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Prepared by Michal Andrle, Andrew Berg, Enrico Berkes, R. Armando Morales, Rafael Portillo, and Jan Vlček*

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Abstract

We extend the framework in Andrle and others (2013) to incorporate an explicit role for money targets and target misses in the analysis of monetary policy in low-income countries (LICs), with an application to Kenya. We provide a general specification that can nest various types of money targeting (ranging from targets based on optimal money demand forecasts to those derived from simple money growth rules), interest-rate based frameworks, and intermediate cases. Our framework acknowledges that ex-post adherence to targets is in itself an objective of policy in LICs; here we provide a novel interpretation of target misses in terms of structural shocks (aggregate demand, policy, shocks to money demand, etc). In the case of Kenya, we find that: (i) the setting of money targets is consistent with money demand forecasting, (ii) targets have not played a systematic role in monetary policy, and (iii) target misses mainly reflect shocks to money demand. Simulations of the model under alternative policy specifications show that the stronger the ex-post target adherence, the greater the macroeconomic volatility. Our findings highlight the benefits of a model-based approach to monetary policy analysis in LICs, including in countries with money-targeting frameworks.

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Author's E-Mail Address: mandrle@imf.org; aberg@imf.org; enrico.berkes@u.northwestern.edu; amorales@imf.org; rportillo@imf.org and janvlcekatcz@gmail.com.

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I. INTRODUCTION

In a companion paper [Andrle et al., 2013], we presented a forecasting and policy analysis system (FPAS) for low–income countries, and applied it to Kenya. We found that the framework, based on a semi–structural new-Keynesian open economy model, could help make sense of inflationary developments in Kenya in recent years. One notable feature was the treatment of monetary policy as an interest–rate–based rule and the absence of monetary aggregates in the analysis. While a good first approximation to the country's *de facto* policy regime, this modeling choice was in stark contrast with the central role assigned to targets on monetary aggregates, and especially reserve money, in the *de jure* policy framework in Kenya, and more generally in sub–Saharan African countries (SSA) with managed exchange rates.[2] The purpose of this follow–up paper is to fill this gap.

Here we extend our previous work to introduce a potential role for reserve–money targeting in the monetary policy framework. We study three related issues : target design, potential link with interest rate policy, and interpretation of target misses. First, we introduce a general rule by which the authorities set targets for reserve money for the next quarter, which encompasses simple Friedman–type rules as well as money targets based on optimal forecasts of future money demand. The calibration of the rule captures the extent to which central banks engage in money demand forecasting when they set targets, which we show has important implications for the stabilization properties of monetary policy. Second, we allow for the possibility of a systematic relation between target misses, i.e., deviations of realized reserve money from its target, and the stance of policy, which in our framework is best captured by the deviation between short–term interest rates and the rate implied by a Taylor rule. We refer to this relation as target adherence, i.e., systematic but possibly incomplete efforts by the central bank to hit its targets. The resulting specification of monetary policy is quite general in that it combines both interest rates and money targeting rules, and therefore nests the policy rule in [Andrle et al., 2013].[3] Third, we apply the extended model to Kenyan data from our previous work, adding data on reserve money and associated targets. The filtration of the data through the model helps us provide a novel interpretation of target misses in terms of structural shocks to the economy.

Our approach recognizes that, in practice, reserve money in a money–based framework is not a perfect analogue to interest rates in an Inflation Targeting (IT) framework. The authorities set both money targets and interest rates with a view to achieve their final price stability objective. However, money targets are typically set several months in advance, so that adherence to the target is itself a policy choice. Perfect adherence is often impossible, given exogenous movements in the central bank balance sheet which are beyond the central bank's control. Given this *de facto* flexibility, the interpretation of target misses has in practice become an important element of monetary policy analysis in central banks with *de jure* money targeting regimes. Until now however this type of analysis suffered from lack of a

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[2] See [Berg and Portillo, 2008].

[3] In this regard our paper extends the analysis of [Berg et al., 2010], which studies the degree of optimal adherence to reserve–money targets in selected low–income countries using a similar methodology.

comprehensive framework, which resulted in assessments based mainly on ad–hoc judgement.

Money–targeting central banks in SSA operate along a policy continuum in terms of money target adherence. A few, at least for some time, broadly hit their preannounced money targets systematically. For these central banks, the question we analyze here is how should targets be set in a way that, while anchoring inflation expectations, also help stabilize the economy. Most, though, do not strictly hit their targets. In general, their decision whether or not to do so depends on the level of interest rates and the exchange rate and the authorities' views on whether broader inflation and output objectives are being met.[4] For these banks, the framework in this paper can help structure this discussion, interpreting target misses in terms of structural shocks and linking observations about key macroeconomic variables, forecasts of inflation and output, and money aggregates in a coherent analysis.

The model described here can also be used to support the transition from regimes that put greater emphasis on money targets to interest–rate–based frameworks, including by combining money targets with operational targets for short–term interest rates in a consistent manner. The goal is to facilitate better and more forward-looking discussions of monetary policy, and ultimately better decisions.

In the case of Kenya, we find that money targets are set in a manner consistent with the forecasting of future money demand. Reserve money targets set by the central bank of Kenya (CBK) display two important empirical properties: they correct for past target misses and contain some information about (future) money growth. In our framework, such properties are consistent with money targets as forecasts of future money demand, which is a more sophisticated version of target setting than simple money growth rules. The observation that target growth contains information about actual money growth reflects the efforts that central banks undertake to identify changes in the demand for liquidity in the near term, e.g., stemming from fiscal operations. The correction for past target misses implies the central bank of Kenya lets bygones be bygones. The correction is not complete however, which suggests institutional or informational rigidities, likely stemming from the fact that targets are set every six months.

We do not find a systematic role for money targets in the conduct of monetary policy in Kenya, however. We call on three pieces of evidence. First, target misses are large and persistent which suggests that hitting targets has not been a policy priority. When target misses have been corrected over time, it has been because of an adjustment of the target, as discussed above. Second, money growth dynamics are unrelated to past targets or target misses. Third and correspondingly, we fail to detect a systematic relation between the monetary policy stance and target misses. In our framework, target adherence implies that positive target misses (money above its target), all else equal, should elicit an increase in short–term interest rates relative to the Taylor rule benchmark, as the central bank attempts to

[4] [Berg and Portillo, 2008] shows that central banks with low–to–moderate inflation often miss their money targets, and that doing so typically has no particular implication for their achievement of their inflation objectives, suggesting that they often miss advisedly.

withdraw liquidity to bring reserve money back in line with its target. This is not the case empirically. In some periods, the opposite is true: episodes of positive target misses are associated with accommodating monetary policy. In other periods, target misses are reversed or corrected without any corresponding change in the policy stance. Note that this lack of systematic relation does not imply that money targets have not mattered during certain episodes: as we argued in [Andrle et al., 2013], efforts to hit broad money and credit targets during 2010 did contribute to an accommodating policy stance that resulted in a large increase in inflation in 2010–2011. However, weak target adherence in Kenya implies that monetary policy analysis can, to a large extent, abstract from the analysis of money targets altogether, thus validating our earlier approach.

Money target misses in Kenya have been mainly driven by shocks to money demand. There have been periods when target misses have been driven in part by monetary policy shocks; as described above, this was the case in 2010. For the most part, however, misses have reflected unexpected changes in money demand, underscoring our assessment that money demand has been quite volatile. Shocks to aggregate demand and supply do not play an important role. These findings validate the weak target adherence observed in Kenya, as it shows that the CBK has been correct in not responding systematically to target misses.

We complete our analysis of monetary aggregate in kenya with two additional exercises. First, building on the structural apparatus we have created, we assess the implications of target design and adherence for the cyclical properties of the Kenyan economy. Second, we analyze the potential of monetary aggregates for nowcasting exercises.

The cyclical behavior of an economy depends on the policy regime chosen. Simulations of the model calibrated to the Kenyan economy support the conclusion that adherence to pre-announced money targets in Kenya would imply high volatility of money market interest rates, favoring thus more accommodative rules. The same finding extends to both nominal and real exchange rates, which would also be more volatile if money target adherence was high. The implication of greater money target adherence for output and inflation volatility depends on the shock. In the case of money demand shocks, the answer is unambiguous: target adherence results in considerably more volatile inflation and output, e.g., relative to an interest–rate–based inflation targeting regime. In the case of cost push shocks, strict money targeting results in more volatile output but less volatile inflation, which implies that policy is tighter than under IT. The opposite holds in the case of demand shocks. We also find that, in the case of money demand shocks, more sophisticated money targeting rules are less costly than simple rules, because the policy mistakes induced by target adherence are less persistent.

The relative volatility of output and inflation under strict money targeting implied by our simulations is unlikely to be a desirable outcome for the authorities. First, this change comes at the expense of substantial interest rate volatility, the stability and predictability of which should be a policy objective in itself, as revealed by the experience of most central banks around the world. Second, it is the by-product of the structure of money demand, which is typically unstable and subject to structural change, and is therefore likely to result to further changes in relative volatilities in unexpected ways. If the authorities do prefer such outcome, then interest–rate–based rules can replicate these relative volatilities simply by changing the relative importance given to inflation stabilization over output stabilization, while still accommodating shocks to money demand. More generally, IT–type regimes offer a framework that allows the central bank to explicitly discuss its own objectives and relate these to its policy decisions. The latter discussion is considerably more difficult under strict money targeting.

Monetary aggregates, which are available almost immediately, can help improve the framework's forecasting and nowcasting properties. Money is a noisy indicator of real growth and can in principle help forecast (or rather 'nowcast') current values of output, which are usually available with some lag. We show this is the case for Kenya.

As with its companion paper, this paper seeks to promote more explicit employment of simple macroeconomic models in evaluation of country developments. Our model allows for a robust assessment of monetary policy in an environment reflecting country-specific factors. In the case of Kenya, this motivates the emphasis on the role of food and non-food prices, which was extensively analyzed in [Andrle et al., 2013], and the analysis of money targets we undertake here. As both of these features are relevant in other SSA countries, we believe our framework could also apply to other countries in the region or countries with similar characteristics.

In particular, our results have implications for countries in which money targets remain central to the policy framework. It may be that some countries prefer to work with money instruments, perhaps because of reasons such as fear of fiscal dominance, very weak credibility, or insufficiently developed financial markets. Even in these cases, the results in this paper suggest that simple backward–looking or passive money–aggregate–targeting frameworks are likely to be inferior to a framework in which money targets are set with a view to the shocks hitting (and the likely evolution of) the economy. In this sense, a money–target–based or other hybrid policy regime is likely to benefit from an explicit forward–looking monetary policy framework such as that presented here. Our hope is that countries considering a transition towards interest–rate–based frameworks will find the hybrid regime discussed in this paper useful during that transition.

Our paper is organized as follows: section II surveys goals and instruments of monetary policy, following the literature, to lay a groundwork for the analysis. In Section III we introduce money targeting into a New–Keynesian dynamic model for Kenya, motivate our modeling choices and illustrate the main features of the model. Section IV reviews monetary policy implementation in Kenya. We use the model to interpret money target misses and illustrate its use for nowcasting with incomplete data. The last section summarizes the paper's finding.

II. Monetary Policy Targets and Instrument Choice

Here we briefly review the role of monetary aggregates and interest rates in both the design and the implementation of monetary policy. It is useful to distinguish the ultimate goals of monetary policy from intermediate and operational targets. We follow the consensus that the ultimate goal of monetary policy is to achieve price stability in a way that minimizes undesirable macroeconomic volatility. In order to achieve this goal, central banks decide on their policy regime and choose intermediate and operational targets, e.g., as described in [Bindseil, 2004] and [Walsh, 2001]. Intermediate targets focus on variables that provide information about the expected path of the variable of interest (prices). In principle, under money targeting, broad money typically serves as intermediate target; likewise, the inflation forecast serves as the intermediate target under IT. These variables help guide policy without the presumption that they must be met, and it is understood that target misses are inevitable.

