting monetary policy. This paper ventures into this path breaking exercise by examining the conduct of monetary policy in Kenya since liberalisation in mid-1990s using approaches to estimate reaction functions for emerging economies.

The deregulation of economic activities in early 1990s marked a major milestone in the conduct of monetary policy in Kenya in terms of objectives, instruments and institutional framework. The Central Bank of Kenya (CBK) Act was amended in 1996 to allow CBK greater operational autonomy in the conduct of monetary policy. The same Act stipulated the principal objective of the CBK as formulation and implementation of monetary policy directed to achieving and maintaining stability in the general level of prices. Against this background, we investigate the behaviour of the CBK over the past ten years or so using a policy rule with appropriate modification to take into account the characteristics of the economy. Specifically, we first test whether the CBK reacts to changes in inflation and GDP

growth in a consistent and predictable fashion, as predicted by the standard Taylor rule. To establish the sensitivity of the CBK in responding to external shocks, we incorporate the exchange rate into this baseline specification. As the CBK used a reserve money framework in conducting monetary policy, the policy variable is the monetary aggregate – borrowing from McCallum (1988).

The results indicate that CBK has been targeting monetary aggregate (broad money M3) in its policy decisions. At times of high inflation, or positive output, the CBK responded by reducing money supply. This lends credence to the effectiveness of the current framework in controlling inflation at least for the greater period in the sample. The implicit Taylor type specification, where the interest rate is the policy variable supports the McCallum monetary base specification. In particular, the coefficient of inflation with respect to repo rate is 2.4, which is consistent with the Taylor's non accommodative policy. We also find a statistically significant reaction to exchange rate in the interest rate rule, although with a low coefficient of 0.04. This perhaps explains the relative stability of the exchange rate during the greater period in the sample.

The rest of the paper is organized as follows. The next section, i.e. section 2, characterises the salient aspects of monetary policy in Kenya since liberalization. Section 3 reviews the literature on monetary policy rules, followed by the methodology for estimating a monetary policy reaction function for Kenya in section 4. Section 5 provides the empirical results, while section 6 gives the conclusion.

2. The Conduct of Monetary Policy in Kenya since Liberalization

a. Institutional and Operational Aspects

Following economy-wide economic reforms aimed at allowing market forces more latitude in decision-making in early 1990s, the conduct of monetary policy at the CBK was substantially modified to reflect the objectives of a modern central bank. While the CBK's monetary policy strategy continued to be that of targeting monetary aggregates, there was a shift away from direct to indirect instruments of monetary control with clearly defined objectives and greater operational autonomy.

A new institutional framework for conducting monetary policy was formalized with the amendment of the CBK Act in 1996. The principal objective of the CBK was stipulated as formulation and implementation of monetary policy directed to achieving and maintaining stability in the general level of prices. In addition, the Act provides for greater autonomy of the CBK in the conduct of monetary policy. Specifically, the Governor, the Deputy Governor and five other members of the Board of Directors are to be appointed by the President for a four-year term (renewable once). The Governor can be removed in the course of his term under a tribunal constituted to investigate his conduct. The Permanent Secretary of the Ministry of Finance and the Head of the Civil Service and Secretary to the Cabinet of the Office of the President are ex-officio members of the CBK Board of Governors.

With respect to accountability and communication, the law stipulates that the CBK, at intervals of not more than six months, submit to the Minister for Finance a monetary policy statement. The Statement specifies the policies and the means by which the Bank intends to achieve the policy targets; state the reasons for adopting such policies and means; and reviews the progress of the implementation by the Bank of monetary policy during the period to which the preceding policy statement relates. The Minister shall lay every statement submitted by the CBK before the appropriate committee of the National Assembly not later than the end of the subsequent session of Parliament after the statement is submitted.

Initially, for a greater part of 1990s, the conduct of monetary policy focused on the behaviour of the broad monetary aggregate, M2,[1] defined as currency in circulation and term and non-term domestic currency deposits with banks as well as with non-bank financial institutions (NBFIs). The stability of the relation between M2 and nominal GDP came into question with increased openness of the economy. By 1998, the Bank had shifted to a much broader monetary aggregate, M3, defined as M2 plus foreign currency deposits (FCD) held by residents, as its intermediate target. The reserve money continued to be the operating target.

In terms of instruments of monetary policy, the CBK initially managed monetary conditions in Kenya to obtain suitable growth in the money supply by engaging in primary auctions of government paper. The volume of paper sold was in principle determined by both budgetary

[1] Effective January 2006, CBK renamed the definition of monetary aggregates to conform to harmonized definition within the East Africa Community. Consequently, M3 was renamed M2 and M3X was renamed M3.

financing needs and monetary policy considerations. In addition, the reserve requirement and foreign exchange operations were actively used to influence monetary conditions. Later in the second half of 1990s, further refinement was made in the monetary policy instruments with CBK engaging in open market operation (OMO) through repurchase agreements (REPO) and less reliance on reserve requirement. Reserve ratio requirement that was actively used before mid-1990s was gradually lowered to the current level of 6 percent from 20 percent in 1994.

