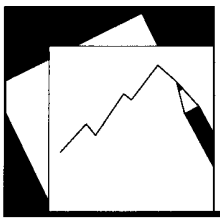
WP/06/300



IMF Working Paper

A VAR Analysis of Kenya's Monetary Policy Transmission Mechanism: How Does the Central Bank's REPO Rate Affect the Economy?

Kevin C. Cheng

INTERNATIONAL MONETARY FUND

 WP/06/300

IMF Working Paper

African Department

A VAR Analysis of Kenya's Monetary Policy Transmission Mechanism: How Does the Central Bank's REPO Rate Affect the Economy?

Prepared by Kevin C. Cheng[1]

Authorized for distribution by Godfrey Kalinga

December 2006

Abstract

This paper examines the impact of a monetary policy shock on output, prices, and the nominal effective exchange rate for Kenya using data during 1997–2005. Based on techniques commonly used in the vector autoregression literature, the main results suggest that an exogenous increase in the short-term interest rate tends to be followed by a decline in prices and appreciation in the nominal exchange rate, but has insignificant impact on output. Moreover, the paper finds that variations in the short-term interest rate account for significant fluctuations in the nominal exchange rate and prices, while accounting little for output fluctuations.

JEL Classification Numbers: E52; E58

Keywords: Monetary Policy; Monetary Transmission Mechanism

Author's E-Mail Address: Kcheng@imf.org

[1] The author would like thank Godfrey Kalinga, Anne-Marie Gulde-Wolf, and Lusine Lusinyan for their helpful comments.

Table of Contents

I. INTRODUCTION

Despite the importance of Kenya's financial role in East Africa, relatively little analytical work has been done on the transmission mechanism of monetary policy, which is essential to the appropriate design, management, and implementation of monetary policy. Further research on this area could help to shed light on such questions as: what accounts for the double-digit inflation in Kenya between September 2004 and June 2005? What are the trade-offs between output stabilization and price stability? How does monetary policy affect movements in the exchange rate?

The transmission mechanism of monetary policy has been an area of abundant economic research in many countries. A prominent recent trend in this field has been the empirical analysis of how a monetary policy shock, usually defined as a temporary and exogenous rise in a short-term interest rate, affects output, prices, exchange rates, as well as other key economic variables. Typically, this strand of research has been conducted in the context of a vector autoregression (VAR) framework pioneered by Sims (1980). Notable examples using VAR to identify transmission of monetary policy for advanced economies include Christiano, Eichenbaum, and Evans (2000) for the United States, Kim and Roubini (2000) for G-7 economies, as well as Peersman and Smets (2003) for the euro area.

As regards sub-Saharan Africa, a number of recent papers have also studied the monetary transmission mechanism for a number of countries in the region. For example, Saxegaard (2006) uses a threshold vector autoregression model for a number of sub-Saharan African countries and finds that excess liquidity in the region weakens the monetary transmission mechanism and thus the ability of monetary authorities to influence demand conditions in the economy. Aron and Muellbauer (2002) use multi-step models to study inflation and output in South Africa and finds important link between interest rates and output and that low inflation is associated with higher openness of the economy, low wholesale prices relative to consumer prices, high real exchange rate, low real mortgage payments, low real interest rates, low output gap, as well as low indirect tax rate. Durevall and Ndung'u (1997), using Kenyan data during 1974–1996, find that exchange rates, foreign prices, and terms of trade have long-term effects on prices, while interest rates and money supply have short-term effects.

This paper uses VAR techniques to analyze the monetary transmission mechanism in Kenya. Specifically, it seeks to answer the following two questions:

- How does a monetary policy shock—defined as a temporary and exogenous rise in the Central Bank Kenya's (CBK) Repurchase Agreement (REPO) rate—affect real output, prices, and the nominal effective exchange rate?

- How much do variations in the short-term interest rate account for fluctuations in output, prices, and the nominal effective exchange rate?

Using monthly data during 1997–2005, the paper observes the following[2]:

- A temporary exogenous rise in the CBK's REPO rate tends to be followed by a decline in prices and appreciation in the nominal exchange rate, with effects culminating 9–12 months after the incipient shock. The impact on output appears to be sluggish and small; and

- Variations in the short-term interest rate account for around one-third of the fluctuations in prices and half of the fluctuations in the nominal exchange rate, while accounting for around 10 percent of the output variation.

The empirical findings suggest a weak transmission mechanism from monetary policy stance to real variables, likely reflecting a slew of structural problems in the financial market, including inadequate financial infrastructure and weak legal framework. On the other hand, there appears to be a strong link between monetary policy and nominal variables. A plausible transmission mechanism is as follows: a rise in interest rates associated with a tight monetary stance makes domestic assets more profitable vis-à-vis foreign assets, resulting in capital inflows, thereby exerting appreciating pressure on the exchange rate. Strengthening domestic currency in turn makes imports cheaper, thereby easing inflation.

This paper is organized as follows: Section II briefly describes the institutional background and summarizes stylized facts about the Kenyan monetary economy; Section III presents the econometric framework and discusses the results and interpretations; Section IV concludes with policy implications and caveats. The appendix presents a robustness exercise for the analysis in Section III.

II. Institutional Background and Stylized Facts

A. The Monetary Policy Framework in Kenya

Objective of the Monetary Policy

The Central Bank of Kenya Act stipulates that "the principal object of the Bank shall be to formulate and implement monetary policy directed to achieving and maintaining stability in the general level of prices." In addition, "the Bank shall foster the liquidity, solvency, and proper functioning of a stable market-based financial system."

[2] The sample is truncated at 1997 because the CBK embarked on the open market operations using repurchase agreements to manage daily liquidity since end-1996. In addition, prior to the mid-1990s, Kenya undertook a host of drastic financial reforms, such as an exchange rate regime change, liberalization of trade and the capital account, as well as the removal of interest rate controls. Estimating the model using longer time series may capture extensive structural breaks, thereby rendering technical problems for the VARs.

Monetary Instruments

Monetary policy is conducted through monetary programming, with the broad money (M3X) as the intermediate target. Reserve money, comprising bank deposits at CBK and currency outside bank, serves as the operating target.[3]

Main tools that CBK uses to implement monetary policy include the following:

- Open Market Operations (OMO)—This is by far the main active monetary instrument most frequently used by the CBK to manage liquidity. The OMOs were conducted through sale and purchase of government securities using repurchase agreement (REPO) with commercial banks.[4] Auctions—where commercial banks bid for rates, which the CBK accepts or rejects—are held daily.

- Reserve Requirements—Commercial banks are required to maintain a daily proportion of their liabilities in cash—currently 6 percent—at the CBK. This is not an actively used monetary policy instrument.

- Other Instruments—These include Rediscount Facilities and Lender of Last Resort Facility, which have not been recently used as the key tools for implementing monetary policy.