An operational target is an economic variable that the central bank can control, typically on a daily basis. This denomination applies to variables that directly influence the money or exchange rate market equilibrium, usually signaling the current policy stance. Should this operational target be the interest rate or reserve money?[5] The choice between interest rate and monetary aggregates targeting is the classic ‘instrument problem’. An important strand of thinking, influential in academic circles, goes back to the seminal work of Poole [Poole, 1970], which emphasizes the role of imperfect information: if the authorities do not exactly know which shocks are currently hitting the economy, but are aware of the shock’s distribution (their relative importance), the resulting uncertainty will impact the choice of target. Poole concludes that where the dominant shocks are to aggregate demand, e.g., shocks to fiscal policy, money targeting provides more stability, while a predominance of money demand shocks argues for interest rate targeting.[6]

In practice, there is no such equivalence between money and the interest rate as operational targets, at least at daily or weekly frequency. Operational targets on reserve money cannot be met at high frequency without generating extremely high volatility in interest rates. The reason is simple: the central bank’s supply of reserve money is in part driven by autonomous factors—such as changes in government deposits—that are both beyond the bank’s control and are difficult to forecast. Attempting to offset the impact of these factors on reserve money supply would require large changes in open market operations. However, as demand for central bank balances are very inelastic in the short run, such offsets, even if small, would require very large changes in interbank interest rates and may even disrupt the functioning of money markets. For this reason, central banks in advanced economies have always relied on short term interest rates as the operational target of policy, even when broad money served as an intermediate target (see [Borio, 1997] or [Disyatat, 2008]). To the extent reserve money targets play a role in the formulation of monetary policy, as is described below for many SSA countries, it falls somewhere between an operational and an intermediate target, as the central bank decides on the degree of adherence to the target.

“Flexible money targeting” is a good characterization of the policy framework in many SSA countries. Most countries feature both reserve and broad money targets, which have a quarterly frequency. These targets are set annually or semiannually, often in the context of an

[5]We focus on flexible exchange rate regimes in this paper. See [Benes et al., 2013] for an explicit discussion of managed floats.

[6]See also [Friedman, 1988] and [Walsh, 2001].

IMF program, using a monetary programming framework.[7] The framework is straightforward: starting with a forecast for GDP, an inflation objective, and estimates of money velocity and the money multiplier, the authorities construct an annual forecast for broad and base money. The annual forecast is then divided into quarters, in part by incorporating additional information about government flows and seasonal patterns. These quarterly forecasts then become the policy targets. Note that the emphasis is typically on the reserve money target, because it falls more squarely under the influence of the central bank. Central banks typically miss their reserve money targets in both directions, i.e., both overshooting and undershooting. Previous empirical work has found that target misses have little consequence in terms of inflation, especially in countries that have succeeded in stabilizing inflation.[8] Central banks allow these target misses because, as discussed above, attempting to hit them would bring unnecessary volatility to the interest rate. Moreover, the assessment of the target miss is typically conditional on the state of the economy: they are considered unrelated to the “true” stance of monetary policy if inflationary and aggregate demand pressures are contained, or if real interest rates are positive. The opposite assessment is made if inflation is increasing or if real interest rates are negative. In some cases, e.g., over some periods, central banks in some countries have hit their targets more systematically, or have made great efforts to do so, at the cost of sizeable interest rate volatility.[9]

In this paper we do not take a stand on why countries may want to target money in the first place. Rather, we take it as given and analyze some of the consequences. However, some discussion of the possible reasons may shed light on the applicability of the framework. One possible reason, explored for example in [Berg et al., 2010], has to do with imperfect information. Money aggregates may contain information about aggregate demand and interest rates that are not readily observable in real time. Even interest rates may not be market clearing in shallow financial system, such that it is hard to infer the true opportunity cost of future consumption from observable rates.[10] In this paper, we make the simplifying assumption of full information. Another reason may be that the central bank has imperfect credibility, and adherence to pre-announced money targets may be a mechanism to build that credibility.[11]

Yet another possible reason why some SSA countries continue to target money is that the authorities are not prepared to pursue a forward-looking policy with the objective of stabilizing inflation and output. This may be due to a lack of operational independence. In this case, strict money targeting may provide a bulwark against fiscal dominance. However,

[7]This is often embedded in a more general and mutually–consistent analysis of the economy (fiscal accounts, balance of payments) that relies on the IMF’s Financial Programming approach, e.g., as described in [Selassie et al., 2006]

[8]See [Berg and Portillo, 2008].

[9]See [Berg et al., 2013].

[10]This is a refinement of Poole’s original idea, as it emphasizes the role of money as an indicator variable, yet not fundamentally different from other indicator variables which may also be available to the central bank.

[11]See [Clinton et al., 2010] for a simple way of analyzing the central bank credibility problem, though without monetary aggregates.

the cost may be excess volatility relative to a forward-looking IT–like policy. A related argument is that, if there is limited capacity to adjust policy as needed to stabilize inflation, there may be some advantages in having a passive money–targeting policy (like a constant–growth–rate rule). In such a regime, the Taylor principle—the notion that an increase in inflation eventually requires an increase in real interest rates for inflation to be stabilized—is likely to be satisfied due to the low short–term interest rate elasticity of money demand.[12] A similarly passive interest rate rule, on the other hand, would tend to lead to instability.

III. Introducing Money Targeting in a New–Keynesian Model for Kenya

We modify the model in [Andrle et al., 2013] to allow for monetary targeting. The modification consists of: (i) adding a money demand block and, (ii) introducing a rule for setting money targets, and (iii) modeling different degrees of adherence to these targets.

The model is a New–Keynesian small open economy model featuring a set of nominal and real rigidities. There are four main equations in the model.[13] The IS curve links the output gap with foreign demand and real monetary conditions, including both real interest and exchange rate gaps. As the share of food prices in overall CPI is about 40 percent in Kenya, there are two Phillips curves—for food and non-food prices—in the model. Real marginal costs are the main driving force of inflation. These are driven by domestic demand pressures, the real exchange rate and import prices. The model also includes relative price trends anchoring relative food prices in the long run. We assume a version of the uncovered interest rate parity (UIP), which equalizes domestic and foreign interest rates, adjusted by the expected appreciation of the exchange rate and a country risk premium.

The model does not capture the money market operations that help implement the operational targets. The model is quarterly, reflecting the understanding that operational targets are revised only periodically. The operations that help achieve those targets, such as the setting of an overnight interest rate within a prescribed corridor or the management of required reserves, are not analyzed here. However, liquidity management issues, e.g., the inability or unwillingness to implement the policy prescription that results from monetary policy analysis, can seriously affect the stance of policy and have undesired macroeconomic consequences.

[12] This can be seen by equating money supply and money demand, and solving for the nominal interest rate. The latter variable would respond, at equilibrium, to movements in inflation, with a coefficient given by the inverse of the interest elasticity of money demand. The Taylor principle would be satisfied if the inflation coefficient is higher than one, or alternatively if the interest elasticity is less than one.

[13] The model is extensively described in [Andrle et al., 2013], we provide a brief summary here.

A. Money Demand

We introduce a demand equation for money. We use an error–correction specification, which allows for both short-run and long-run dynamics:

$$\Delta m_t = \omega_y \Delta y_t - \omega_{rs} \Delta rs_t - \Delta v_t + \omega_m \widehat{m}_{t-1} + \varepsilon_t^{m_d} \quad (1)$$
$$\widehat{m}_t = m_t - (\psi_{const} + \psi_y y_t - \psi_{rs} rs_t - v_t). \quad (2)$$

Equation (1) states that changes in demand for real money balances Δm_t, where $m_t = M_t - P_t$, depend on the growth rates and the level of output y_t, the annualized nominal interest rate rs_t, velocity v_t, and the real money gap $\widehat{m}_t$. We define the real money gap as the error–correction term, i.e., the deviation between real money balances and their long run value.[14]

We distinguish two types of exogenous changes in money demand: liquidity shock $\varepsilon_t^{m_d}$ and persistent changes in velocity v_t. Shocks to liquidity or velocity drive a wedge between movements in monetary aggregates and the stance of policy, which is best captured by the interest rate level. Liquidity shocks have temporary effects on the demand for money, with persistence determined by the error–correction specification of money demand. Velocity follows the following autoregressive process in first differences:

$$\Delta v_t = \rho_v \Delta v_{t-1} + (1 - \rho_v) \Delta \bar{v} + \varepsilon_t^v. \quad (3)$$

The above specification implies shocks to velocity ε_t^v have persistent effects on the *growth rate* of money demand.

B. Monetary Policy

Monetary policy is described by a flexible policy rule that allows for pure forms of monetary and interest rate targeting as well as intermediate cases As a specific case, it includes an interest rate rule in which the authorities respond to deviations of the inflation forecast from its target (the Taylor rule). It also allows policymakers to respond to deviations of money growth from its target. The rule is inspired by the analysis by [Berg et al., 2010], who investigate the link between Taylor rules and money growth targets in selected African economies. In this section we begin by presenting operational targets derived from the Taylor rule. We then discuss the modeling of money targets, before discussing how we combine both.

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[14]This money gap differs from another measure that is sometimes used, e.g., in [Berg et al., 2010], which is the difference between real money balances and the level that would hold if the economy was at potential and inflation was equal to target.

1. Interest Rate Rule

The interest rate rule reflects the preferences of the central bank for the stability of output and inflation around its target. This is the rule used in [Andrle et al., 2013], and is the standard characterization of policy in IT or IT-lite central banks. The interest rate rule is the following:

$$rs_{R,t} = \gamma_1 rs_{R,t-1} + (1-\gamma_1)\left[(\overline{rr}_t + \overline{\pi}_{t+1}) + \gamma_2(\pi^{4,cpi}_{t+i} - \overline{\pi}^{4,cpi}_{t+i}) + \gamma_3 ygap_t + \gamma_4 \Delta sgap_t\right]. \quad (4)$$

The term $(\overline{rr}_t + \overline{\pi}_{t+1}) = \overline{rs}_t$ stands for the neutral value of the policy rate, as determined by the neutral real rate and the inflation target.

Monetary policy reacts to deviations between projected year-on-year headline inflation and the inflation target, $(\pi^{4,cpi}_{t+i} - \overline{\pi}^{4,cpi}_{t+i})$. As part of a flexible inflation targeting regime, the central bank may also consider the output gap, $ygap_t$, and the deviation between the nominal depreciation and its equilibrium value, $\Delta sgap_t$, as indicators of the cyclical position of the economy. The rule is forward–looking in that policy is driven by the forecast of future inflation. As we will see below this property of the rule can also extend to the (ex-ante) choice of targets on money, depending on how these targets are set.

In its pure form, the interest rate rule exhibits no adherence to previously forecasted interest rate targets. Next period, as the economy gets hit by new structural shocks, a new path of interest rates is determined.[15] The new path is set to achieve the inflation target over the medium run. This is a crucial difference with targets on money growth, as shown below.

2. Money Growth Target

The rationale behind the setting of the money growth target can be of crucial importance for the stabilization properties of monetary policy. Here we specify the monetary aggregate to be targeted, the rule that determines the target and the timing of target announcements. We seek to mimic to the extent possible the way targets have been set in Kenya in the last decade, and more generally in many SSA countries.[16]

In every quarter, e.g., $(t-1)$, a reserve money target is announced for the quarter ahead, t. This is a slight simplification of current practices at the central bank of Kenya, which usually revisits its targets every six months.[17] Once a target is set it is not revised, e.g., the target for

[15]Most countries resort to verbal indication of the future policy stance, without commitment. The Czech Republic, Israel, Norway, Sweden and New Zealand, for instance, publish their interest rate paths. Note however that path dependence—committing to a previously announced interest rate path even if new developments call for a different policy stance—has been recently advocated in many advanced economies, in the presence of a binding zero lower bound on interest rates. See Woodford (2012), among many others.

[16]This approach sets us somewhat apart from the vast literature on money targeting rules. We present some of these rules in the appendix.

[17]The current practice is difficult to implement in a recursive model such as ours. We can approximate this behavior however by varying the persistence term in the setting of the target, shown below.

period t that was set in period $t-1$ is not revised once quarter t (and the new information available then) arrives. We do however investigate the consequences of various degrees of target adherence. Note that we do not extend the analysis to the setting of broad money targets, for the sake of simplicity.