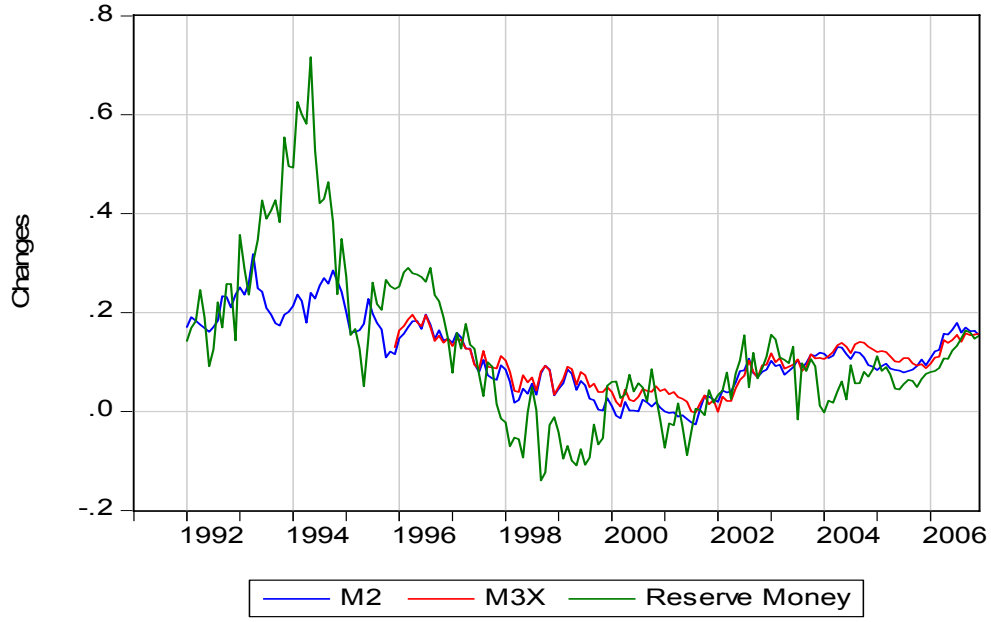
A further interesting aspect to highlight in relation to monetary policy making in Kenya in the post liberalization period is how the exchange rate has been organised. At the initial stages following liberalisation, there was virtually no intervention by CBK in the foreign exchange market. As result, Kenya was categorised among developed countries as a free floater.[2] The stated exchange rate policy of the CBK has been and continues to be to pursue a market-determined exchange rate, intervening only to smooth out erratic movement, service external obligations and achieve targeted level of foreign exchange reserves. Nonetheless, there have been instances where intense lobbying from non-traditional exporters for a depreciated exchange rate putting pressure on the CBK to influence the market exchange rate in the short run. There were also instances where depreciation pressures emanating from speculative tendencies occasioned by fragile donor relations and large food importation to mitigate adverse effects of drought could have led CBK to intervene in the foreign exchange market to reduce pressures on domestic inflation.

b. Conduct of Monetary Policy

Following changes in the institutional framework described above, there was a fundamental shift in the way the CBK conducted monetary policy beginning mid-1990s. The control of inflation became a major focus of monetary policy to reign in the consequences of relaxation of monetary policy that followed the run up to Kenya's first multiparty election in 1992 and increase in international oil prices occasioned by the first Gulf war. As indicated in figure 1, annual changes in monetary aggregates, since early 1990s, decelerated to fairly low levels and were sustained at the low levels through 2000 before picking up slightly in the run up to the 2002 elections.

[2] See the International Monetary Fund's categorization of exchange rate regime of members countries published in International Financial Statistics (IFS) before mid-1990s.

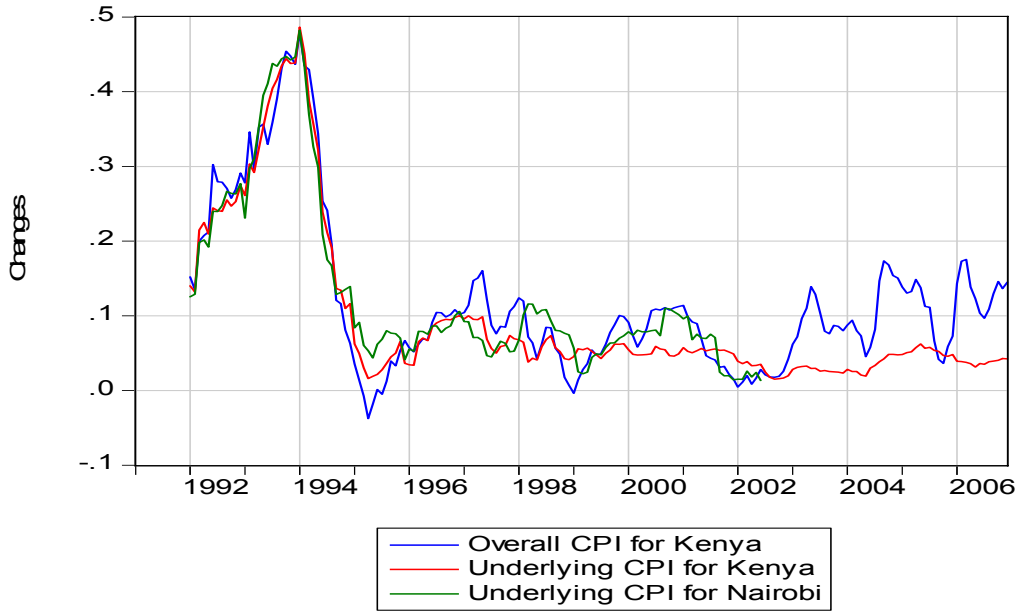
Figure 1: Annual Absolute Changes in Monetary Aggregates



Source: Central Bank of Kenya

Inflation also declined remarkably as CBK pursued a tight monetary policy (figure 2). The monetary control framework was implemented within the context of a floating exchange rate regime with a significantly liberalized capital account.