B. Stylized Facts

Major developments of the monetary sector in Kenya during January 1998-June 2005 can be summarized with four stylized facts:[5]

- **Monetary stance began to loosen since mid-2002—**Tight monetary stance appears to have been one of the dominant features for the Kenyan economy between 1998 and 2002. As shown in Figure 1, nominal short-term interest rates were mostly double-digit prior to the second quarter of 2002, with a few exceptions of brief episodes of interest rates falling slightly short of 10 percent. Similarly, during the same period, annual year-on-year money growth rates appeared to have been moderate, with the reserve money growing at negative rates during some prolonged periods and broad money growing rather mildly (Figure 2). However, starting around the second and

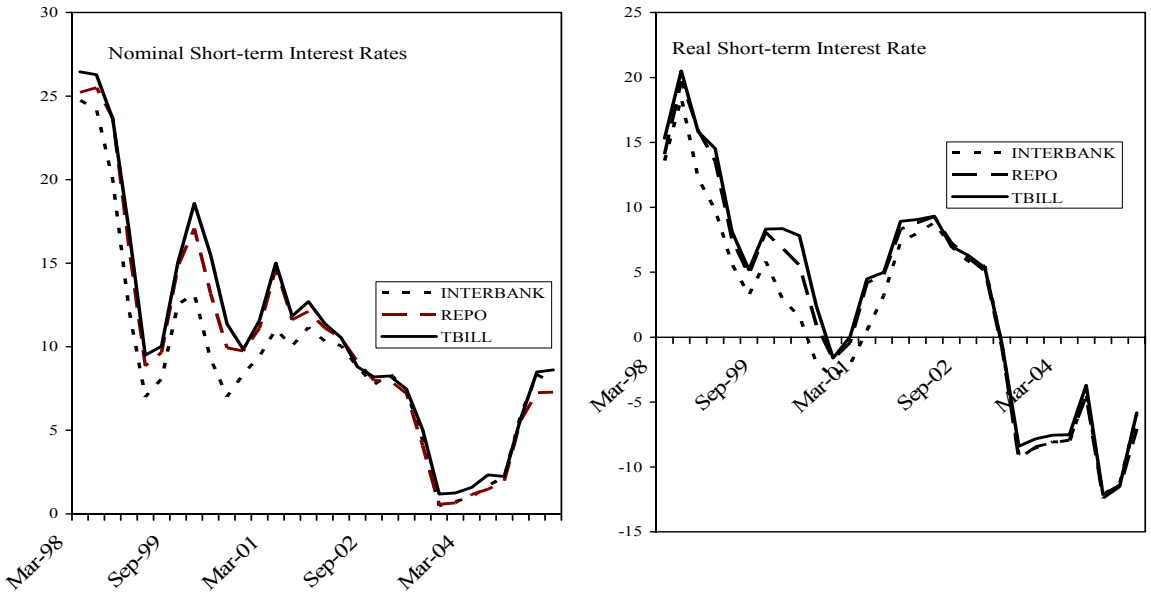
[3] Kenya has a managed-float exchange rate regime. Foreign exchange operations have not been geared towards managing domestic liquidity.

[4] While the OMO could also inject liquidity into the banking system, most operations in recent years had aimed at mopping up excess liquidity.

[5] While the sample period for the econometric analysis starts at 1997, one year is lost when computing the growth rates for some variables. Therefore, the stylized facts only focus on developments since 1998.

third quarters of 2002, looser monetary policy stance came into force, with nominal short-term interest rates beginning to fall below 10 percent and continuing to fall to less than 1 percent in 2004, resulting in a prolonged period of negative real interest rates since the first quarter of 2003. Corresponding to these developments are accelerated growth rates for the money supply.[6]

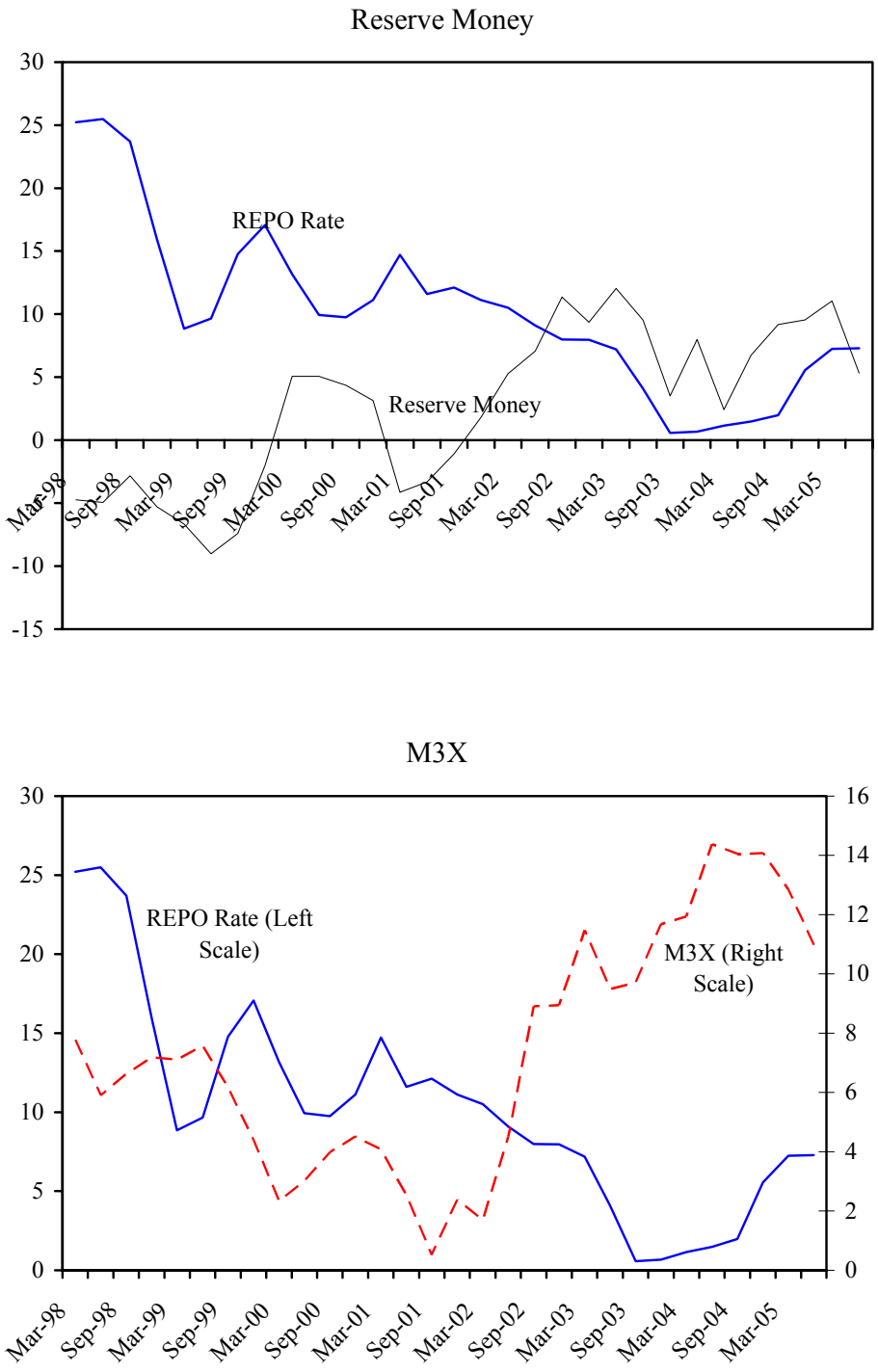
Figure 1. Kenya: Developments of Short-term Interest Rates, 1998 Q1-2005Q2



Source:
Central Bank of Kenya and IMF staff estimates.

[6] The decrease in the reserve requirement from 10 percent to 6 percent in mid-2003 further fueled the growth of money.

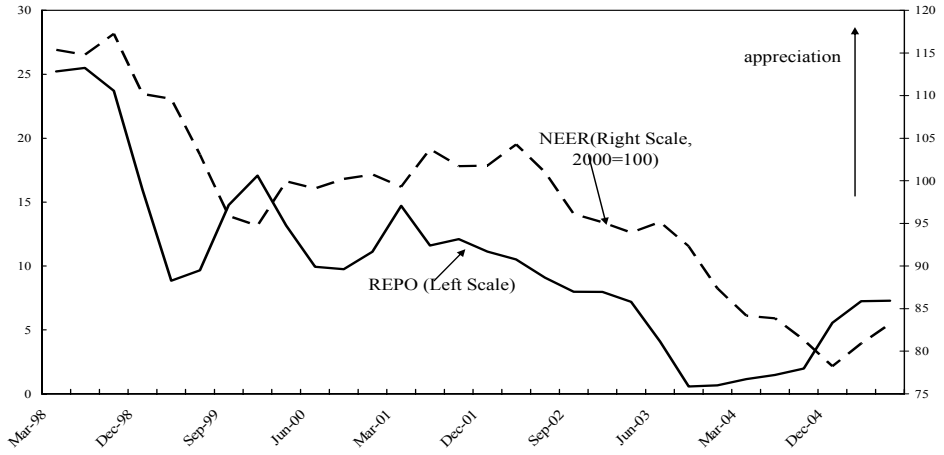
Figure 2. Kenya: Annual Growth Rates of Money, 1998 Q1-2005 Q2



Source: Central Bank of Kenya and IMF staff estimates.