We first define the money growth target, $\Delta\overline{M}_t^*$, as the forecast of the growth in the demand for nominal money balances at t given the central bank's forecast of inflation and real money demand, and conditional on all available $(t-1)$ information.[18] Specifically:

$$\Delta\overline{M}_t^* = \overline{M}_t - M_{t-1} = M_{t|t-1} - M_{t-1} = \Delta m_{R,t|t-1} + \pi_{t|t-1}. \tag{5}$$

Here $M_{t|t-1}$, $\Delta m_{R,t|t-1}$ and $\pi_{t|t-1}$ denote expectations, at time $(t-1)$, of nominal money balances, real money growth and inflation at time t. We assume that the forecast for real money demand is consistent with the interest rate implied by the interest rate rule in (4):

$$\Delta m_{R,t|t-1} = \omega_y \Delta y_{t|t-1} - \omega_{rs}\left(rs_{R,t|t-1} - rs_{t-1}\right) - \Delta v_{t|t-1} + \omega_m \widehat{m}_{t-1} + \varepsilon^{m_d}_{t|t-1}. \tag{6}$$

Part of the liquidity shock $\varepsilon^{m_d}_t$ is anticipated by the central bank ($\varepsilon^{m_d}_{t|t-1}$). This reflects additional information that the central bank may have about liquidity patterns (money demand), which is beyond the scope of the model. It can be due for instance to weather patterns, government financing needs, etc. In practical terms, this shock helps match the forecast of money demand implied by the model with the actual money target observed in the data. It will also result in money growth being correlated with the target, regardless of whether money targets are binding for monetary policy. $\varepsilon^{m_d}_{t|t-1}$ should not be interpreted as reflecting a shock to the monetary policy stance.

The above specification implies that money targets do not respond to past target misses. As equation (5) indicates, the setting of $\overline{M}_t$ does not depend on past misses, i.e., bygones are bygones. This has implications for the rate at which targets grow, which we denote $\Delta\overline{M}_{T,t}$:

$$\Delta\overline{M}_{T,t}^* = \overline{M}_t - \overline{M}_{t-1} = \Delta\overline{M}_t^* + (M_{t-1} - \overline{M}_{t-1}), \tag{7}$$

The corollary of eq. (5) is that the *growth rate* of money targets always accommodates past target misses $(M_{t-1} - \overline{M}_{t-1})$. Targets grow at a faster rate whenever reserve money is above the target, so that target levels catch up with the level of reserve money. The latter is a property of targets when interpreted as forecasts of future money demand.

If money targets follow rules (5, 6) there is perfect *ex ante* consistency between the money target and the interest rate rule. That is, the money target and expectations of next period's interest rates, given by rule (5), signal the same policy stance. As shown in [Berg et al., 2010], ex ante consistency is a desirable property of regimes with multiple targets because they greatly reduce the tension between these targets. Making money targets consistent with

[18] This approximates the process involved in the IMF's Financial Programming approach, e.g., as described in [Selassie et al., 2006]

an interest rate rule is also desirable because the former inherit (in principle) the stabilizing property of the latter.

We nonetheless then expand rules (5, 6, 7) to encompass a wider range of money–targeting rules, in order to examine policies that do not correspond to any interest rate rule of the form of (4). The general equation for money–target setting, specified in terms of their growth rate, is now the following:

$$\Delta \overline{M}_{T,t} = \alpha \left[(1-\rho_{\bar{M}}) \, \Delta \overline{M}_{T,t-1} + \rho_{\bar{M}} \Delta \overline{M}^{*}_{T,t} \right] + (1-\alpha) \, \Delta \overline{M}. \tag{8}$$

$$\Delta \overline{M}_{t} = \Delta \overline{M}_{T,t} - (M_{t-1} - \overline{M}_{t-1}). \tag{9}$$

$\Delta \overline{M}^{*}_{T,t}$ is given by (7), i.e., the growth rate of money targets that is consistent with the optimal forecast of money demand under the interest rate rule. $\Delta \overline{M}$ denotes long run money growth, which we assume equals the sum of potential output growth, the inflation objective and the growth rate of velocity (in the long run). Parameters $\rho_{\bar{M}}$ and α move money targets away from the optimal money demand forecast $\Delta \overline{M}^{*}_{t}$. A $\rho_{\bar{M}} < 1$ makes money target setting sluggish (persistent), so that targets react gradually to an expected change in money demand. An $\alpha < 1$ makes money targets less responsive to new information. In the limit, $\alpha = 0$, money targets are set according to a Friedman rule.[19] This can be used to describe a passive central bank, which keeps the growth rate of targets unchanged regardless of any new developments. More generally, the pair $(\rho_{\bar{M}}, \alpha)$ captures potential institutional rigidities in target setting. Realistically, institutional constraints and credibility issues—which we do not model explicitly—may prevent sharp revisions of targets.

The pair $(\rho_{\bar{M}}, \alpha)$ has implications for how money targets react to past target misses. $\rho_{\bar{M}} < 1$ or $\alpha < 1$ implies the accommodation described in (7) is less than complete. This incomplete accommodation is due to the same institutional constraints described above, especially the fact that targets are not set every one quarter in advance but every six months for the next two quarters. We will draw on the empirical evidence on money targets in Kenya to calibrate this rule.

The general specification in (8)-(9) implies that money targets may be *ex ante* inconsistent with the interest rate rule. $\rho_{\bar{M}} < 1$ or $\alpha < 1$ implies the money target is not consistent with the interest rate implied by the rule in (4), even before time t comes along. If money targets matter for monetary policy, the ex-ante tension between targets will have longer lasting effects on the stance of policy. We will analyze this case in the section below.

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[19] We use the term "Friedman rule" to describe a constant money growth rule, without necessarily specifying the actual growth rate of money. This differs from the way the term "Friedman rule" is often used in the macroeconomics literature, i.e., a rule that would set the nominal interest rate to zero, on average.

3. Intermediate cases

Having described both targets, we now describe how to combine them in a general specification. We approximate intermediate policy frameworks, i.e., frameworks that pay attention to both interest rates and money, by assuming that the central bank sets the actual policy rate, rs_t, as a combination of the interest rate that would correspond to a Taylor rule, $rs_{R,t}$, and the interest rate implied by strict adherence to the money target, $rs_{MT,t}$:

$$\begin{aligned} rs_t &= \gamma rs_{R,t} + (1-\gamma) rs_{MT,t} + d_t, && (10) \\ d_t &= \gamma_1 d_{t-1} + \varepsilon_t^d, && (11) \end{aligned}$$

where, d_t denotes a persistent shock to monetary policy. $rs_{MT,t}$ is obtained by inserting rule (8) in the money demand equation (2) and solving for the interest rate that would hold under that specification. Although this may appear counterintuitive at first, this specification helps nest the two polar cases. Calibrating the parameter γ, we can model a pure Taylor rule that approximates inflation targeting ($\gamma = 1$), a pure money growth rule with full adherence to the money targets ($\gamma = 0$), or any combination of the two ($0 < \gamma < 1$).[20]

The Taylor rule emerges as a natural benchmark for assessing the stance of monetary policy in the general case. Combining the equation for money demand (1), with the money demand that would hold under perfect adherence to the money target, we can provide an alternative presentation of the general rule in (10):

$$rs_t = rs_{R,t} + \underbrace{\frac{(1-\gamma)}{\gamma}\frac{1}{\omega_{rs}}(M_t - \overline{M}_t) + \tilde{d}_t}_{\text{policy stance deviation}}, \tag{12}$$

where $\tilde{d}_t = d_t/\gamma$. Note that in this specification, the interest rate prescribed by the Taylor rule and the money target play two distinct roles. The former serves as the policy prescription and helps anchor inflation expectations, while, depending on the value of γ, money target misses may help understand deviations in the policy stance.

A $\gamma < 1$ implies a systematic relation between the money target misses and the policy stance. Depending on how targets are set, this systematic relation can take various forms. To see this, we solve for $(M_t - \overline{M}_t)$, using eqs. (5)-(9):

$$\left(M_t - \overline{M}_t\right) = \left(1 - \alpha\rho_{\bar{M}}\right)\left(M_{t-1} - \overline{M}_{t-1}\right) + u_t,$$

[20] In principle, any form of money growth target coupled with money demand can be rewritten as an interest rate rule and vice versa, see [Razzak, 2003]. However, the equivalence between money based rule and interest rate rules does not constitute equivalence in the operational conduct of monetary policy, see [Disyatat, 2008] or [Bindseil, 2004].

where the innovation to the money target miss, u_t, is given by:

$$u_t = (1-\alpha)\left(\Delta M_t - \Delta M\right) + \alpha(1-\rho_{\bar{M}})\left(\Delta M_t - \Delta\overline{M}_{T,t-1}\right) + \alpha\rho_{\bar{M}}\left(\Delta M_t - \Delta\overline{M}_t^*\right).$$

When $\alpha = 1$ and $\rho_{\bar{M}} = 1$ money target misses behave as forecast errors, i.e., $\left(M_t - \overline{M}_t\right) = \left(\Delta m_t - \Delta m_{t|t-1}\right) + \left(\pi_t - \pi_{t|t-1}\right)$. These forecast errors are i.i.d.; in this case adherence to money targets introduces simple noise in interest rates.[21] When either $\alpha < 1$ or $\rho_{\bar{M}} < 1$, money target misses follow an autoregressive process with persistence given by $(1-\alpha\rho_{\bar{M}})$. In addition, innovations to target misses (u_t) can also become persistent, e.g., if money growth deviates persistently from its long run value. In this case, systematic target adherence implies persistent deviations in interest rates from the Taylor rule: episodes of policy accommodation or tightness would be explained by efforts by the central bank to hit its money targets. In sum, the specification of the target rule can have important implications for the properties of the policy stance.

Equation (12) can also be used to interpret policy in countries where the money target takes center stage in policy discussions. The terms can be rearranged as follows:

$$M_t = \overline{M}_t + \frac{\gamma}{(1-\gamma)}\omega_{rs}(rs_t - rs_{R,t}) + \hat{d}_t,$$

where $\hat{d}_t = -\omega_{rs}/(1-\gamma)d_t$. In this version, deviations between the nominal growth rate of money and its target result from either monetary policy shocks $(\hat{d}_t)$ or some concern with interest rate not straying too far from the rate implied by the Taylor rule $(rs_t - rs_{R,t})$. Even in this case however, the stance of policy is best understood by the deviation between interest rates and the Taylor rule.

In summary, we have presented a general framework that nests various policy rules. The type of regime can be characterized by three parameter values: γ, α, and $\rho_{\bar{M}}$. Note that the policy specification in [Andrle et al., 2013] amounts to $\gamma = 1$. We now discuss alternative calibrations for these parameters and their macro implications.

C. Key Features and Properties of the Model

This section describes the properties of the model under alternative specifications of the general rule. We have already extensively discussed the properties of the model under the interest rate rule, including its forecasting competence, and have also used it to provide an interpretation of Kenyan developments, in [Andrle et al., 2013]. Here, instead, we focus on the business cycle properties of the economy depending on the specification of policy and the relevant shock.[22] Table (1) below compares standard deviations of basic macroeconomic

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[21]The noise we are interested in is at the quarterly frequency.

[22]We do not assess the cyclical properties of the model against a central bank objective function, i.e., a weighted sum of key volatilities meant to reflect the preferences of the central bank. We could do so, though because the model is not micro-founded any objective function would be arbitrary.

variables under different policy strategies—ranging from pure IT ($\gamma = 1$) to strict money forecast targeting ($\gamma = 0$), with no target persistence ($\rho_{\bar{M}} = 1$) and full use of information ($\alpha = 1$). We look at three set of shocks: an aggregate demand shock, aggregate supply shocks, and money demand shocks. The analysis is conditional on the calibration from [Andrle et al., 2013], including the relative volatilities of the shocks to aggregate demand and supply, to which we add the calibration of money demand and the volatility of shocks to liquidity and velocity (summarized in Table 2 and discussed below).

Standard deviations in Table (1) are normalized with respect to the Friedman rule case ($\gamma = 0, \alpha = 0$). The Friedman rule specification serves as a straightforward benchmark and should not be interpreted as a desirable, or even implementable, alternative to the existing regimes. The normalization is useful however in that it allows for two dimensions along which to assess money targeting: the degree of target adherence (varying γ) and the role of the targeting rule itself, which can be seen by comparing the most basic type (the Friedman rule, $\alpha = 0$) with the most sophisticated (optimal money demand forecasting consistent with an interest rate rule, $\alpha = 1, \rho_{\bar{M}} = 1$). Consistent with the discussion in the previous section, the first comparison highlights the implications of the potential interest rate noise introduced by money targeting, while the latter measures the implications of persistent money–target driven movements in interest rates.