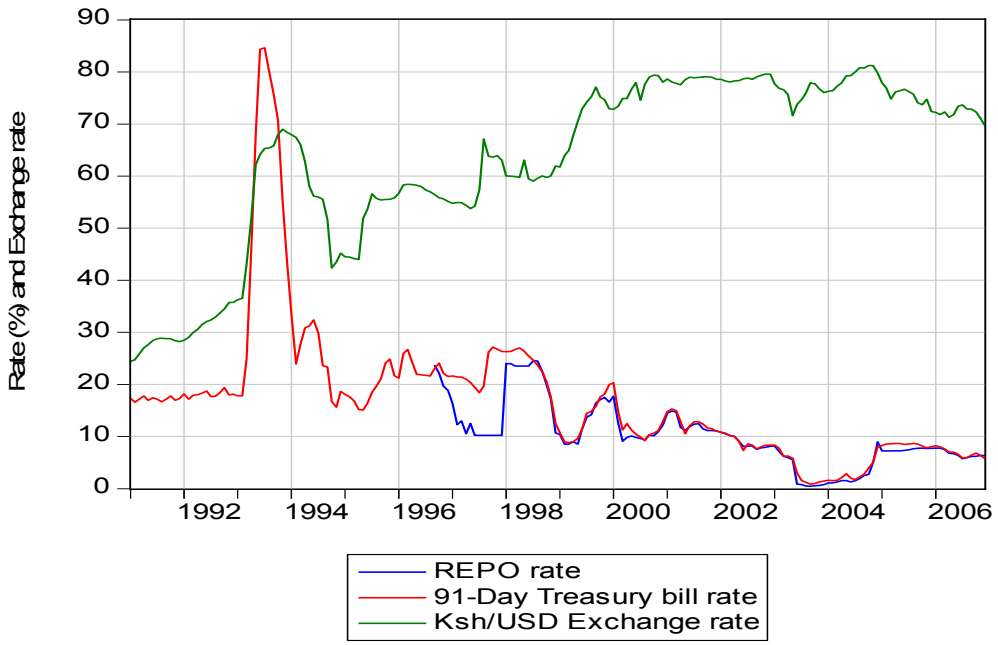
Figure 2: Overall and Underlying Inflation



Source: Central Bank of Kenya

Reflecting the tight monetary policy stance, short-term nominal and real interest rates moved up significantly causing an appreciation of the exchange rate, which later weakened to stabilise for a greater part since 1999 (Figure 3).

Figure 3: Interest Rates (%) and Exchange Rates



Source: Central Bank of Kenya

Generally, Figure 1 through 3 shows a strong co-movement of interest rates, monetary aggregates and inflation since liberalization in early 1990s. This indicates that CBK tightened money supply (implying tolerance of high interest rates) in period when inflation crept up. It therefore suggests that systematically adjusting money supply to offset inflationary pressures appears to have been a key feature since 1993. This study sought to investigate this observation empirically by estimating a policy reaction function for Kenya. The literature review on the reaction function follows in chapter 3.

3. Review of Literature

Literature on monetary policy rule focuses on two types of instrument rules - interest rate and monetary based – which, respectively, are known as Taylor rule (see Taylor, 1993) and McCallum rule (see McCallum, 1988). The distinction between the two rules is the choice of

an instrument in a central bank's reaction function in response to changes in macroeconomic conditions.

Most studies that have investigated interest rate setting behaviour of the central banks using Taylor rule have concentrated in developed countries. The specification of the model is represented by the following equation:

$$i = b_0 + b_1(\pi - \pi^*) + b_2(\gamma - \gamma^*), \quad (1)$$

where i is the instrument rate in period t, b_0 is a constant, π-π* is the "inflation gap", where π is the rate of inflation and $\pi^* \geq 0$ is a given inflation target, y- y* is the GDP gap, where y is log of output and y* is log of potential output, and the coefficients b_1 and b_2 are positive.[3]

The general finding using the simple Taylor rule (equation 1) indicates that the rule perform well in explaining central bank behaviour in developed countries, and estimation are robust in the sense that results do not substantially change across different model settings. Furthermore, there is widely accepted agreement among researchers that no central banks adopts a simple rule as a formal policy rule in conducting monetary policy, although different modifications of the Taylor rule have been used as a guidelines in decision making process.
On the other hand, researchers using McCallum rule have specified the instrument variable as the growth rate of monetary base expressed as follows:

$$\Delta b_t = \Delta x^* - \Delta v_t + 0.5(\Delta x^* - \Delta x_{t-1}), \quad (2)$$

where Δb_t is rate of growth of the monetary base, in percent per year, Δx* is the target rate of growth of nominal GDP, in percent per year, Δv_t rate of growth of base velocity, in percent per year, averaged over the previous four years, in the original McCallum estimation, and Δx is rate of growth of nominal GDP, in percent per year. In this rule, the target value of nominal GDP growth is calculated as the sum of the target inflation rate and the long-run average rate of growth of real GDP.

[3] More specifically, the condition that determines a unique non-explosive equilibrium, corresponding to the optimal commitment, is $b_1 > 1$ and $0 < b_2 < 1$ (see Woodford, 1999).

The application of both rules in developing countries raises the issue of what modification is required to take into account the realities in these economies, including the underdeveloped financial markets and vulnerability to external shocks, among others. In addressing this question, a number of researchers have argued that policymakers in developing countries are more concerned with exchange rate stabilization because of the problem of exchange rate pass-through to prices (see, among other, Taylor (2001) and Williamson (2000)). As such, this characteristic has been included in the central bank's reaction for developing economies.