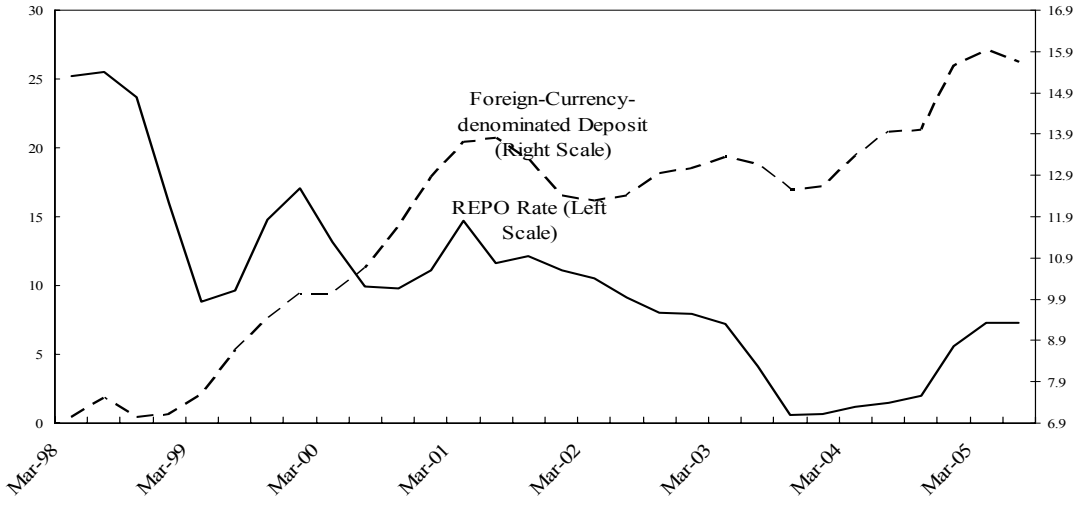
- **Low interest rates tend to be followed by a depreciation of the Kenyan shilling—** Figure 3 suggests that the movement of the nominal effective exchange rate (NEER) seems to have followed the short-term interest rate with a lag, with an appreciation following an increase in nominal interest rates and vice versa. Such an observation can be plausibly explained by capital mobility induced by interest rate movements. Indeed, Figure 4 shows that the proportion of foreign-currency- denominated deposits in broad money tend to rise with a decline of interest rates. Specifically, when interest rates were high in the late 1990s, the shilling was strong while a weak currency seems to have been concurrent with a low interest rate environment recently.

Figure 3. Kenya: Short-term Interest Rate and the Nominal Effective Exchange Rate (NEER)



Source: Central Bank of Kenya and IMF staff estimates

Figure 4. Kenya: Nominal Short-term Interest Rate and the Ratio of Foreign Currency-Denominated Deposit to M3X, 1998 Q1-2005 Q2 (In percent)

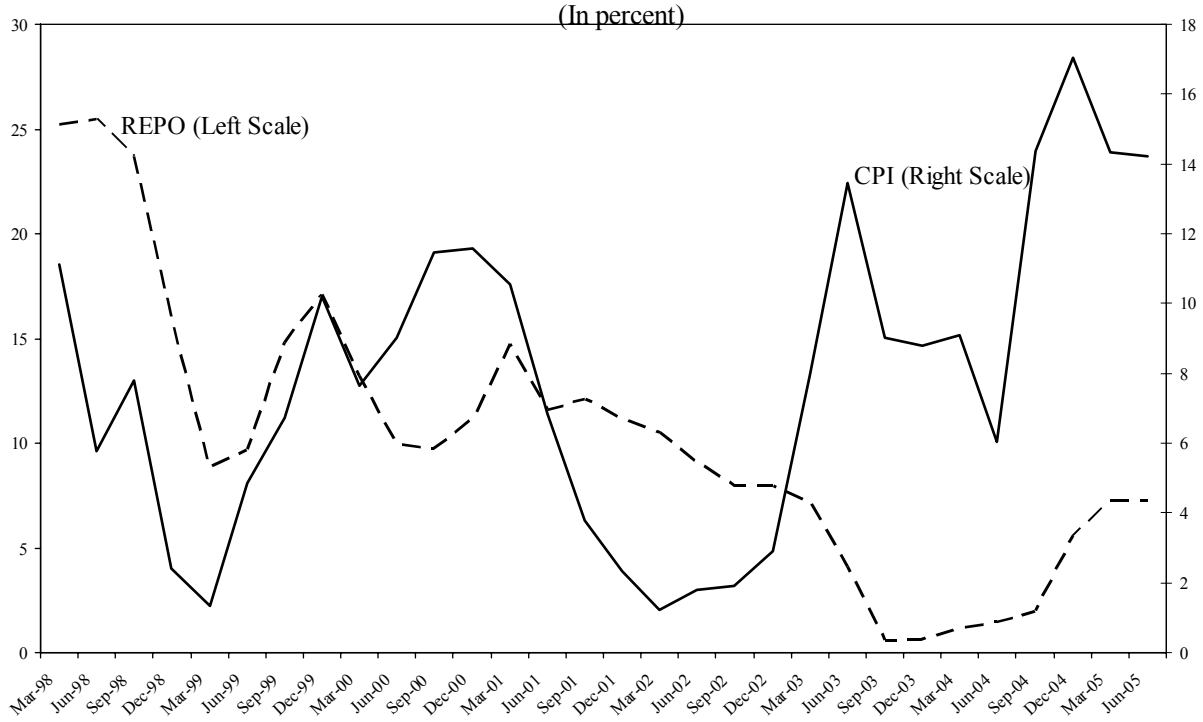


Source: Central Bank of Kenya and IMF staff estimates

- **Low short-term interest rates tend to be followed by high inflation—**As indicated in Figure 5, inflation in Kenya, amid high interest rates, was mild during 1998-2002,

except a few brief episode of inflation slightly above 10 percent in 2000 owing to a severe drought. However, following the loosening of monetary stance starting in mid-2002, inflation starting from 2003, amid very low interest rates, was on average considerably higher than the previous period.