The results indicate that the more weight is placed on money targeting (lower γ), the larger is the variance of the nominal exchange rate and the interest rate. This is true across the three sets of shocks we analyze here, obviously in the case for money demand shocks, and also, surprisingly, in the case of aggregate demand shocks. For the latter, interest rates and exchange rates are a hundred times more volatile when money target adherence is complete ($\gamma = 0$) than when money targets play no role in policy ($\gamma = 1$). The higher nominal exchange rate volatility is a direct result of the higher variance of interest rates. This is because of the uncovered interest parity condition: holding future exchange rates constant, an unexpected increase in short–term interest rates feeds one–for–one into spot exchange rates. The closer the adherence to money targets, the larger (and immediate) the initial effect on interest rates is in response to shocks, to clear the money market, and therefore the larger the volatility of the exchange rate.[23] The type of money targeting rule (Friedman rule versus optimal money demand forecasting) does not seem to make much of difference for the volatility of these two variables, which suggests most of the increased volatility comes from the effect on short–run volatility.

The impact of money demand shocks obviously depends on target adherence but also on the type of money targeting rule. The larger the target adherence the larger the impact of money demand shocks on the economy. This is a well known weakness of money targeting. More interestingly, the type of money targeting matters as well. Relative to the simple Friedman rule, target adherence based on optimal money demand forecasting reduces the costs of money–target–related policy errors. This can be seen by looking at the ($\gamma = 0$) case: it

[23] This outcome should not be confused with the higher variability of the exchange rate that typically results from inflation targeting and flexible exchange rate regimes. In fact, many countries conduct money growth targeting along with exchange rate interventions and smoothing, which would reduce the volatility of exchange rates.

delivers considerably lower inflation and output volatility than the Friedman rule, which is consistent with the discussion in the previous section.

In the case of real shocks, adherence to money targets has implications for the relative volatility of output and inflation. Under supply shocks, greater adherence to money targets helps reduce the volatility of inflation but at the cost of higher output volatility. The reason is the following: A supply shock that raises inflation also increases the demand for nominal balances. Greater target adherence implies this nominal money demand is not satisfied, which requires an increase in interest rates to clear the money market, and with the latter increase depending on the interest elasticity of money demand. The increase in interest rates helps offset the inflationary effect of the shock but at the expense of a contraction in output, which explains the change in relative volatilities. In the case of aggregate demand shocks, the opposite holds: adherence to money targets also results in a large increase in interest rates, which helps reduce the impact of the shock on aggregate demand but increases the volatility of inflation through its effects on exchange rate volatility. Note that these results do not depend on the type of money targeting.

The results in Table (1) highlight the benefits of moving towards more flexible money growth rules and IT–like regimes. First, the substantial increase in interest rate and exchange rate volatility, one–hundredth fold in some cases, is an enormous shortcoming of greater adherence to money targets. The stability and predictability of interest rates has become a policy objective in itself, as revealed by the experience of most central banks around the world, both for financial stability reasons and to help guide markets about future policy decisions.

Second, the properties of the economy under money targeting stem from the implications that these rules have for interest rates, via the structure of money demand. The latter is the only variable through which monetary policy affects the real economy, so that monetary policy is best specified as operating directly on this variable, and not indirectly via monetary aggregates. To see this link, let us focus on an extreme case (strict money targeting under the Friedman rule). Inserting the money target in the money demand equation (5), and solving for the interest rate we obtain the following:

$$rs_t = rs_{t-1} + \frac{1}{\omega_{rs}}\left(\pi_t - \bar{\pi}\right) + \frac{1}{\omega_{rs}}\left(\Delta y_t - \Delta y^*\right) - \frac{1}{\omega_{rs}}\left(\Delta v_t - \Delta v\right) + \frac{\omega_m}{\omega_{rs}}\hat{m}_{t-1} + \frac{1}{\omega_{rs}}\varepsilon_t^{m_d} + d_t, \tag{13}$$

where we have relied on the identity $\Delta M = \bar{\pi} + \Delta y^* - \Delta v$ and have assumed $\omega_y = 1$. The performance of the Friedman rule relative to the case of no target adherence depends on how eq. (13) compares with eq. (4). The rule looks somewhat similar to the Taylor rule, except that it features even greater persistence in interest rates, and the coefficients on output and inflation depend on the short–term interest rate elasticity of money demand. As the latter coefficient is low, this rule will strongly react to output and inflation movements, regardless of their source. This elasticity is also likely to be time–varying, so that the policy link between interest rates and output and inflation may be quite unstable. In addition, the rule features changes in velocity and money demand as two direct sources of policy fluctuations, which adds to the overall volatility of the economy.

To the extent the authorities prefer the volatility of output and inflation delivered by money targeting, e.g., in the case of supply shocks, these outcomes are best achieved via an interest–rate–based policy. As can be seen in eq. (13), these relative variances can be obtained with an interest rate rule that responds to inflation and output in an aggressive way. This will help deliver the desired outcome while also avoiding the policy volatility that results from target adherence, which in the above case is given by $-\frac{1}{\omega_{rs}}\left(\Delta v_t - \Delta v\right)$ $+\frac{\omega_m}{\omega_{rs}}\hat{m}_{t-1} + \frac{1}{\omega_{rs}}\varepsilon_t^{m_d}$.

We now examine some of the impulse responses of the model. The response of the economy to a positive foreign demand shock is depicted in Figure (13). Under the Taylor rule, the increase in foreign demand raises the domestic output gap and creates a nominal depreciation, as foreign interest rates increase, all of which results in an increase in inflation and a gradual increase in interest rates. Under partial adherence to money targets the increase in money demand creates upward pressures on the interest rate, which increases on impact by more than under no adherence. Depending on how money targets are set, the jump in the interest rate is either immediately corrected (under optimal money demand forecasting) or results in a persistently large increase in interest rates (when $\alpha < 1$). The interest rate spike also reduces the nominal depreciation and in the case of $\alpha < 1$ results in a nominal appreciation. The tighter policy stance results in a smaller increase in output and inflation, again at the cost of large interest rate volatility.

Impulse responses of the model to shocks to liquidity and domestic demand are presented in the Appendix. When the authorities strictly adhere to money targets, liquidity shocks cause dramatic fluctuations in output and inflation, as opposed to no effects under an interest rate rule. Results for the domestic demand shock are similar to the foreign demand shock, though with larger relative volatility of macroeconomic variables, due to its faster propagation through the economy. In both cases, less responsive targeting rules ($\alpha < 1$) amplify the effects of the shocks on inflation.

IV. Empirical Application – The Kenyan Economy

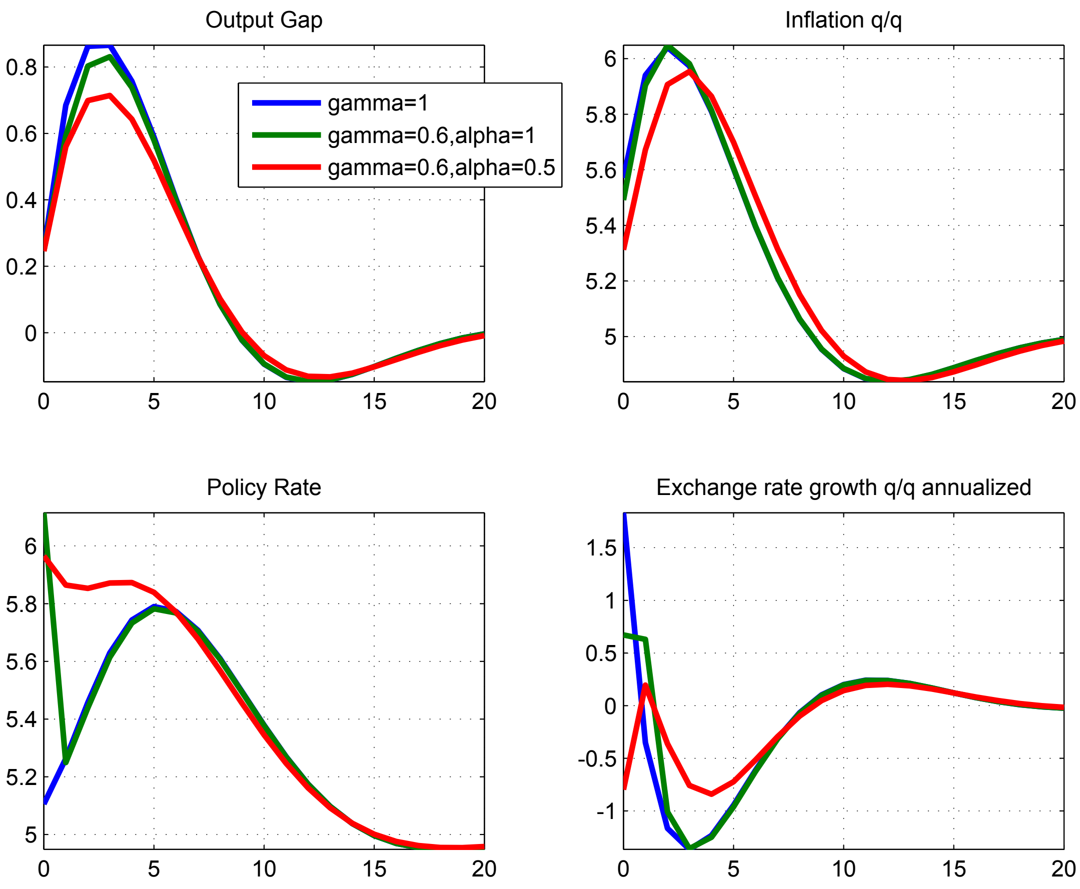
The model presented in the previous section is calibrated to Kenyan economy. We use the model to analyze movements in reserve money and its target, and to decompose the actual data into structural shocks. First, we briefly review the monetary policy regime in Kenya. Last, we demonstrate a potential role for money as a leading indicator.

A. The Monetary Policy Regime in Kenya – A Brief Review

The principal objective of the Central Bank of Kenya (CBK) is to achieve and maintain price stability and to sustain the value of the Shilling.[24] The CBK Act also requires the bank to support the growth objectives of the government and promote the health of the financial

[24] A more detailed discussion of the monetary policy stance is provided in [Andrle et al., 2013].

Figure 1: Foreign demand shock



sector. The price stability objective is reflected in the inflation target set by Ministry of Finance. Since December 2005, the target has been set to 5 percent with a tolerance of +/- 2 percent for year-on-year overall inflation.

Monetary policy is in principle based on a modified monetary aggregate framework. Reserve money targets are declared as the *de jure* operational target, broad money (M3) is considered an intermediate target and the Central Bank Rate (CBR) is supposed to signal the monetary policy stance, see e.g. [CBK, 2011], [Ndung'u, 2012]. Quantitative targets are set for net international reserves (NIR) and net domestic assets (NDA), following the Extended Credit Facility (ECF) program established with the IMF.[25]

The CBK employs repo operations (both repo and reverse repo) and cash reserve requirements (CRR) as the key instruments for managing liquidity in the money market. The repo operations have a 7–day maturity. Historically, the CBK has used repo operations to

[25]Following the latest revision of the monetary policy framework, the CBK has been using the CBR to guide interbank market rates, since early 2011. See e.g. [IMF, 2012, pp.15]

Figure 2: Money Market Rates and Central Bank Rate (CBR)