Other researchers such as Ball (1999) have suggested that in an open economy the central bank could use a weighted average of the nominal interest rate and the exchange rate as an instrument. As to the choice of policy instrument in conducting monetary policy in emerging economies, Ball states that given the specific nature of markets in developing countries, the policy instrument could be not only short-term interest rate, but also the monetary base or some other monetary aggregate. Furthermore, he stresses the importance of exchange rates in monetary policy rule setting in developing countries and argues that the inclusion of the exchange rate in the central bank reaction function does not contradict the objectives of central banks, since in emerging economies sometimes exchange rate stabilization is a precondition for output stabilization and bringing down inflation to a targeted level.

Taylor (2001) further argues that even though the effect of monetary policy on real variables through the financial markets is limited, because of the less developed nature of these markets, still monetary policy could have significant impacts through changes in wages and property prices. Thus, a predictable behaviour of central banks in emerging economies considerably improves the transmission and effectiveness of monetary policy.

In line with this theoretical argument, over the past few years the monetary policy regime in emerging economies has shifted towards adopting a rule like policy. For instance, Mohanty and Klau (2003) indicate that, out of 13 leading emerging economies in their study, only two had not adopted inflation targeting (IT), a related type of rule-based policy. Since inflation targeting leads to a more systematic response by the central bank to inflation, the interest rate setting process in these economies has been guided by such a rule-like policy. The main conclusion of their study is that, in emerging economies, central banks, most of the time, change short-term interest rate in response to deviations in inflation and exchange rate movements. They also note that although price stabilization remains a main objective of

central banks in emerging countries, other objectives such as output stabilization, stability of the exchange rate and in few cases, stability of asset prices and current account deficit have been highlighted as central bank objectives.

Several studies have estimated a forward looking version of the Taylor rule. Clarida, Galí, and Gertler (1998a and 1998b) examine the post war United States economy for the period before and after Paul Volker's appointment as the chairman of the Federal Reserve Bank in 1979. The results showed significant differences in the estimated equations across the two periods with the interest rate policy in the pre Volcker-Greenspan period appeared to be more sensitive to changes in the expected inflation compared to the pre-Volcker period. The Federal Reserve's monetary policy reaction function was specified as:

$$r_t^* = r^* + \beta\left(E\{\pi_{t,k}/\Omega_t\} - \pi^*\right) + \gamma E\left(y_{t,q}/\Omega_t\right), \tag{3}$$

where r^* is the target rate for the federal funds rate at time t. The target rate at time t is modelled as a function of gaps between expected inflation and output and their respective targets. $\pi_{t,k}$ denotes inflation in $t+\kappa$. π^* is the inflation target. $y_{t,q}$ measures the GDP growth in $t+\kappa$. The GDP growth is defined as the percentage deviation between actual GDP and the corresponding target. E is the expectation operator while Ω_t is the available information at the time the interest rate is set by the Federal Reserve Bank. r^* denotes the desired nominal rate at the time both inflation and output are at their target levels.

In summary, while work on testing rule-based behaviour in monetary policy has concentrated in developed countries, there is evidence that this tradition is shifting with more applications in developing economies. This trend has been aided by emerging consensus on the extent of modifications made to the standard specification and instrument rate in order to deal with circumstances in the developing countries. Indeed, the observation by Taylor that even though the effect of monetary policy on real variables through the financial markets is limited, because of the less developed nature of these markets, still monetary policy could have significant impacts through changes in wages and property prices.

4. Methodology

As discussed in Section 2, the short-term interest rate has not been the most important instrument in conducting monetary policy in Kenya, due to several factors such as inefficient financial markets and uncompetitive banking sector. Instead, the CBK has been placing emphasis on quantitative based instrument to monetary control, exchange rate interventions and the changes in minimum reserve requirements in conducting monetary policy. A natural choice for the instrument variable for CBK would, therefore, be a monetary aggregate. Furthermore, as has been indicated by Taylor (2000), uncertainty in measuring real interest rates and large external and domestic shocks make monetary aggregates a preferred instrument. This is also consistent with McCallum's (1988) popular nominal feedback rule that considered the monetary base as the policy instrument.

Since liberalization of the financial sector in early 1990s, the monetary control framework used by the Central Bank of Kenya to pursue the inflation objective has been reserve money targeting, with broad money (M3) as the intermediate target, and open market operations as the main instruments. Despite the problems associated with the direct control of M3 and significant fluctuations in velocity, we use this aggregate as a policy instrument in conducting monetary policy in Kenya. As in developed countries where the short-run interest rate is the main instrument, we will also attempt an estimation of a modified version of the famous Taylor rule, assuming that CBK had an implicit target for interest rate when setting the target for M3.

In terms of targets of monetary policy, the standard variables—inflation and output gap—will be considered in a reaction function for Kenya. Further, it can be argued that since Kenya has had a flexible exchange rate with some sort of interventions to target a particular path, the exchange rate could be one of the important (implicit) CBK's targets. We estimate this by including the exchange rate in the baseline to yield an alternative specification.

Following a forward looking approach as was the case for Clarida, Gali, and Gertler (1998a and 1998b), the policy reaction function for Kenya would work as follows: assume that within each operating period the CBK has a target for broad money (or monetary base), which is based on the state of the economy. Let it also be assumed that the CBK cares about

stabilizing inflation and output, while allowing for the possibility that the CBK adjusts its policy response to anticipated inflation and output.

Specifically,

$$\Delta m_t^* = \Delta m^{LR} + \beta(E[\pi_{t+n}|\Omega_t] - \pi^*) + \gamma(E[y_{t+m}|\Omega_t] - y^*), \quad (4)$$

where Δm^{LR} is the long-run equilibrium change in the monetary base, π_{t+n} is the rate of inflation in period $t+n$, y_{t+m} is real output in period $t+m$, and π^* and y^* are the targets for inflation and output, respectively. In particular, y^* is defined as the equilibrium level of output that would arise if wages and prices were perfectly flexible. Additionally, E is the expectation operator and Ω_t is the information available to the policy maker.