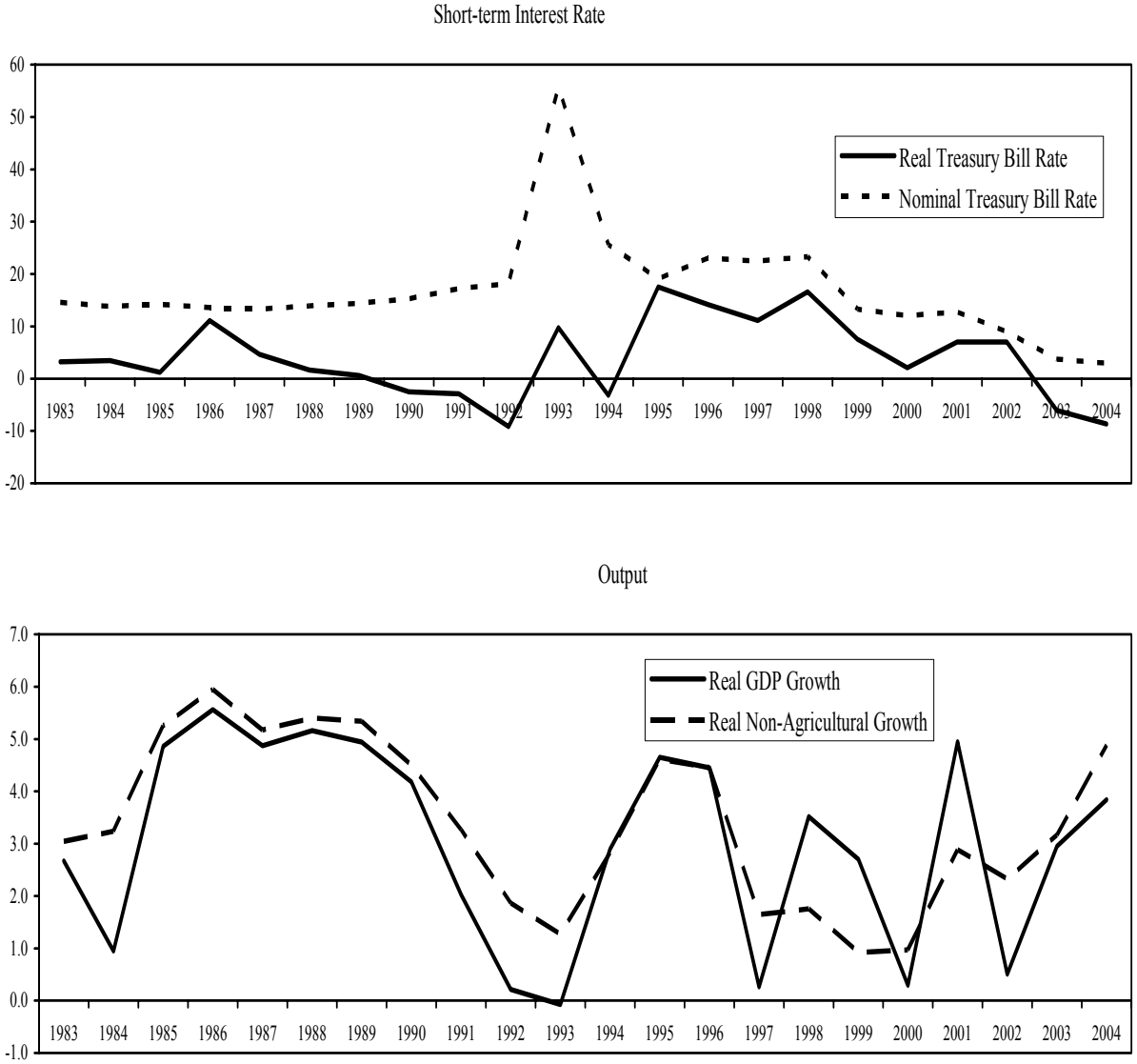
Figure 5. Kenya: Kenya Nominal Short-term Interest Rates and Inflation
(In percent)



Source: Central Bank of Kenya and IMF staff estimates

- **Short-term interest rates do not seem to bear a significant relationship with the real output—**While the highly negative real interest rates associated with the sharp monetary expansion since mid-2003 seemed to have contributed to robust credit growth in 2004, as shown in Table 1, the very high short-term interest rate environment in 1998 was also accompanied robust credit growth to the private sector. While the low-interest rate environment coincided with strong growth in real non-agricultural output in 2004, similar environment in 2003 coexisted with a negative growth in real investment. Moreover, the extremely high interest rate in 1998 and the low interest rate in 2004 were both accompanied by an equally robust real investment growth. In fact, as shown in Figure 6, high short-term interest rates in the past twenty years have not necessarily been followed by stagnation, while low short-term interest rates have not necessarily stimulated the economy. Notable examples included the high interest rate environment and robust growth in mid-1980s and negative real interest rate and sluggish growth in early 1990s.

Figure 6. Kenya: Historical Interest Rate and Output,1983-2004



Source:
IMF staff estimates.

III. A VAR Model for Kenya

A. Model Setup

To formalize the above observations, this section presents a vector autoregression (VAR) analysis. The VAR model assumes that the Kenyan economy can be described by the following structural form equation:

$$G(L)Y_t = C(L)X_t + \varepsilon_t, \tag{1}$$

where *G(L)* is a $n \times n$ matrix polynomial in the lag operator; *C(L)* is a $n \times k$ matrix polynomial in the lag operator; Y_t is a $n \times 1$ vector of endogenous Kenyan variables; and X_t is a $k \times 1$ vector of exogenous foreign variables; ε_t is a $n \times 1$ vector of structural disturbances, with $\text{var}(\varepsilon_t) = \Lambda$, where Λ is a diagonal matrix.

Corresponding with this structural model is a reduced-form VAR:

$$Y_t = A(L)Y_t + B(L)X_t + \mu_t, \tag{2}$$

where $A(L)$ and $B(L)$ are matrices polynomial; μ_t is a vector of reduced-form disturbances, with $\text{var}(\mu_t) = \Sigma$.

Let F be the contemporaneous coefficient matrix in the structural form, and let *H(L)* be the coefficient matrix in *G(L)* without contemporaneous coefficient. That is,

$$G(L) = F + H(L) \tag{3}$$

Therefore, the structural and reduced-form equations can be related by

$$A(L) = -F^{-1}H(L) \text{ and } B(L) = F^{-1}C(L). \tag{4}$$

And the error terms are related:
$\mu_t = F^{-1}\varepsilon_t$ or $\varepsilon_t = F\mu_t$, which implies

$$\Sigma = F^{-1}\Lambda F^{-1}' \tag{5}$$

Consistent estimates of F and Λ are inferred by estimates of Σ, which can be obtained by the maximum likelihood estimation. Since the right-hand side contains $n \times (n+1)$ free parameters to be estimated, while the left-hand side contains only $n \times (n+1)/2$ parameters, we need $n \times (n+1)/2$ restrictions to achieve identification. Normalization of the diagonal elements of F to be unity leaves $n \times (n-1)/2$ additional restrictions, which should be motivated by economic theory.

Throughout this paper, the exogenous vector X_t is assumed to contain a commodity price index (*Comm*), which is calculated based on Kenya's main exports, the world fuel commodity price index (*Oil*), and the U.S. Federal Fund's rate (*Fed*):

$$X_t' = \begin{bmatrix} Comm & Oil & Fed \end{bmatrix} \tag{5}$$

These variables are included to control for changes in overall global economic stance, and fluctuations in energy prices and commodity prices of Kenya's main exports. Given that the Kenyan economy is unlikely to have an impact on the global economy, these variables are treated as exogenous.

The endogenous variables include real GDP, consumer price index (*CPI*), money stock (*M*), short-term interest rate (*S*), and the nominal effective exchange rate (*NEER*):

$$Y_t' = \begin{bmatrix} GDP_t & CPI_t & M_t & S_t & NEER_t \end{bmatrix} \tag{6}$$

In the benchmark model, the money stock (*M*) and short-term interest rate (*S*) are chosen to be broad money (M3X) and the REPO rate respectively. Estimation based on other interest rates and other monetary aggregates will also be examined in the Appendix to check the robustness of the result.

In the remainder of this section, two different identification schemes, which have been widely used for studies on monetary policy transmission mechanism, will be discussed.