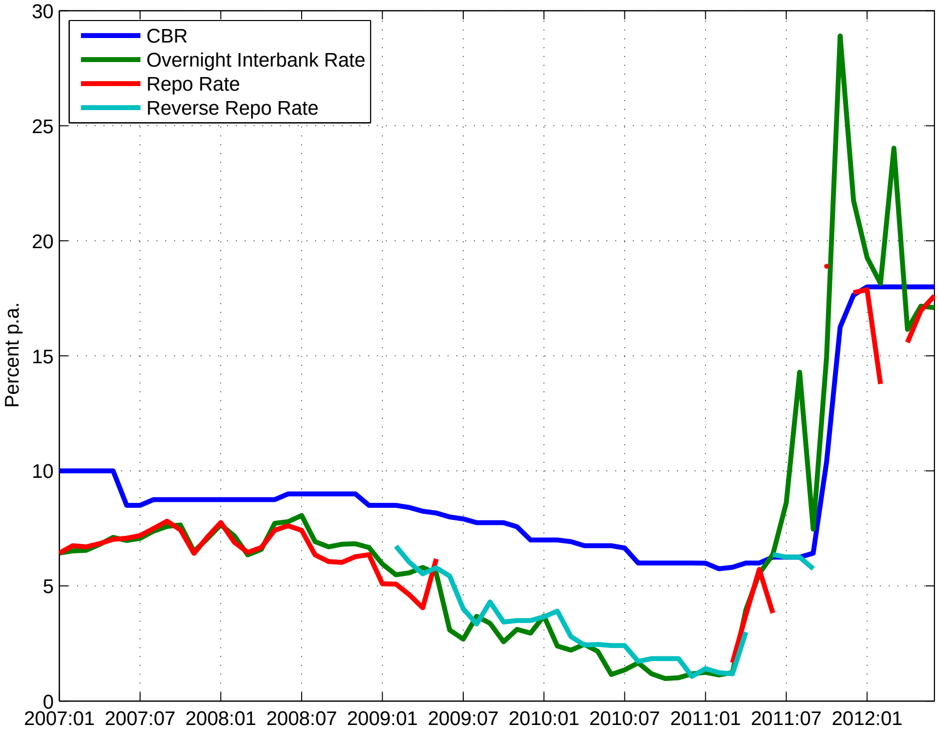
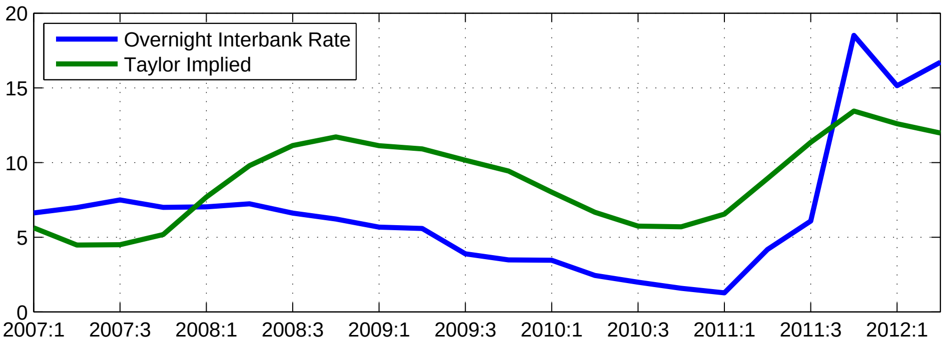


Figure 3: Overnight Interbank Rate and Taylor–Rule–Implied Rate



mop up liquidity in the banking system, although foreign exchange operations have also been used extensively at times.

The stance of monetary policy has been frequently adjusted without revising the money target. The corollary is that money target misses have been frequent, as we will see below. In addition, although the CBK is also meant to signal the monetary policy stance via the Central Bank Rate (CBR), the level of which is announced by the Monetary Policy Committee every two months, it relevance has varied over time. Prior to 2011, changes of the CBR rarely affected money market rates, even though it served as the reference rate for overnight borrowing at the CBK's standing facility. Since November 2011, the CBR has served as the reference for the bank's liquidity operations, and in 2012 the CBR has been used primarily as a ceiling for repo auctions. The CBR has become increasingly effective in guiding interbank rates.

Inflationary pressures, along with imperfections in monetary operations, led to severe volatility of short-term interest rates in 2011. The interbank market moved within a range of 11-30 percent in the second half of 2011 and early 2012, as shown in Figure (2). The central bank stayed away from the interbank market during several episodes in the second half of 2011, mainly to induce a liquidity shock and bring down inflation expectations. Complementary measures were also taken, including the introduction of reserve averaging and a minor increase in minimum reserve requirements, allowing for better liquidity management by commercial banks.

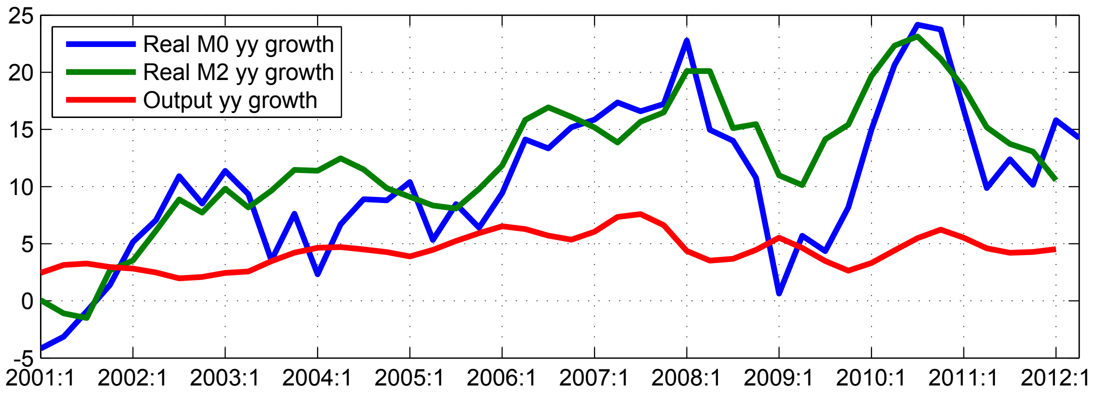
In the past, the CBK was slow to react when inflation exceeded its target.[26] In the face of inflation shocks, arising from exchange rate depreciation or hikes in commodity prices, it can be argued that the central bank found weak guidance from the evolution of monetary aggregates to make monetary policy decisions. The underlying assumption was that exogenous shocks would wane relatively quickly, without an impact on inflation expectations. Problems with the inflation index also added to the policy challenges until 2010, when a new index was introduced. In retrospect, 2011 was a breakthrough year: large food inflation had a significant impact on consumer prices and the exchange rate, which eventually led the central bank to redesign its monetary policy framework and tighten policy simultaneously. This helped bring inflation down, which even fell below target by end 2012.[27]

The stance of monetary policy in Kenya in recent years is well captured by deviations between the interest rate level and the interest rate implied by the Taylor rule in our model. The comparison is displayed in Figure (3) and extensively discussed in [Andrle et al., 2013]. This analysis identifies a prolonged period of monetary accommodation that lasted from early 2008 until late 2011. While the monetary accommodation did not result in high inflation in 2009 to mid 2010, as the economy was affected by spillovers from the global financial crisis, it did fuel inflationary pressures starting in mid–2010. The large policy tightening at the end of 2011 resulted in policy overshooting relative to the Taylor rule

[26]The target was missed at the end of 2004, at the beginning of 2005, in 2008, and most recently in 2011.

[27]Inflation increased to about 20 percent during 2011, from about 4 percent in mid 2010, before declining to less than 5 percent by end 2012.

Figure 4: Real Money and Output Growth



prescription, probably in order to build credibility for the redesigned policy framework. In the section below, we will study whether the inclusion of money targets in the analysis helps make sense of the policy stance during this period.

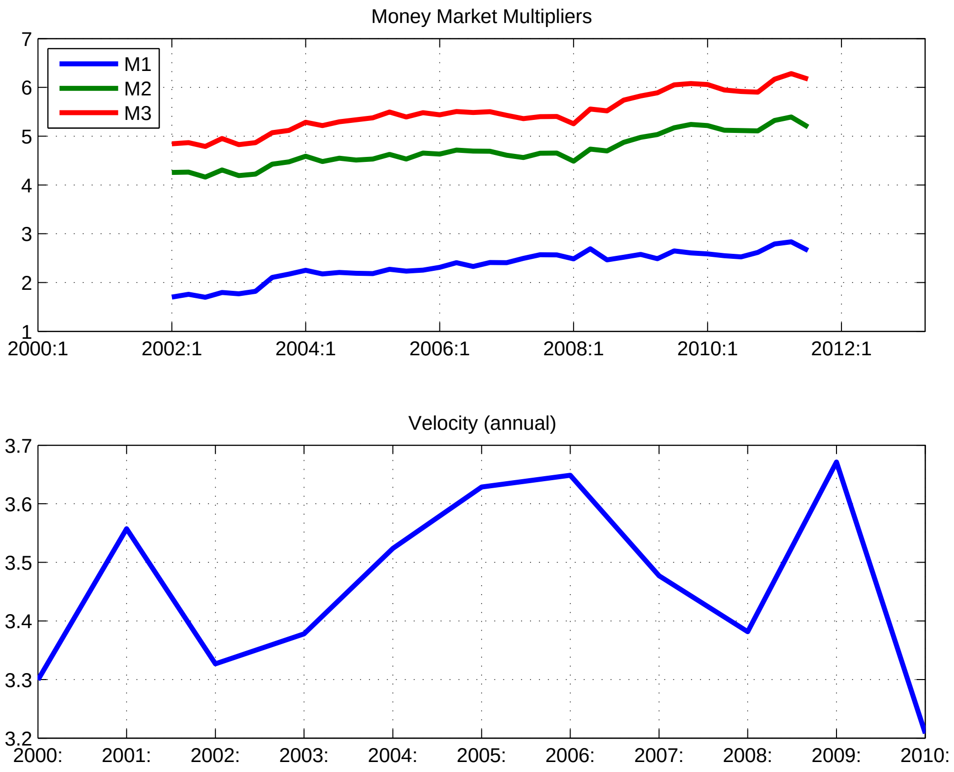
B. Money Demand in Kenya

Reserve and broad money in Kenya have experienced large swings in recent years.[28] Figure (4) displays year–on–year growth for real reserve and broad money since 2001. There are two clear periods of rapid money growth, 2005:4-2008:2 and 2009:2-2011:1, with a marked slowdown during the global financial crisis. Both reserve and broad money comove quite strongly, although broad money grows faster on average. Note that real output growth, which is also displayed in Figure (4), also comoves somewhat with real money balances, with a correlation of about 0.5 with both measures. Despite the comovement, money relations are quite unstable. First money multipliers have been somewhat volatile and increasing, especially since 2008, see Figure (5). This is reflected in the decline in the cash to deposit ratio, due to increasing financial intermediation driven mainly by mobile-based banking initiatives (as the mobile–phone–based payment system M–pesa). In addition, deviations between real money and output growth imply that velocity has also been volatile and displayed large swings, as displayed in Figure (5).

The money demand function in (1) has been calibrated to the Kenyan economy. The calibration is presented in Table (3); it combines econometric estimates with prior judgments

[28]Reserve money comprises currency in circulation (currency outside banks and cash held by commercial banks in their tills) and deposits of both commercial banks and non-bank financial institutions held with the CBK. However, it excludes Government deposits. Aggregate M3 includes currency outside the banking system, demand deposits, time and saving deposits, certificates of deposits, deposit liabilities of non-bank financial institutions and residents' foreign currency deposits, see [CBK, 2012].

Figure 5: Money Multipliers and Velocity



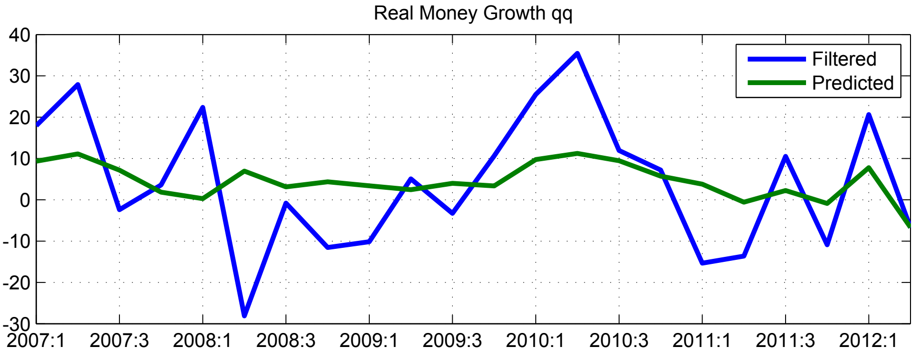
and restrictions imposed by the balanced growth path of the model. Consistent with the above discussion, shocks to liquidity and velocity are quite volatile. A corollary of this volatility is that the endogenous dynamics of the model cannot account for much of the variation in reserve money growth. This is reflected in Figure (6), which compares actual real reserve money growth (quarter on quarter) filtered through the model with the real money growth *predicted* by the model. The difference, which is accounted for by shocks to velocity and liquidity, is quite large, providing further evidence of the volatility of money demand.

C. Money Targets

Money targets and the actual path of reserve money move together over the medium term, but there are persistent target misses. Both variables are presented in Figure (7). Reserve money has been above its target for most of the period, except during the global financial crisis, during which it fell below target. Target misses have fluctuated between plus and minus ten percent of the quarterly level of reserve money, and they also display persistence. Casual inspection of both series suggests that targets are revised to reduce or correct the target miss, i.e., money targets increase (decrease) when there is a positive (negative) target miss.