To capture concerns about potentially disruptive shifts in the monetary base, it is assumed that the monetary base is adjusted only partially to its target level:

$$\Delta m_t = (1-\rho)\Delta m_t^* + \rho\Delta m_{t-1} + \upsilon_t, \quad (5)$$

where the parameter $\rho \in [0,1]$ captures the degree of exchange rate smoothing. The exogenous random shock to the exchange rate, υ_t, is assumed to be *i.i.d.*

To define an estimable equation, let $\alpha = \Delta m^{LR} - \beta\,\pi^*$ and $x_t = y_t - y^*$, then equation (4) can be written as:

$$\Delta m_t^* = \alpha + \beta E[\pi_{t+n}|\Omega_t] + \gamma E[x_{t+m}|\Omega_t]. \quad (6)$$

So, combining equation (6) with the partial adjustment mechanism (5) and eliminating the unobserved forecast variables yields:

$$\Delta m_t = (1-\rho)\alpha + (1-\rho)\beta\pi_{t+n} + (1-\rho)\gamma x_{t+m} + \rho\Delta m_{t-1} + \varepsilon_t, \quad (7)$$

where the error term ε_t is a linear combination of the forecast errors of inflation and output, and the exogenous disturbance υ_t. The reaction of the CBK to inflationary development is expected to be a negative relationship. The same is expected for the GDP growth measure, unless the CBK followed a *lean with the wind policy*. The GDP growth is intended to serve as a measure of whether the economy is above (below) its potential, and therefore of inflationary (deflationary) pressures.

Letting u_t be a vector of variables (set of instruments) within the policymaker's information set (i.e., $u_t \in \Omega_t$) that are orthogonal to ε_t. Possible elements of u_t include any lagged variables that help forecast inflation and output, as well as any contemporaneous variables that are uncorrelated with the current exchange rate shock υ_t. In particular, the choice of instruments includes 1 to 6, 9, and 12 lags of CPI inflation, GDP gap, and the monetary base.

Thus, since $E\left[\varepsilon_t \mid u_t\right] = 0$, the following equation is estimated for Kenya using the Generalized Method of Moments (GMM) with an optimal weighting matrix:[4]

$$E[\Delta m_t - (1-\rho)\alpha - (1-\rho)\beta\pi_{t+n} - (1-\rho)\gamma x_{t+m} - \rho\Delta m_{t-1} \mid u_t] = 0. \quad (8)$$

This J-statistic is used to carry out hypothesis tests from GMM estimation (Newey and West 1987a). The J-statistic can be used to test the validity of over-identifying restrictions when there are more instruments than parameters to estimate. Under the null hypothesis that the over-identifying restrictions are satisfied, the J-statistic times the number of regression observations is asymptotically distributed as χ^2 with degrees of freedom equal to the number of over-identifying restrictions.

5. Empirical Analysis

a. The Data

The data used to fit the model consists of annual changes in monetary aggregates (Reserve money and M3), core Consumer Price Indices (CPI), GDP growth, the Kenya Shilling to US dollar exchange rate, and the interest rates (repo, interbank and Treasury bill rate). With the exception of interest rates, all the other data variables are analysed in annual changes of their logarithms. There are, however, no monthly observations for output (GDP). The limitation of the lack of monthly observations on output is overcome by interpolating the annual series on the basis of seasonality indices derived from real cash outside banks (CoB) series. The correlation between CoB and actual GDP is over 99.7 percent but the correlation is about 99.5 percent with interpolated monthly data, indicating that the distributional properties of the interpolated data are not significantly different from that of the original data.

[4] The use of an optimal weighting matrix implies that GMM estimates are robust to heteroskedasticity and autocorrelation of unknown form. It is worth noting that the GMM technique requires no information about the exact distribution of the error term, which, in general, is assumed to be drawn from a normal distribution.

The GDP and CPI data were obtained from the annual Economic Surveys and monthly inflation reports, respectively, which are publications by the Kenya National Bureau of Statistics. Data on monetary aggregates, interest rates and exchange rates was obtained from the Central Bank of Kenya database.

The sample period for the study is from October 1997 to December 2006. The sample period was determined on the basis of availability of the new Consumer Price Index for Kenya and the new GDP series which are currently available from October 1997 and 1996 respectively. However, the Kenya National Bureau of Statistics unveiled quarterly GDP data in the 2007 annual economic survey and backdated the data to 2000. However, the GDP data series is very short (i.e. 24 observations). This number of observations is considered very few for purposes of estimation as this could result in inefficient coefficient estimates.

b. Estimation Results of Monetary Aggregate (M3) as an instrument

We first estimate our baseline specification for policy function given in equation 7. Since we are using monthly data (derived as annual changes), the sample period runs from 1998:10 to 2006:12. Table 1 shows the results for the baseline specification. The fitted model has a very high explanatory power (R^2= 92 percent). Furthermore, all the explanatory variables are significant at 10 percent significance level while the J-statistic indicates that the null hypothesis that the model is over-identified is rejected at 5 percent significance level. The instruments in the GMM estimation of the model included 1 to 6, 9, and 12 lags of CPI inflation, GDP growth, the monetary base, and exchange rate only in the equation including the exchange rate.