Identification Scheme One: Recursive VAR

The first identification scheme is the standard approach that imposes a recursive structure of the VAR, with the ordering of variables given by (6). Intuitively, it assumes that prices (*CPI*) have no immediate effects on output (*GDP)*, money stock (*M*) has no immediate effect on prices, monetary policy shock (*S*) has no immediate effect on the money stock, and the nominal effective exchange rate (*NEER*) has no immediate effect on the monetary policy. Technically, this amounts to estimating the reduced form, then computing the Cholesky factorization of the reduced form VAR covariance matrix. In other words, the relation between the reduced-form errors and the structural disturbance is given by:

$$\begin{bmatrix} \varepsilon_t^{GDP} \\ \varepsilon_t^{CPI} \\ \varepsilon_t^{M} \\ \varepsilon_t^{S} \\ \varepsilon_t^{NEER} \end{bmatrix} = \begin{bmatrix} 1 & 0 & 0 & 0 & 0 \\ f_{21} & 1 & 0 & 0 & 0 \\ f_{31} & f_{32} & 1 & 0 & 0 \\ f_{41} & f_{42} & f_{43} & 1 & 0 \\ f_{51} & f_{52} & f_{53} & f_{54} & 1 \end{bmatrix} \begin{bmatrix} \mu_t^{GDP} \\ \mu_t^{CPI} \\ \mu_t^{M} \\ \mu_t^{S} \\ \mu_t^{NEER} \end{bmatrix}$$

Identification Scheme Two: Non-Recursive Structural VAR

Unlike the recursive identification, which assumes no contemporaneous between monetary policy, money, and the exchange rate, following Sims and Zha (1998) and Kim and Roubini (2000), an alternative identification scheme relaxes these assumptions. Specifically, these papers use the following restrictions:

$$\begin{bmatrix} \varepsilon_t^{GDP} \\ \varepsilon_t^{CPI} \\ \varepsilon_t^{M} \\ \varepsilon_t^{S} \\ \varepsilon_t^{NEER} \end{bmatrix} = \begin{bmatrix} 1 & 0 & 0 & 0 & 0 \\ f_{21} & 1 & 0 & 0 & 0 \\ f_{31} & f_{32} & 1 & f_{34} & 0 \\ 0 & 0 & f_{43} & 1 & f_{45} \\ f_{51} & f_{52} & f_{53} & f_{54} & 1 \end{bmatrix} \begin{bmatrix} \mu_t^{GDP} \\ \mu_t^{CPI} \\ \mu_t^{M} \\ \mu_t^{S} \\ \mu_t^{NEER} \end{bmatrix}$$

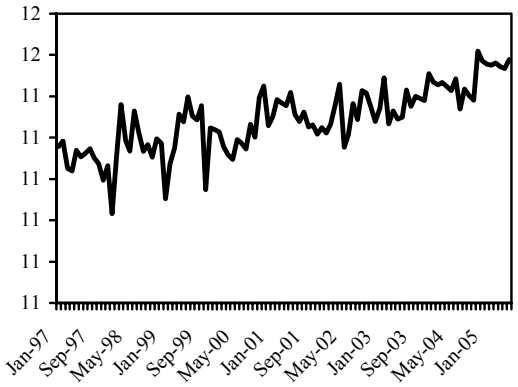
The first two equations represent sluggish response of real GDP and prices with respect to shocks to the nominal variables, money stock, short-term interest rates, and the nominal effective exchange rate. The third equation can be interpreted as a short-run money demand equation, with money demand allowed to respond contemporaneously to shocks to output, prices, and short-term interest rates. The fourth equation can be interpreted as the monetary policy reaction function, which responds contemporaneously to money demand and the exchange rate, but does not respond immediately to contemporaneous output and price shocks because data on output and prices is usually only available with a lag. The last equation suggests that the nominal exchange rate responds immediately to all other variables.

The VAR models are estimated in levels using monthly data between 1997 and 2005. Given the short sample, this paper will not consider an explicit analysis of the long-run behavior of the economy. By estimating the VAR in levels, implicit cointegrating relationships are allowed in the data. All variables are seasonally-adjusted and expressed in logarithms, except interest rates, which are in percentage terms.[7] Standard information criteria are used to select the lag lengths of the VARs, which turn out to be 5. A sequential Chow test suggests that there is no evidence of structural breaks at the 5 percent confidence level. Figure 7 displays the data used for the estimation of the VAR.

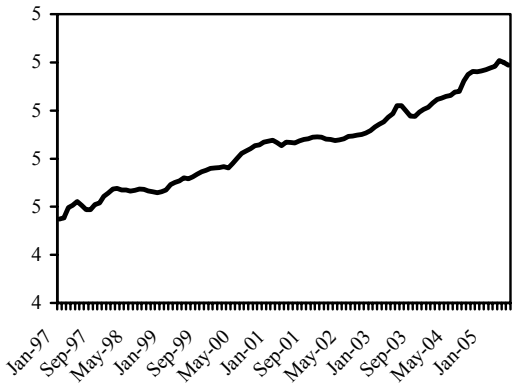
[7] Monthly GDP is obtained by interpolating the annual GDP based on monthly production data of key sectors in the economy.

Figure 7. Kenya: Data used for the Estimation of the VAR, January 1997-June 2005
(All data are seasonally-adjusted and expressed in logarithms, except the interest rate)

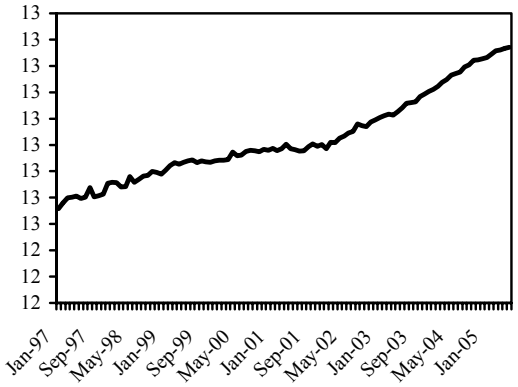
Output



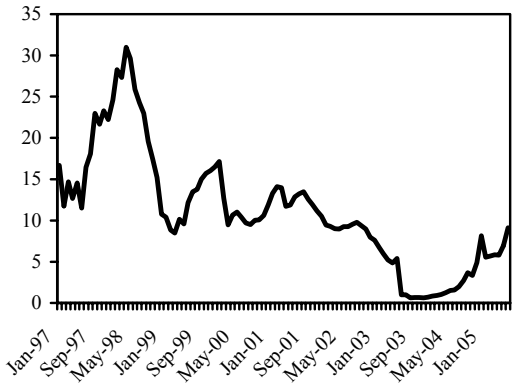
Prices



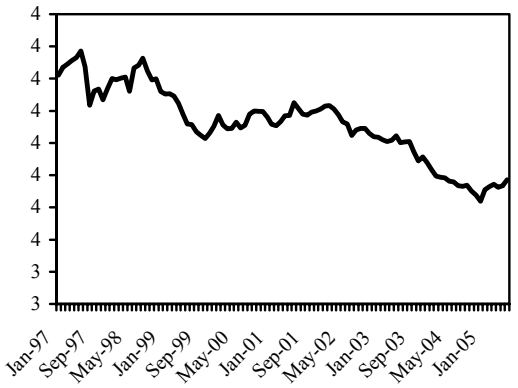
M3X



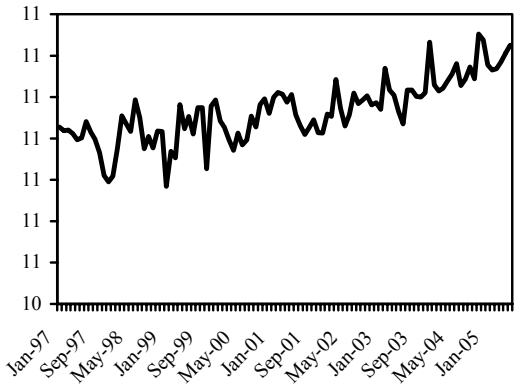
REPO Rate



NEER



Non-Agriculture Output



Source:

IMF staff estimates.

B. Estimation Results

The results of the benchmark model under the two identification schemes are shown in Figures 8 and 9. The graphs display the impact (the impulse response) of a one-standard deviation monetary policy shock—defined as an exogenous, unexpected, temporary rise in the REPO rate at *t=0*—on output, prices, the REPO rate, and the NEER, together with a 95 percent confidence band.[8]

The results can be summarized as follows:

- The effect of a monetary policy shock on output appears to be insignificant. Specifically, the impact is not statistically distinguishable from zero, given that the horizontal axis is broadly within the 95 percent confidence band during the next 36 months after the shock;

- On the other hand, a monetary shock has a significant and persistent impact on prices. An unexpected and temporary rise in the short-term interest rate is followed by a decline in prices, with the effect peaking at 9 to 12 months after the shock;

- Likewise, the nominal effective exchange rate responds strongly to a monetary shock. An unexpected and temporary rise in the short-term interest rate tends to be followed by nominal appreciation, with the impact culminating 9-12 months after the shock.