We run a vector error–correction estimation to assess the money/target relation and help

Figure 6: Money Growth: Filtered vs. Predicted.



calibrate the rule in (8). We estimate the following system:

$$\begin{bmatrix} \Delta M_t \\ \Delta \overline{M}_{T,t} \end{bmatrix} = C + \Phi \begin{bmatrix} \Delta M_{t-1} \\ \Delta \overline{M}_{T,t-1} \end{bmatrix} + \Gamma \left[M_{t-1} - \overline{M}_{T,t-1} \right] + e_t,$$

where $e_t = [e_{M,t}, e_{\bar{M},t}]$. Results are presented in Table (2). The growth in money targets is driven mainly by two factors: correcting for previous target misses and innovations, with little role for lagged target growth. Regarding the former, the correction is less than complete: target misses result in an increase in the growth rate of target that is less than one (0.67). Results in Table (2) have direct implications for the calibration of targeting rule (8), which can be rewritten as:

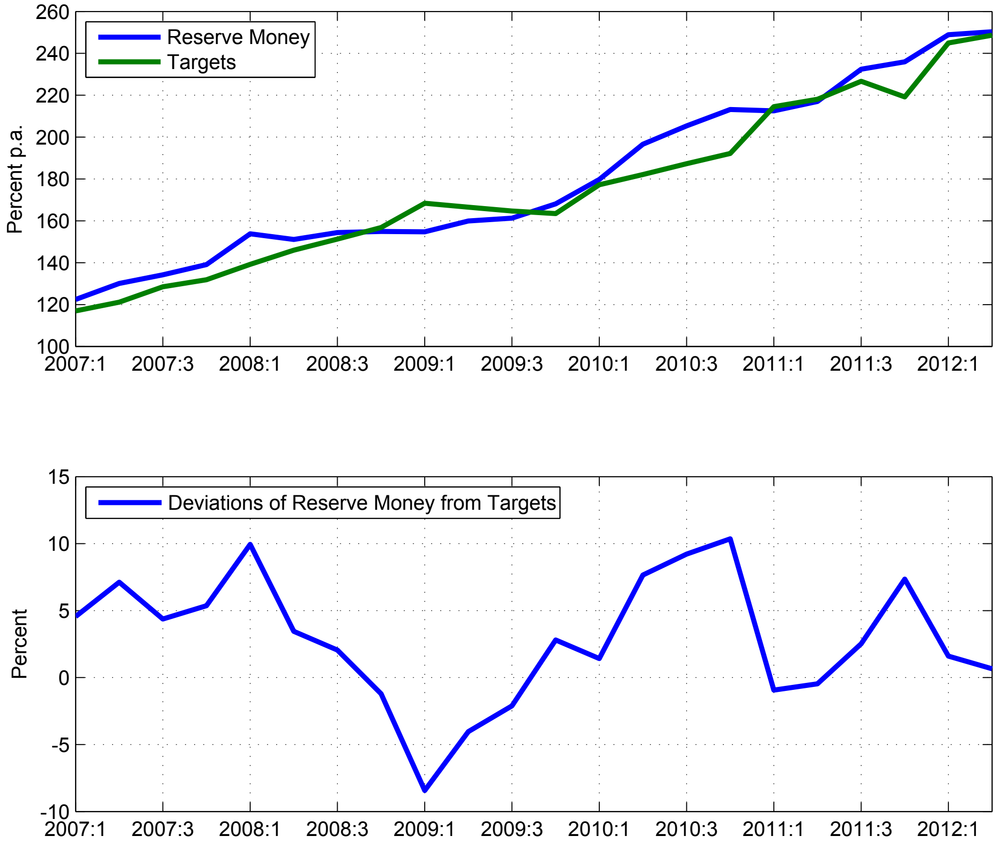
$$\Delta \overline{M}_{T,t} = (1-\alpha)\, \Delta \overline{M} + \alpha\, (1-\rho_{\bar{M}})\, \Delta \overline{M}_{T,t-1} + \alpha \rho_{\overline{M}} \left[M_{t-1} - \overline{M}_{T,t-1} \right] + \alpha \rho_{\bar{M}} \Delta \overline{M}_t.$$

The VECM results imply $\alpha = 0.7$ and $\rho_{\overline{M}} = 1$. They also suggest that money targets are set using considerable information about future money demand, the R^2 from the regression is quite low, yet innovations to the money target are correlated with innovations to actual money growth. Finally, Table (2) indicates that the dynamics of money growth are completely unrelated, from a statistical perspective, to past target values.

D. Do Money Targets Matter for Monetary Policy in Kenya?

Various evidence on monetary aggregates suggest that target adherence $(1-\gamma)$ has been very weak in Kenya. First, the large volatility of realized money growth suggest that money demand shocks have been for the most part accommodated. Second, the size and persistence of money target misses suggest target adherence has not been a policy priority. Third, the observation that money targets do not depend at all on past money target growth values or past target misses suggest that money targets have not steered money growth in any meaningful way, whereas the opposite is true: target misses steer the growth rate of target growth. Finally, while the positive correlation between target innovations and money growth

Figure 7: Actual Reserve Money and Reserve Money Targets



innovations is in principle consistent with money targets affecting money growth, it is equally consistent with money targets providing a reasonable forecast of future money growth, but without implying any causation.

The relation between interest rates and money target misses is also suggestive of weak target adherence. Unlike other countries in the region in which money targets play a more central role in policy, interest rates do not display the type of quarterly noise, i.e., one-off movements, that would be expected under money targeting.[29] More importantly, money target misses do not help understand changes in the policy stance, unlike what is suggested by (12). To recap, equation (12) implies that positive target misses (money above its target) should result in increases in interest rates above the Taylor rule, and viceversa, all else equal. To see whether this relation holds in the date, the policy stance ($rs_t - rs_{R,t}$) and the target miss ($M_t - \overline{M}_t$) are displayed in Figure (8). The episode of persistent policy accommodation observed between 2008 and 2011 coincides with money target misses oscillating from negative (money falling below its target) during the global financial crisis to positive during 2009:3 to 2011:1. During the latter period, episodes of positive target misses are associated with interest rates being below the Taylor–implied rate. Although in principle the empirical evidence could still be consistent with eq. (12), with the difference between the two variables in Figure (8) explained by offsetting movements in the monetary policy shock, the more likely explanation is that money targets have not played a systematic role in monetary policy making.

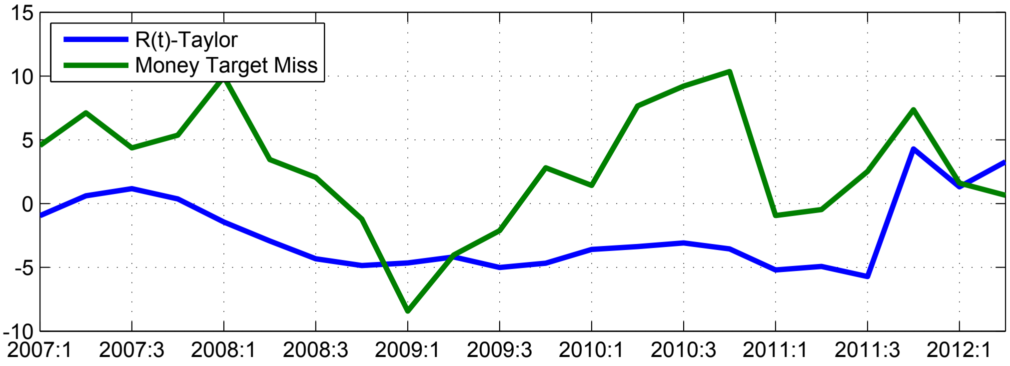
The calibration of the model is consistent with this empirical evidence. We set $\gamma = 0.99$, which suggests a very small, almost negligible, role for money targets in the policy framework. Since quarterly money target misses are annualized, the above specification implies a one percent increase in the money target miss results in a increase in interest rates of 7 basis points. This compares with a one percentage increase in expected inflation resulting in an immediate increase in interest rates of 43 basis points, and a long run increase of 170 basis points. Note that this calibration is specific to Kenya, and it may vary considerably in other countries in which money targets play a larger role.[30]

We also assessed the possibility that target adherence was non–negligible but time varying, but the evidence is inconclusive. The CBK sets its money targets six months ahead. Assuming that these targets are conditioned on the same information set, it could be conjectured that the optimal forecast for money one quarter ahead is more precise than the forecast two quarters ahead, and therefore that the central bank adheres more closely to its one–quarter ahead target than its two–quarter ahead target. If so, adherence would time-varying, it could also mean that the effective target (two–quarters ahead) has in fact changed. Figure 9 plots a distribution of deviations of money from its target in the first and the second period. Although the second period misses are on average larger, one cannot make

[29]This is the case in Tanzania, and in Uganda before 2009. See [Berg et al., 2013] for a discussion.

[30]See [Davoodi et al., 2013] for an application to Tanzania.

Figure 8: Policy Stance and Target Misses



a conclusive statement due to the small sample size and the presence of outliers.[31] We therefore maintained the assumption of constant (but very low) target adherence.

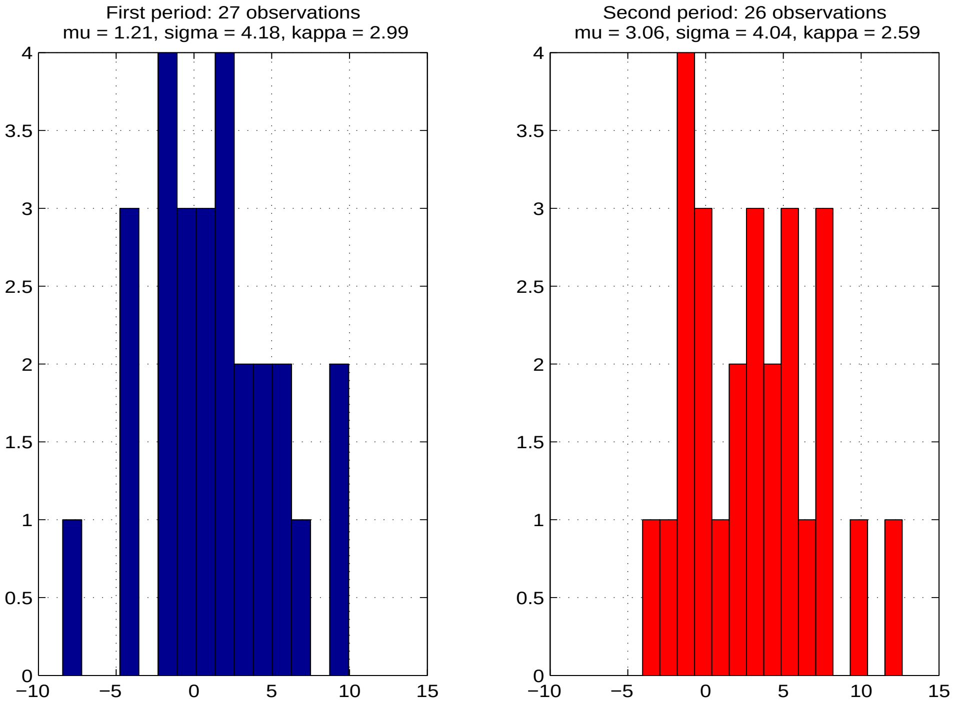
E. A macroeconomic decomposition of money targets and monetary policy in Kenya

The previous analysis has been based on a partial equilibrium context. We now use the model to make sense of developments in monetary aggregates and targets in the context of a comprehensive assessment of the state of the economy and of the monetary policy stance. Even if, as foreshadowed in the discussion of the previous section, we find that money aggregates do not shed much additional light on macroeconomic developments or monetary policy, the approach we present here may be useful in other contexts, in which monetary policy is more money–aggregate–based. In particular, we will see how we can systematically and coherently analyze the setting of money targets, the causes of misses, and the implications for monetary policy. Of course the results we get depend on the other elements of the model, such as the volatility of supply and demand shocks. But this is a feature of the world, not of this particular approach, and we believe that the model can help put the various pieces together explicitly.

As part of the filtration of Kenyan macro data through the model, we recover a model–based decomposition of all the relevant variables into the different shocks: demand shocks, supply or inflation shocks, etc. A similar analysis was done in [Andrle et al., 2013] for other macro variables such as sectoral inflation and the output gap; here the emphasis is on money target misses. We are particularly interested in whether money target misses reflect shocks to monetary policy or shocks to money demand (both liquidity and velocity). This is the standard problem facing policy makers in countries with money targets, yet the analysis of target misses has, until now, suffered from lack of a comprehensive framework. In practice

[31] Figure 9 presents histograms of the first period after the declaration of target and the second period. The mean, standard deviation and kurtosis is indicated. Note, that the kurtosis of Gaussian distribution is 3.