The key result is the estimate of the coefficient on the inflation gap, β=*-4.23* with a standard error of 1.08. The estimate for β is significant at 5 percent significance level implying that the prediction that CBK lowers the expansion of money supply in response to inflationary pressures is indeed statistically significant. The result also implies that a rise in expected annual inflation of 1 percent induces the CBK to lower the expansion of M3 by 4.23 percent.

Table 1: CBK Reaction Function – Monetary Aggregate (M3)

	α	β	γ	ρ	*Exchange rate*	*Sample*	*J-Statistic (p-value in bracket)*	R^2
Baseline	0.269 (5.158)	-4.231 (-3.928)	-0.185 (-0.606)	0.914 (44.448)		1999M10 - 2006M12	16.25 (0.70)	0.917
Baseline	0.301 (4.903)	-4.620 (-3.884)	-0.618 (-1.757)	0.908 (39.07)		1999M10 - 2005M12	13.72 (0.84)	0.898
Baseline	0.273 (5.156)	-4.168 (-3.528)	-0.226 (-0.848)	0.917 (45.38)		2001M1 – 2006M12	13.84 (0.84)	0.914
Replacing:								
inflation with the first lag	0.328 (6.112)	-5.321 (-4.855)	0.001 (0.003)	0.903 (48.08)		1999M10 – 2006M12	15.82 (0.73)	0.914
inflation with the third lag	0.277 (7.681)	-4.648 (-5.730)	0.273 (1.153)	0.886 (44.825)		1999M10 – 2006M12	14.35 (0.81)	0.917
inflation with the sixth lag	0.209 (6.647)	-3.759 (-4.710)	0.496 (2.014)	0.890 (31.296)		1999M10 – 2006M12	15.61 (0.74)	0.906
inflation with the first lead	0.269 (5.097)	-4.612 (-4.052)	0.121 (0.471)	0.908 (42.035)		1999M10 – 2006M12	14.93 (0.78)	0.914
inflation with the third lead	0.346 (3.289)	-6.485 (-2.768)	0.166 (0.471)	0.934 (43.275)		1999M10 – 2006M12	14.21 (0.82)	0.908
Baseline with Exchange rate	0.160 (8.314)	-1.751 (-4.791)	0.240 (1.883)	0.822 (36.314)	-0.072 (-6.134)	1999M10 - 2006M12	16.74 (0.61)	0.913

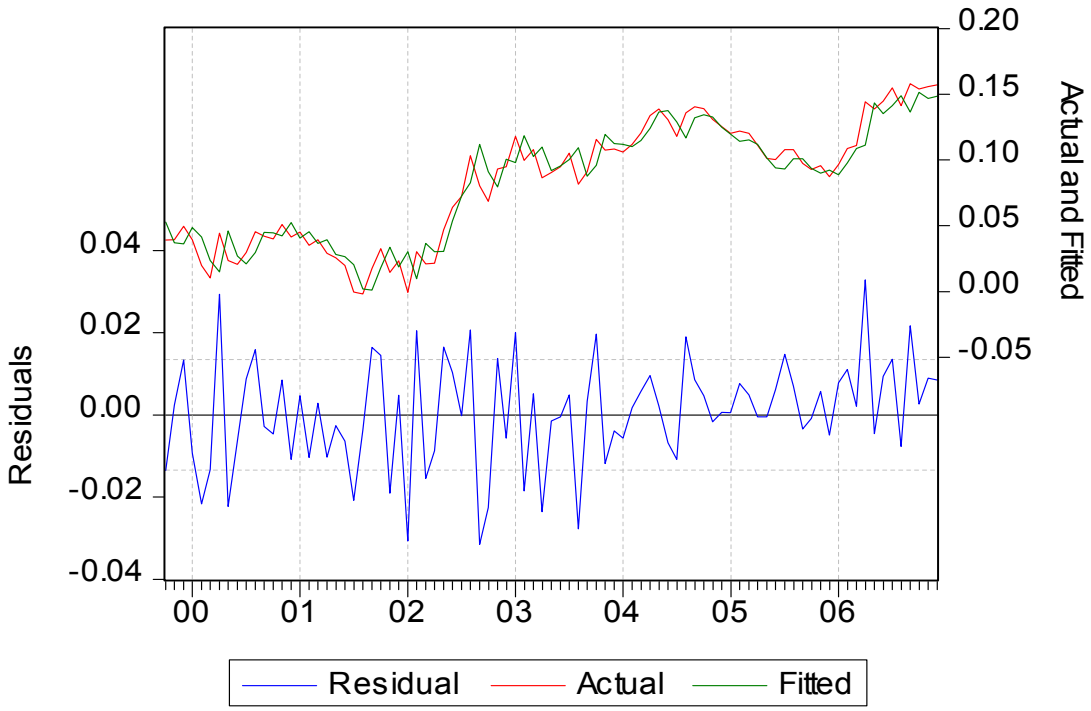
Note: t-statistics for coefficient estimates are in brackets.

Another interesting result is that the estimate of the coefficient of the GDP growth is negative although not statistically significant at 5 percent level i.e. –0.19 with a standard error of 0.61. The coefficient is, however, statistically significant at 10 percent significance level for the sample 1999:10 to 2005:12. The results imply that if the expected inflation is held constant, a 1 percent rise in GDP growth induces the CBK to lower the expansion of M3 by 0.19 percent. The implication, of course, is that the CBK responds to real economy independently of its concern about inflation.

Lastly, the coefficient that captures policy inertia is fairly high i.e. $\rho = 0.91$ with a standard error of 0.02, an indication that monetary policy adjusts the monetary aggregate M3 smoothly. Figure 4 shows a comparison of actual growth values of M3 with those implied by the baseline monetary policy reaction function. The figure shows that monetary policy was generally consistent with the monetary policy rule. This is seen from the residuals which fall within the 95% confidence intervals. However, the chart shows that monetary policy was tighter in 2001 and 2002 than the policy rule suggested.