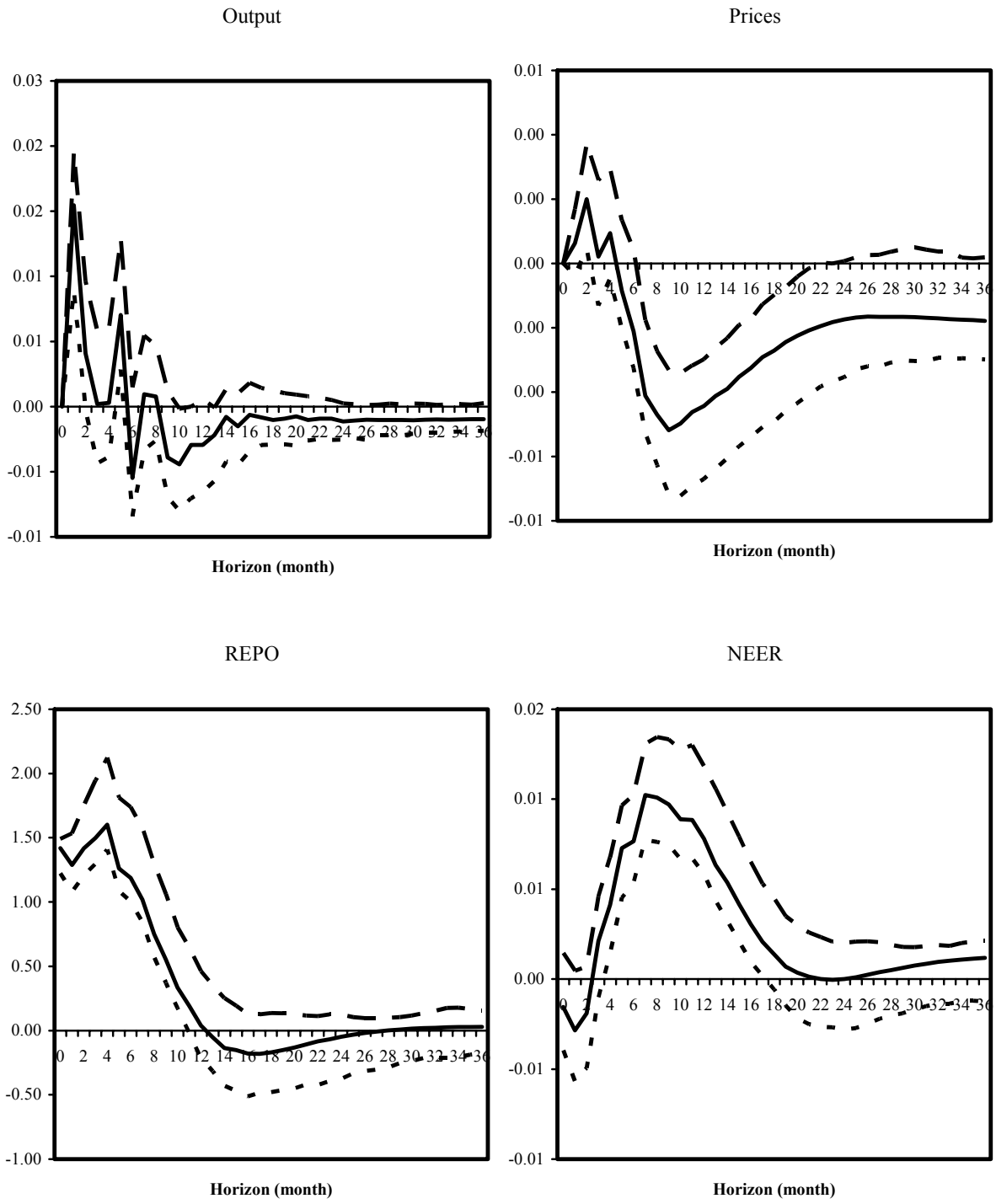
The relative importance of the monetary policy shock for fluctuations in each variable can be gauged through the forecast error variance decompositions. Figure 10 shows the forecast error variance of output, prices, and the nominal effective exchange rate at different forecast horizons that can be attributed to the monetary policy shock. Under both the recursive and structural VARs, the monetary shock accounts for one third of the fluctuations in prices and a half of the fluctuations in the nominal exchange rate, while around a tenth of the fluctuations in output can be attributed to the monetary shock. Hence, consistent with the impulse response analysis, a monetary shock has significant impact on prices and the nominal exchange rate, while output is relatively sluggish vis-à-vis the monetary policy shock.

Given that monetary stance is perceived to have little impact on agriculture in Kenya—which is often largely driven by exogenous factors beyond the control of the CBK, such as weather—the large share of agriculture on Kenya's GDP appears to provide for an apparent reason for the insignificant relationship between total output and monetary policy. It is therefore worthwhile to isolate agriculture and examine the monetary impact on non-agricultural output. However, Figure 11 shows that, econometric results estimated using non-agricultural output in lieu of GDP as in the benchmark model. The finding indicates that, like total GDP, monetary policy has little impact on non-agricultural output.

---

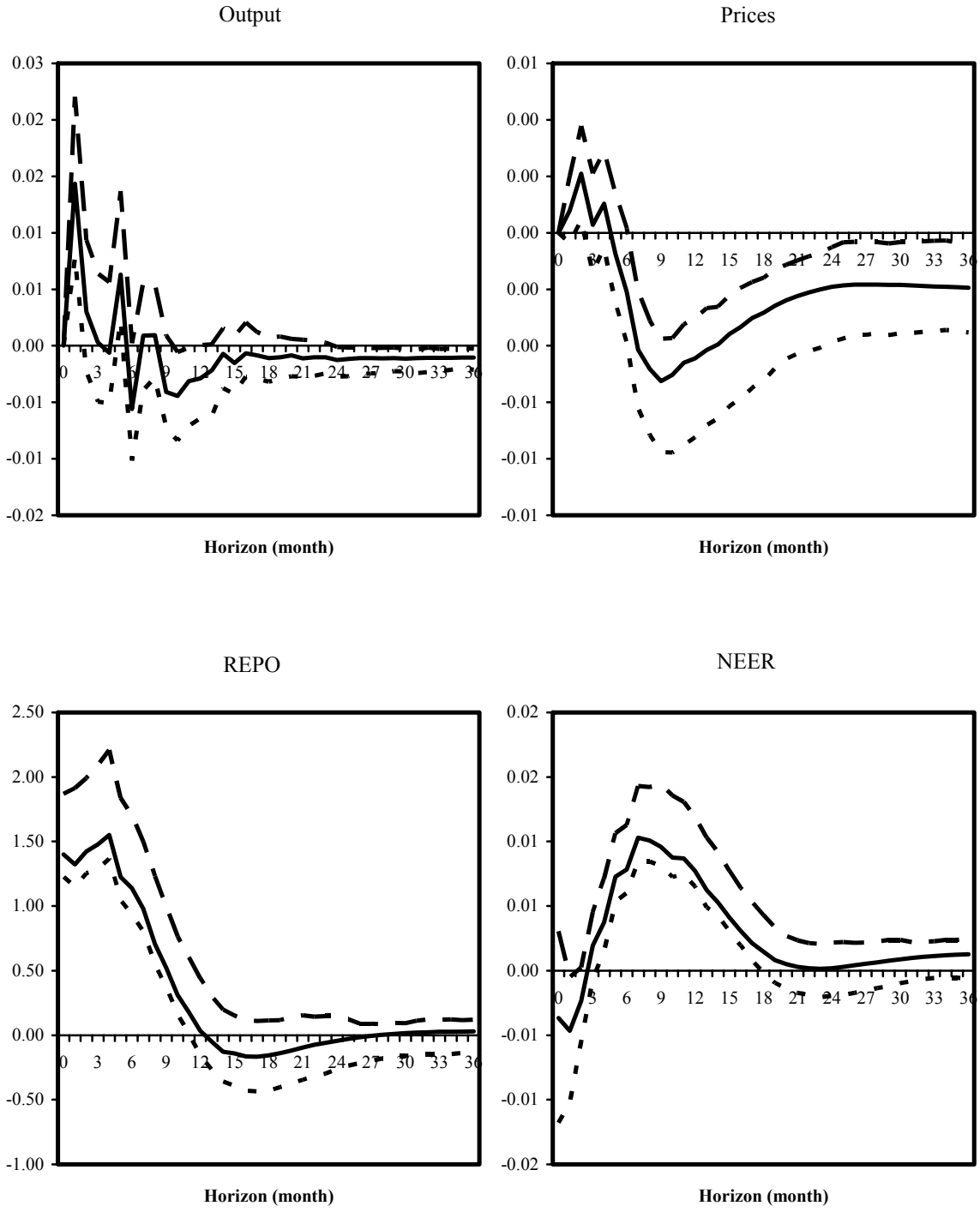
[8] The 95 percent confidence band is obtained by bootstrapping with 500 replications, as described in Hall (1992).