Figure 9: Reserve Money Deviations from Target

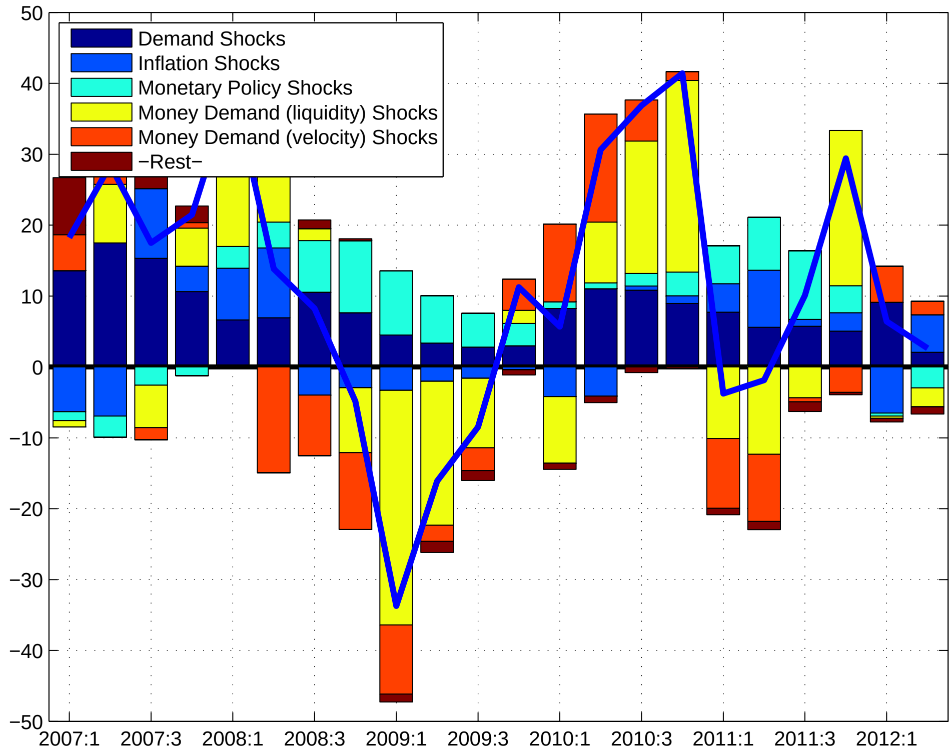


this has resulted in assessments made purely on judgement and on an ad–hoc basis: if inflation is high then target misses are typically considered as driven by monetary policy, otherwise target misses are interpreted as reflecting money demand shocks with little implications for inflation.

The issue of the sources of target misses is related but different from the issue of whether money targets matter for the stance of policy. Mechanically, the two issues are related because the decomposition of target misses into shock depends on the calibration for γ. In the extreme case that $\gamma = 0$, the only possible explanation for target misses is a monetary policy shock, see eq. (3). If γ is instead closer to one, as in our calibration, then target misses will be accounted for by monetary policy shocks insofar as these shocks result in changes in the demand for nominal money balances, via their effects on short–term interest rates. In the latter specification, the transmission of the shock to monetary aggregates is less direct, but is more likely to reflect the way monetary policy shocks are transmitted into the economy. Beyond this mechanical relation, the analysis of target misses can provide a crosscheck on the assessment of monetary policy, even when target adherence is low as in Kenya. If targets reflect monetary policy shocks to some extent, then they can provide additional confirmation that the policy stance is tight or loose. Such cross check can be valuable in data–poor environments, as is the case in many LICs.

The model interpretation of actual data suggests that money target misses were mainly driven by shocks to money demand. The decomposition is shown in Figure (10). Each bar in the figure denotes the contribution of the particular shock to the target miss. Regarding monetary

Figure 10: Reserve Money Target Misses, Shock Decomposition



policy shocks, 2010 provides an interesting exception in that monetary policy shocks did contribute to target misses in that year. The CBK was aware of the misses, yet the frequent overshooting was not considered a threat for inflation as intermediate objectives—broad money, credit growth, and NDA—were close to their targets.[32] The observed overshooting was also consistent with the accommodative monetary policy pursued by the CBK during that period, as reflected in the analysis of interest rates shown in Figure (3). There are however other periods in which positive monetary policy shocks are associated with negative target misses. This is the case during the global financial crisis and in 2011. Business cycle shocks, such as demand and supply shocks, have played a small role in driving target misses, although they have contributed to lower frequency movements.

F. Model–Based Real-Time Analysis and Money as an Indicator Variable

As documented in [Andrle et al., 2013], the forecasting properties of the model are adequate to its use. Forecasting is an endeavor filled with judgment, yet the model itself needs to be a relatively reliable tool, if it is to be used for informing policymakers about the state of the economy. In contrast to our companion paper, here we analyze one step-ahead predictions of the model for output, food and non-food inflation and aggregate inflation, all conditioned on available information about the exchange rate, nominal policy variables (including money)

[32]See e.g. Monetary Policy Statement, June 2011, Central bank of Kenya.

and foreign variables. These are the high–frequency variables that would be available to the central bank in real time. This is effectively a nowcasting problem, which we briefly discuss here.

Most of the analysis in this paper has focused on the setting of and adherence to money targets as a potentially important component of the monetary policy regime. However, even if money targets do not play a central policy role, as seems to be the case *de facto* in Kenya in recent years, they may still contain important information. Monetary aggregates are available to central banks in a timely manner and the reporting and accounting system is under their direct control. This is not the case of other relevant macroeconomic variables, such as GDP. Money aggregates may—to the extent that money demand is stable—belong among other immediately–available variables such as interest rates, exchange rates, and other foreign variables that may help nowcast GDP and inflation. [33]

Adding money block to the analysis improves the model's nowcasting performance. Intuitively, a one-step ahead prediction based on the economic dynamics of the model is sharpened by any available information – exchange rate, interest rate, money balances, etc.[34] Figure 11 presents a simple exercise of nowcasting real output and inflation based on information on money aggregates, interest rate, exchange rate and foreign output, inflation and rate of interest. A closer analysis reveals that the use of monetary aggregates lowers the uncertainty of our estimates, but it is not the major success factor relative to other variables such as the exchange rate. The conditioning information lowers the uncertainty of forecasts and nowcasts. The confidence intervals for conditional estimates are narrower than without the use of indicators available. In the case of CPI inflation the confidence bands shrink by 8 percent, in case of output growth the gain is 16 percent. We leave a more in–depth analysis of nowcasting for future work.[35]

V. CONCLUSIONS

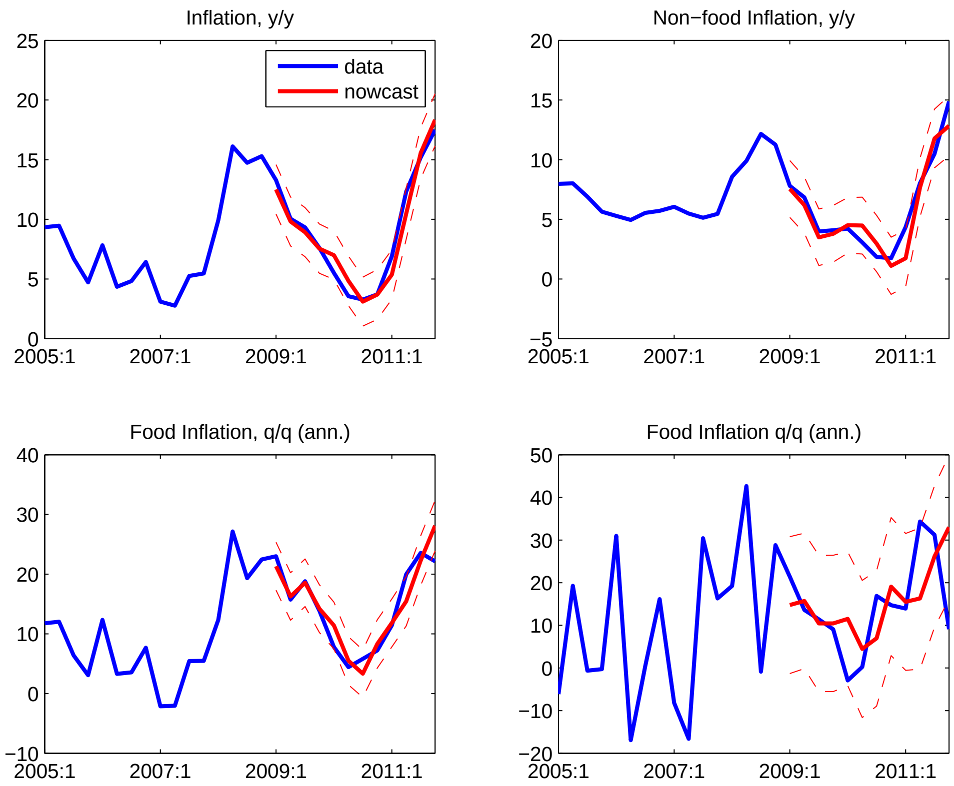
This paper presented a strategy for incorporating money–targeting into the framework in [Andrle et al., 2013] and assessed its relevance for Kenya, a *de jure* money targeter. We

[33]In the case of the Euro area, [Coenen et al., 2005] show that money may bear substantial information about real output.

[34]The approach of this paper is simpler than the one by [Coenen et al., 2005]. We still can assume that the agents in the model feature complete information. It is just the economist who uses the model who does not have all the information. In practical terms the model is used as an empirical coherent dynamic system of the economy, that can be used for filling gaps in the data.

[35]Many central banks have large nowcasting systems, more sophisticated than our model, using a wide–range of monetary and other financial variables. The frequency of the analysis can range from monthly to quarterly, and the use of high-frequency data on industrial production, purchasing managers indices, car sales, surveys and other prominent coincident and leading indicators is common. Models are particularly useful for such an exercise, be it small semi-structural system based on expert judgment or some form of dynamic factor models. Such models can accommodate changes in money velocity and variance of liquidity shocks, similarly to the structural model presented here.

Figure 11: Nowcasting with the Model



use a dynamic economic model to investigate mixed operational targets and thus monetary policy regimes with different degree of adherence to money targets. We use the model to interpret target misses. We also illustrate the indicator value of monetary aggregates, all within a single, consistent framework.

We find that, while money targets are set in a forward looking manner, they do not play a systematic role in Kenyan monetary policy. We characterize the setting of money targets primarily as a money demand forecasting exercise, based on the empirical evidence. We also find that the dynamics of interest rates and monetary aggregates are not systematically related to money targets or money target misses, which we interpret as evidence that money target adherence has been very weak.

Using the model to provide a historical interpretation of Kenyan data, we find that money target misses were mainly driven by shocks to money demand. The analysis suggests that policy shocks contributed to the misses in 2010. Business cycle shocks played a small role, but did contribute to lower frequency movement. The analysis of money target misses validates the weak target adherence observed in Kenya.

Our results suggest that stronger adherence to pre-announced money growth targets leads to increased volatility of macroeconomic variables, particularly money market rates. Sticking to pre-announced money growth targets creates imbalances in money markets facing frequent shocks and implies potential for interest rate volatility and uncertainty, even when the policy rule is rather forward–looking. The instability of money demand and money multipliers contributes to the infeasibility of strong adherence to money targets, but is far from being the sole reason for our results. Notably, supply and demand shocks push money demand in ways that tend to result in undesirable macroeconomic volatility when policy is too focused on the attainment of money targets.

Under any policy regime, monetary aggregates may have an empirical for value for nowcasting the state of the economy, given the publication lags for key macroeconomic data such as output and inflation. We demonstrate that our model can provide reasonable nowcasts of real output and food and non-food inflation given contemporaneous values of interest rates, exchange rates, and foreign variables, and that monetary aggregates generally improve these forecasts. Of course, this use of monetary aggregates does not distinguish them from other potentially useful high–frequency indicators such as industrial production and surveys of expectations.

The paper pointed out a distinction between monetary policy strategy (macro) and monetary policy operations (micro). Monetary policy strategy chooses a policy stance via appropriate level and expected path of interest rates, which affect aggregate demand, exchange rate and prices. Monetary policy operations, on the other hand, focus on daily implementation of policy stance, liquidity management and setup of central bank instruments. We argued that a suboptimal setup of monetary operations my hamper policy implementation and lead to liquidity crunches and volatility of interbank interest rates, as witnessed in Kenya recently.