As a test for robustness, the baseline model was re-estimated for the samples 2001 to 2006 and 1999 to 2005. The results in Table 1 suggest no significant change in the magnitudes, signs, and significance of estimated coefficients.

Figure 4: M3 Actual Growth and the Monetary Policy Rule



We then consider alternatives to the baseline specification. First we allow lagged inflation to enter the baseline reaction function. Lagged inflation turned out to be significant. Adding lagged inflation does no change significantly, the estimates of the other coefficients, β and γ. The results suggest that a backward-looking specification is also important for Kenya. The results are significant implying that Central Bank of Kenya looks more to past inflation than current or expected inflation.

Next, we considered whether the CBK takes into account exchange rates in its monetary policy behaviour. The Kenya shilling to US dollar exchange rate was included in the reaction function. The coefficient of the exchange rate turned out to have the correct negative sign and was statistically significant at 5 percent level. The results indicate that CBK "leans against the wind" by restricting money supply when the exchange rate depreciates. This perhaps explain the relative stability of the exchange rate during the greater part of the sample period, lending support to the prediction that CBK could have participated in the inter-bank foreign exchange with an objective to limit excessive exchange rate depreciation.

As shown in Table 2, substituting M3 monetary aggregate with reserve money in the reaction function yield similar results to those in Table 1 in terms of the signs on the estimated

coefficients. Furthermore, the explanatory power of the model is reasonable (i.e. R^2 = 49 percent for the baseline model). The J-statistic indicates that the null hypothesis that the model is over-identified is rejected at 5 percent significance level. The coefficient on the inflation gap, β=*-6.70* with a standard error of 0.37. This suggests that a rise in expected annual inflation of 1 percent induces the CBK to lower the expansion of reserve money by 6.70 percent. The estimate for β is significant at 5 percent significance level, implying that the CBK lowers the expansion of reserve money in response to inflationary pressures. The baseline model was re-estimated for different samples and with different lags and leads of inflation. As shown in Table 2, the results indicate no significant change in the magnitudes and significance of estimated coefficients.

Table 2: Estimation Results of Reserve Money as an Instrument

	α	β	γ	ρ	*C5 Exchange rate*	*Sample*	*J-Statistic (p-value in bracket)*	R^2
Baseline	0.387 (4.108)	-6.701 (-3.479)	0.485 (1.323)	0.863 (18.987)		1999M10 - 2006M12	14.64 (0.80)	0.49
Replacing:								
lagged inflation (3)	0.523 (2.728)	-8.219 (-2.370)	-0.291 (-0.564)	0.906 (21.416)		1999M10 - 2006M12	14.83 (0.79)	0.46
lagged inflation (6)	0.127 (4.442)	-1.348 (-2.044)	0.546 (1.880)	0.825 (18.675)		1999M10 - 2006M12	16.42 (0.69)	0.54
lead inflation (1)	0.540 (2.300)	-10.669 (-2.066)	1.150 (1.731)	0.914 (18.982)		1999M10 - 2006M12	14.99 (0.78)	0.47
lead inflation (3)	0.136 (5.223)	-1.828 (-3.028)	0.076 (0.459)	0.708 (15.538)		1999M10 - 2005M12	14.47 (0.81)	0.44
Baseline with exchange rate	0.301 (5.263)	-5.794 (-4.471)	0.837 (3.518)	0.851 (24.218)	-0.086 (-3.062)	1999M10 - 2006M12	15.57 (0.69)	0.49

Note: t-statistics coefficient estimates are in brackets.

c. Results of interest rate (repo rate) as an instrument

While the policy variable of the CBK was to target monetary aggregates, we assume that there is an implied objective for the expected short-term interest rates specified as follows:

$$\Delta i_t = (1-\rho)\alpha + (1-\rho)\beta\pi_{t+n} + (1-\rho)\gamma x_{t+m} + \rho\Delta i_{t-1} + \varepsilon_t, \quad (9)$$

We therefore estimated the baseline specification for policy function given in equation 9 above, using the same sample size as before. Table 3 below shows the results for the baseline specification. The explanatory power of the fitted model is high (R^2=93.3 percent for the baseline model). The J-statistic indicates that the null hypothesis that the model is over-identified is rejected at 5% significance level. The key result is the estimate of the coefficient on the inflation gap, β= 2.41 with a standard error of 0.43, implying that β is statistically

significant at 5 percent significance level. The result indicates that a rise in the expected annual inflation of 1 percent induces the CBK to raise repo rates by about 2.41 percent. Therefore, the prediction that CBK increased the repo rate in response to inflationary pressures holds.

The estimate of the coefficient on the real GDP is -0.15 with a standard error of 0.14. The result suggests that holding the expected inflation constant, a 1 percent rise in GDP growth induces the CBK to reduce the nominal repo rate by 15 basis points. However, the coefficient is not statistically significant at 5 percent significance level. The baseline model was re-estimated for the sample 2001:1 to 2006:12. The results indicate no significant change in the magnitudes and significance of estimated coefficients.