Figure 8. Kenya: The Effects of a Monetary Policy Shock (Recursive VAR), Estimation Period: January 1997-June 2005



Source: IMF staff estimates.
Note: The dotted and broken lines show the 95 percent confidence band, derived by bootstrapping. See Hall (1992).

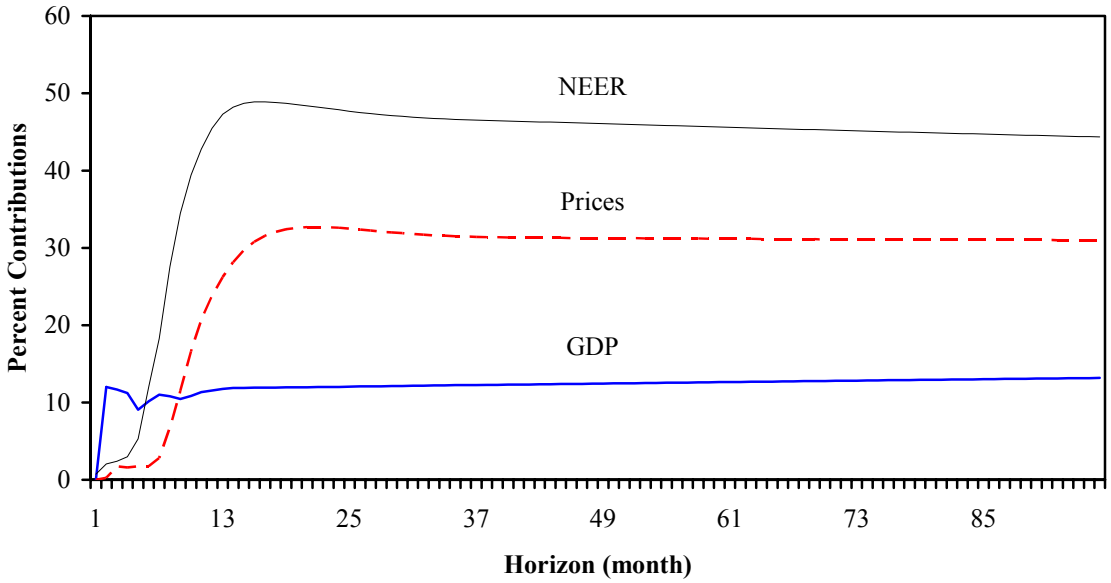
Figure 9. Kenya: The Effects of a Monetary Policy Shock (Non-Recursive Structural VAR), Estimation Period: January 1997-June 2005



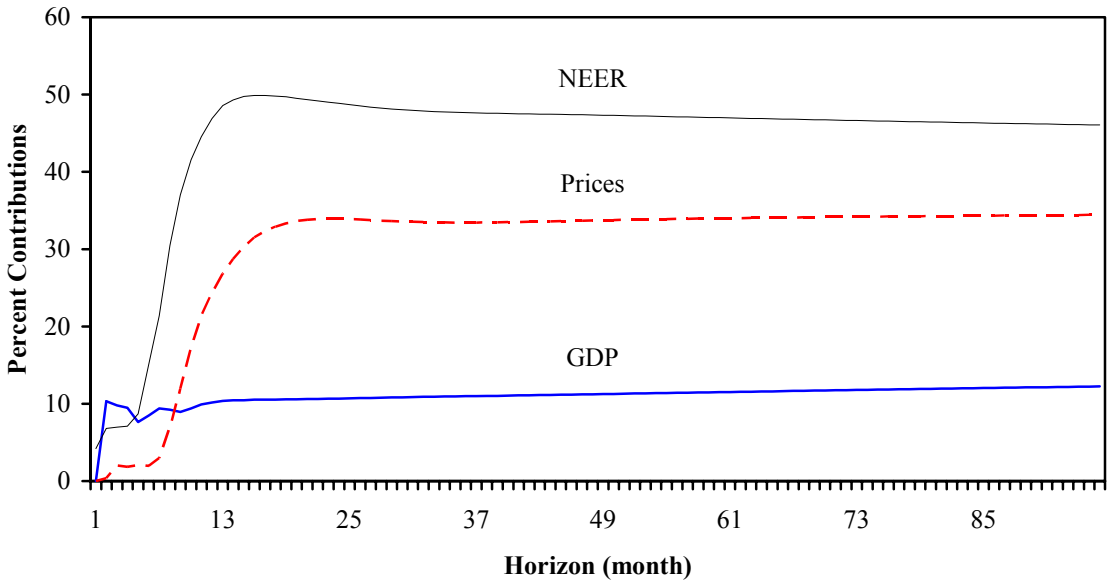
Source: IMF staff estimates.
Note: The dotted and broken lines show the 95 percent confidence band, derived by bootstrapping. See Hall (1992).

Figure 10. Kenya: Contributions of Monetary Policy Shocks to the Forecast Error Variance, Estimation Date: January 1997-June 2005