Given the setup of our model and also many of our results, it is perhaps hard to understand why a central bank would in fact use money targets. In the case of Kenya, we argue that in fact they do not use them very much. Other countries may be different, however. Either they use money targets for reasons not modeled here, such as to achieve credibility or because incomplete financial markets make it difficult to observe the interest rate. For these central banks, the model presented in the paper may be a useful practical tool. As shown in the case of Kenya, it is able to provide a better view on factors affecting the business cycle. It helps identify structural shocks behind target misses. It also provides a platform to assess the macroeconomic implications of potential policy changes aimed at higher target flexibility.

There are several caveats to our analysis. Our analysis deals with low-income countries without fiscal dominance. Second, our dynamic model does not account for issues of limited credibility and imperfect, heterogeneous information. In case of incomplete information in the model, the role of money as an indicator variable would be enhanced. However, the main result on inflexibility of the strong adherence to pre-announced targets should remain untouched. Addressing caveats to this paper is subject to our further research.

Our analysis does not address the possibility that the transmission of monetary policy decisions to the real economy and inflation may itself be hampered by the choice of the policy regime. It can be argued that, mixed regimes, which pay some attention to both monetary aggregates and interest rates, can sometimes send confusing signals about the stance of policy to market participants, thereby weakening the expectations channel of monetary policy and reducing the effectiveness of policy. This argument would suggest that countries wishing to modernize their policy frameworks may consider switching to interest–rate–based regimes altogether. We leave a more formal analysis of signalling for future work.

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Table 1: Standard Deviations

	rs_t	π_t	$ygap_t$	$\Delta sgap_t$
Demand Shocks	Absolute Standard Deviations			
Friedman Rule ($\alpha = 0, \gamma = 0$)	4.8	0.3	0.8	7.5
Forward–looking rules ($\alpha = 1, \rho_{\bar{M}} = 1$):	Relative to Friedman Rule			
$\gamma = 0$	1.0	1.0	1.0	1.0
$\gamma = 0.25$	0.8	0.8	1.0	0.8
$\gamma = 0.5$	0.5	0.6	1.1	0.6
$\gamma = 0.75$	0.3	0.4	1.2	0.3
$\gamma = 1$	0.0	0.5	1.3	0.0
Supply Shocks	Absolute Standard Deviations			
Friedman Rule ($\alpha = 0, \gamma = 0$)	2.4	1.3	0.8	6.2
Forward–looking rules ($\alpha = 1, \rho_{\bar{M}} = 1$):	Relative to Friedman Rule			
$\gamma = 0$	1.1	1.3	0.7	0.8
$\gamma = 0.25$	0.9	1.3	0.7	0.7
$\gamma = 0.5$	0.7	1.3	0.7	0.5
$\gamma = 0.75$	0.5	1.4	0.6	0.4
$\gamma = 1$	0.4	1.4	0.6	0.3
Money Demand Shocks	Absolute Standard Deviations			
Friedman Rule ($\alpha = 0, \gamma = 0$)	1.0	0.3	0.2	1.9
Forward–looking rules ($\alpha = 1, \rho_{\bar{M}} = 1$):	Relative to Friedman Rule			
$\gamma = 0$	1.1	0.3	0.7	0.8
$\gamma = 0.25$	0.9	0.3	0.6	0.7
$\gamma = 0.5$	0.6	0.2	0.4	0.5
$\gamma = 0.75$	0.3	0.1	0.2	0.2
$\gamma = 1$	0.0	0.0	0.0	0.0

The table shows standard deviations for selected variables from simulations of the model under a a subset of the shocks. Demand shocks denote shocks to the IS equation, supply shocks denote shocks to the Phillips curves for food and non–food inflation, and money demand shocks denote shocks to liquidity and velocity. Several specifications are presented: the Friedman rule ($\alpha = 0, \gamma = 0$) and forward–looking policies with varying degrees of target adherence. Standard deviations under Friedman rule are displayed in absolute terms, other results are presented relative to Friedman rule results.

Table 2: Standard Deviations

	ΔM_t		$\Delta \bar{M}_{T,t}$	
	Coeff.	t stat.	Coeff.	t stat.
$Constant$	0.015	2.99	0.010	1.82
ΔM_{t-1}	0.187	1.03	-0.131	0.64
$\Delta \bar{M}_{T,t-1}$	0.034	0.30	-0.048	0.38
$M_{t-1} - \bar{M}_{T,t-1}$	0.054	0.44	0.667	4.81
R^2	0.063		0.395	
$Corr(e_{M,t}, e_{\bar{M},t})$	0.375			
$Number\ of\ obs.$	56			

APPENDIX I. A BESTIARY OF MONEY GROWTH RULES

There are many different types of rules for money growth. These range from strict money targeting rules—Friedman rules—to flexible rules following [McCallum, 1998]. As we have already shown in the case of the Friedman Rule, money growth rules are isomorphic to the interest rate rule of the Taylor type, and their properties are best assessed by looking at their implications for interest rates. We briefly review some of these rules.

Strict money growth rules. A strict money targeting rule implements a constant growth rate for money, consistent with the steady-state (equilibrium) growth of the economy and the inflation target. Such a rule, as in (A1), can also account for changes in velocity, v_t.

$$\Delta M_t = \overline{\Delta} M_t = (\Delta \overline{y}_t + \overline{\pi}_t) + \Delta v_t. \tag{A1}$$

Endogenous money growth rule with full adherence. This rule would keep money growth on a target, $\Delta M_t = \Delta \overline{M}_t$. However, compared to the strict rule, the target of money growth is set in response to inflation deviations from a target or the business cycle position. An example of such a rule is presented below:

$$\Delta M_t = \Delta \overline{M}_t = \Delta y_t + \pi_t + v_t - \left(\alpha_\pi(\pi^{4,cpi}_{t+i} - \overline{\pi}^{4,cpi}_{t+i}) + \alpha_y \hat{y}_t\right) + \varepsilon^{m_s}_t. \tag{A2}$$

Equation A2 is a variant of what is referred to as a McCallum rule (see [Razzak, 2003]), yet more flexible. Besides YoY inflation deviation from a target, $\pi^{4,cpi}_{t+i} - \overline{\pi}^{4,cpi}_{t+i}$, and the output gap, $\hat{y}_t$, the monetary authority steers money growth to accommodate the needs of the real economy, represented by nominal GDP growth, $\Delta y_t + \pi_t$, and changes in velocity. Such an accommodative rule mitigates the volatility of market interest rates, relative to the more strict version presented above.

Money growth targeting with partial adherence. By partial adherence we mean the case when the announced money growth target is abandoned in order to smooth money market interest rates as described in [Berg et al., 2010]. The partial adherence case is discussed in detail in this paper.

Table 3: Calibration of the Money Block Parameters

Parameter	Description	Value	Source/Remarks
	Money Demand		
ω_y	Elasticity to real output growth	1.00	Theory and VEC estimate
ω_{rs}	Elasticity to nom. interest rate changes	0.56	System Properties (S.P.) and VEC estimate
ω_m	Elasticity to real money gap	0.34	S.P. and VEC estimate
ψ_{const}	Money demand constant	1248.00	S.P. and VEC estimate
ψ_y	Elasticity to real output	1.00	Theory and VEC estimate
ψ_{rs}	Elasticity to nom. interest rates	0.02	S.P. and VEC estimate
	Velocity		
ρ_v	Autoregressive parameter	0.25	S.P.
$\bar{v}$	Steady state growth	-0.5	Observed data
	Hybrid Policy Rule		
γ	Weight on the Taylor rule implied rate	0.99	S.P.
	Money Target		
α	Weight on expected money demand	0.7	Observed data
$\rho_{\hat{M}}$	Speed of money target adjustments	1	S.P.
	Taylor Rule		
γ_1	Interest rate smoothing	0.80	S.P.
γ_2	MP sensitivity to inflation deviations	1.40	S.P.
γ_3	MP sensitivity to the output gap	0.00	S.P.
γ_4	MP sensitivity to nom. appreciation	0.25	S.P.

Table 4: Calibration of Standard Deviations (STD) of Shocks

Shock	Description	STD	Source/Remarks
	Money Demand		
ε^{md}	Liquidity shock	0.50	S.P.
$\varepsilon^{md}_{t\|t-1}$	Expected money demand shock	1.00	S.P.
	Velocity		
ε^{v}	Velocity shock	0.50	S.P.
	Hybrid Policy Rule		
ε^{d}	MP shock	0.30	S.P.

APPENDIX II. CALIBRATION OF THE MODEL

Parameters of the model were calibrated to Kenyan economy, Table 3 and 1. Calibration can be characterized as an adaptive strategy of finding parameters values. It relies on observed data and expert knowledge about Kenyan economy. Confronting historical interpretation of actual data by model, historical data filtration, with economic intuition helps to determine parameters values.

Table 5: Reserve Money Data

Variable	Data	Source	Remarks
M	Reserve Money (billions of KES)	CBK	Monetary Policy Statements
$\overline{M}$	Reserve Money Targets (billions of KES)	CBK	Monetary Policy Statements

APPENDIX III. DATA

We use data described in [1]. Additional data related to the money block in the model are described in Table 5. Data are seasonally adjusted.

APPENDIX IV. IMPULSE RESPONSE FUNCTIONS

Figure 12: Domestic demand shock

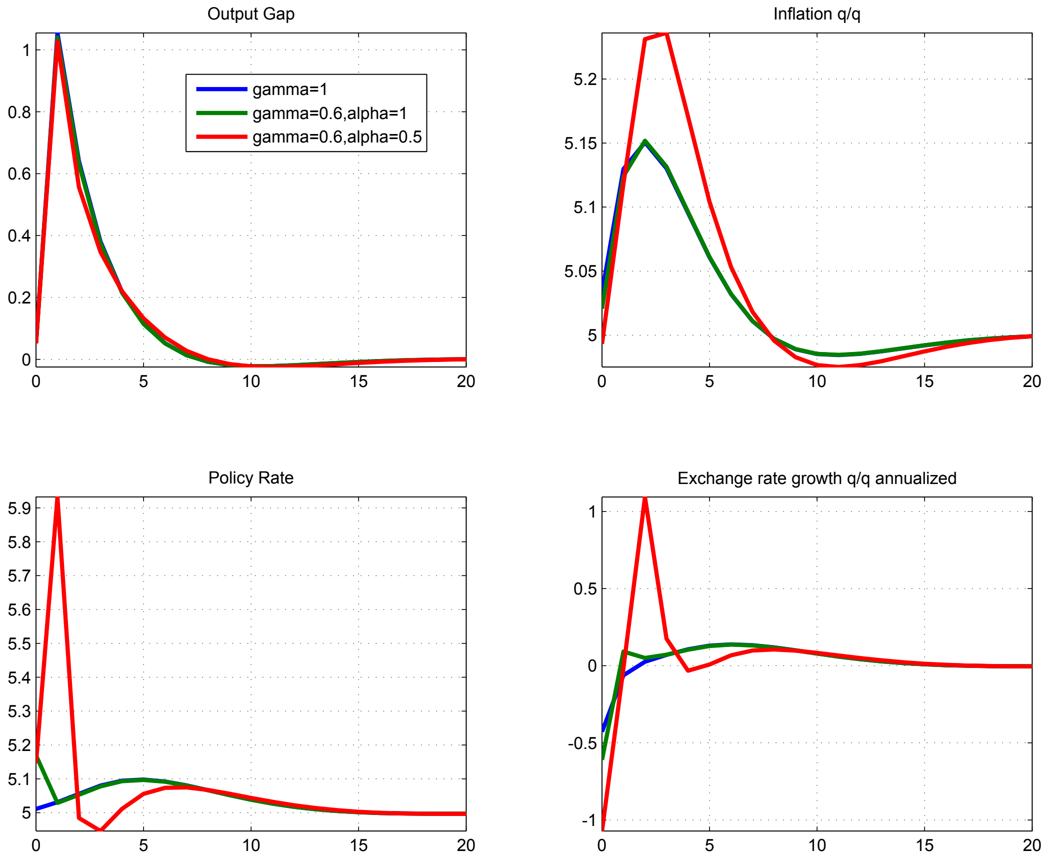

Figure 13: Money demand (liquidity) shock