Table 3: CBK Reaction Function – Repo Interest Rate

	α	β	γ	ρ	*C5 Exchange rate*	*Sample*	*J-Statistic (p-value in bracket)*	R^2
Baseline	-0.031 (-1.588)	2.41 (5.532)	-0.155 (-1.129)	0.935 (77.848)		1999M10 - 2006M12	11.80 (0.92)	0.933
Baseline	-0.038 (-1.241)	2.06 (3.071)	0.200 (1.138)	0.956 (110.053)		1999M10 - 2005M12	13.23 (0.87)	0.931
Baseline	0.002 (0.170)	1.462 (6.189)	-0.090 (-0.938)	0.926 (96.145)		2001M1 - 2006M12	12.19 (0.91)	0.938
Replacing:								
Lagged inflation (1)	-0.022 (-1.509)	2.125 (6.87)	-0.092 (-0.907)	0.920 (76.307)		1999M10 - 2006M12	12.93 (0.83)	0.933
lead inflation (1)	-0.045 (-1.914)	2.964 (5.290)	-0.336 (-1.911)	0.943 (69.734)		1999M10 - 2006M12	10.72 (0.95)	0.932
lead inflation (3)	-0.109 (-2.050)	5.130 (3.872)	-0.770 (-2.660)	0.964 (71.350)		1999M10 - 2006M12	10.48 (0.96)	0.931
Exchange rate	-0.069 (-2.695)	2.961 (5.588)	0.244 (1.531)	0.940 (106.916)	0.045 (9.491)	1999M10 - 2006M12	15.29 (0.70)	0.932

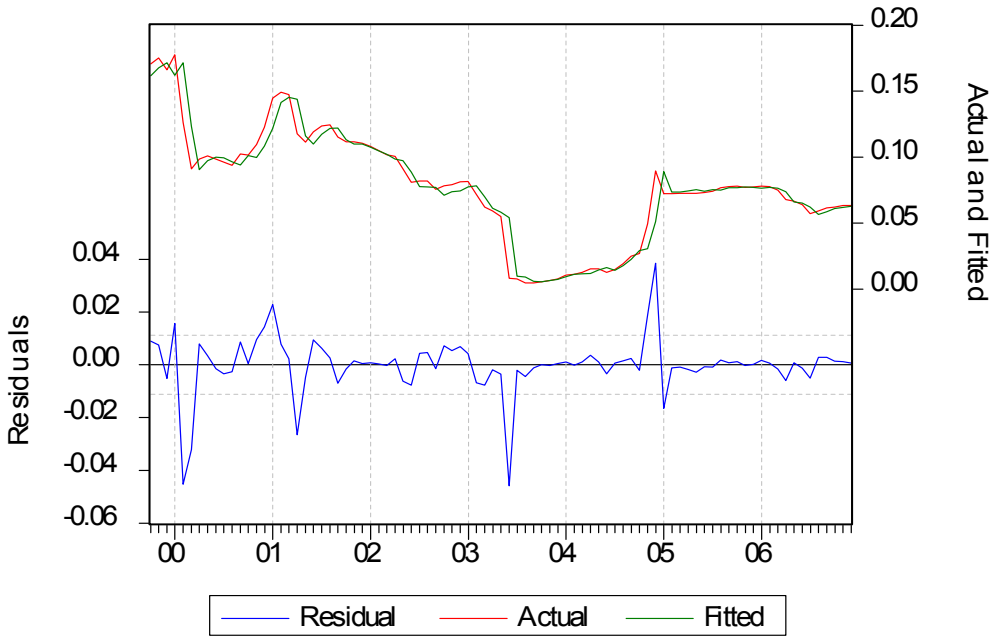
Note: t-statistics for coefficient estimates are in brackets.

We also considered alternatives to the baseline specification with interest rate as instrument rate by including lagged inflation in the reaction function. At lag one, the real GDP and inflation have the correct signs and are statistically significant at 5 percent level. Adding Kenya shilling to US dollar exchange rate to the baseline yields the correct signs, except for the coefficient of real GDP, that are all significant at 5 percent level. The results are generally consistent with those of the M3 reaction function.

Figure 5 shows that monetary policy has generally been consistent with the implied monetary policy rule. However, in the year 2000 and part of 2001, monetary policy was tight as seen from the residuals falling below the 95 percent confidence interval. We deduce from the chart

that, the gap between monetary policy and the monetary policy rule has narrowed significantly since the year 2001 and more so from the year 2005.

Figure 5: Annual Changes in the Repo Interest rate and the Monetary Policy Rule



In all the estimated equations, estimates for the coefficient of real GDP,γ depicts mixed results in terms of the signs and statistical significance. This could be attributed to measurement errors in the GDP data since the series is interpolated and is bound to have some noise. This issue is expected to be addressed once the Kenya National Bureau of Statistics backdates or publishes longer series on the quarterly GDP.

Short sample periods and noisy data result in large variance in the errors of the fitted models implying that the parameters will be imprecisely estimated. Specifically measurement errors on the independent variables could lead to biased estimates. This could result in wrong conclusions from the fitted models (Amato and Gerlach, BIS Papers No.8).

6. Conclusions

The paper has reviewed the recent conduct of monetary policy and the Central Bank rule-based behaviour in Kenya. The empirical results allow us in the preceding section to conclude that since 1997, the CBK has been targeting broad money M3, when making its monetary policy decisions. The results indicate that Central Bank of Kenya has been successful in controlling inflation, at least for the greater period in the sample. At times of

high inflation, or positive output, the CBK responded by reducing money supply. It would appear that CBK followed a rule to target inflation with some allowance for output stabilization. The exchange rate seems to be playing a key part in the CBK's behaviour.

The implicit objective of the short run interest rate seems to perform well in explaining CBK behaviour. We also conclude that at times of high inflation the CBK increased the repo interest rate in order to succeed in mopping up the excess liquidity. Finally, a backward looking specification of the Taylor type also seems important for Kenya. This implies that CBK takes into account past inflation when implementing monetary policy.

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