Recursive VAR

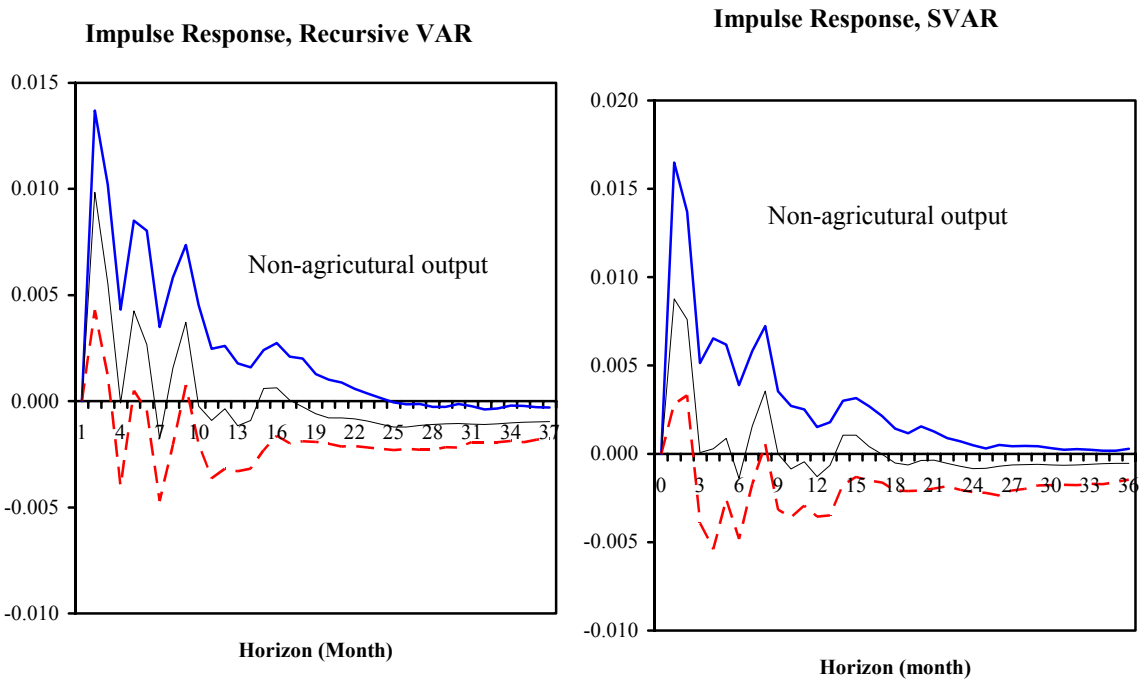


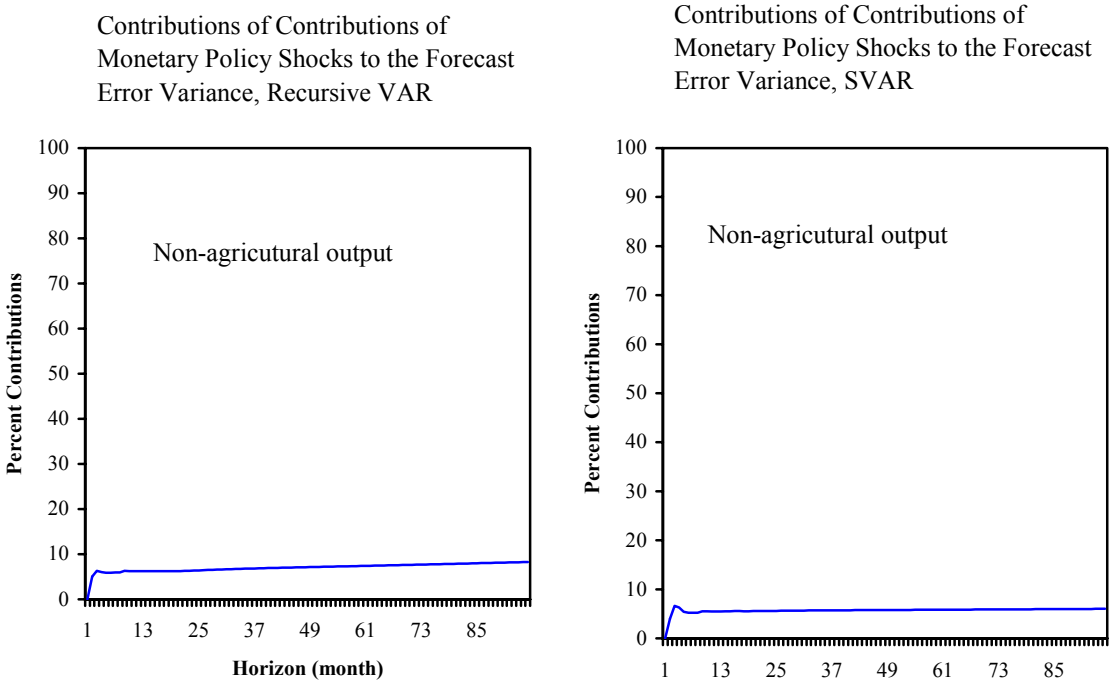
Non-Recursive Structural VAR



Source: IMF staff estimates.

Figure 11. Kenya: Impact of a Monetary Shock on Non-Agricultural Output, Estimation Period, January 1997-June 2005





Source:
IMF staff estimates.

C. Economic Interpretations of the Econometric Results

The above empirical findings suggest that Kenya's nominal exchange rate is highly susceptible to monetary policy, with appreciation following an increase in the short-term interest rates, probably reflecting capital mobility associated with interest rate differentials vis-à-vis other countries. The strengthening of the currency following monetary tightening in turn makes imports cheaper, thereby decreasing the overall price level and the rate of inflation.

Monetary policy, however, seems to have little impact on the real output. This is not a surprising result given the slew of structural weaknesses in the financial sector, which are likely to hamper the transmission mechanism of monetary policy. Main structural weaknesses, as identified by the Fund's Financial Sector Stability Assessment Report, include weak legal framework, poor governance, and insufficient infrastructure, which have contributed to high interest rate spreads, inadequate financial intermediation and heightened risks.

IV. CONCLUDING REMARKS

This paper studies the transmission mechanism of monetary policy based on a vector autoregression framework. The findings suggest that an exogenous, unexpected, and temporary rise in the CBK's REPO rate tends to be followed by nominal appreciation and falling prices, with impact on output being insignificant. A plausible explanation for the sluggish response of output to a monetary policy shock is that the Kenyan financial system is plagued with structural weaknesses, thereby hampering the monetary transmission to the real sector. On the other hand, capital inflows associated a rise in interest rates driven by a tight monetary stance tends to exert appreciation pressures on the exchange rate, thereby making imports cheaper and easing inflation.

Given the weak link between output and monetary stance amid strong link between price stability and monetary stance, there seems little scope for balancing the two competing goals of output stabilization and price stability. In the near future, the overriding objective of monetary policy, therefore, should be to maintain low inflation. Looking forward, the Kenyan authorities should continue to undertake structural reforms aimed at addressing the weaknesses in the financial sector, including improving governance of the CBK, strengthening regulatory framework, as well as enhancing legal framework, with a view to improving the monetary transmission mechanism to the real sector.

Last but not least, a number of caveats need to be taken in account while interpreting the results. First, the sample period is relatively short. Therefore, the findings may only pertain to idiosyncratic economic developments during the sample period, while not necessarily serving as a best guide as to how the Kenyan economy would work in the future. Second, poor data quality, particularly the output data, is a concern. Specifically, given the large size of the informal sector, national accounts statistics may not capture important activities that are influenced by the monetary policy stance.

APPENDIX. A ROBUSTNESS ANALYSIS

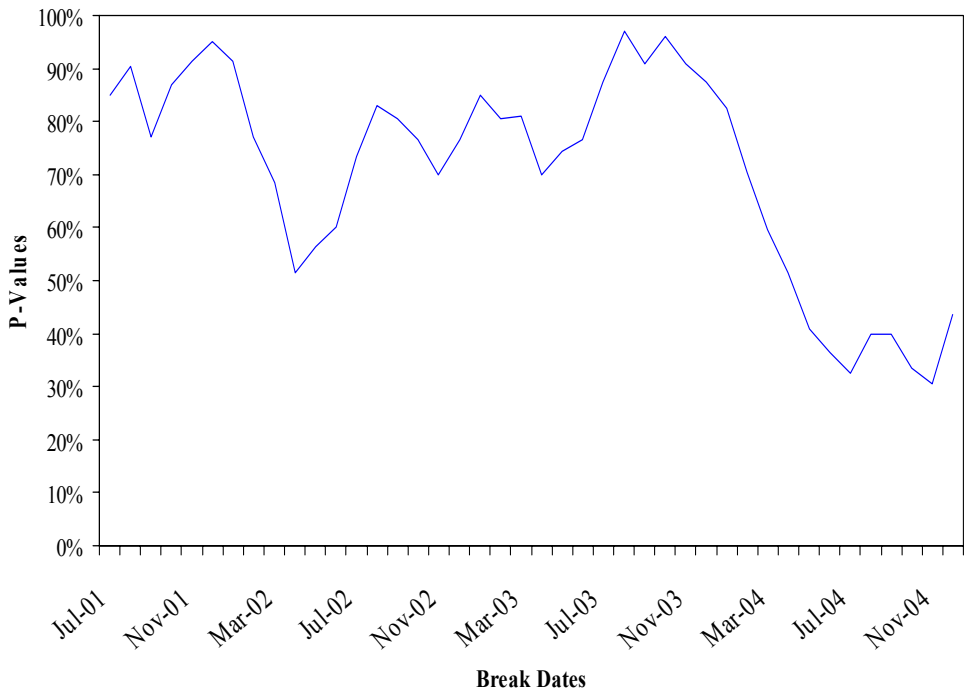
In this appendix, the robustness of the main econometric results of the paper is examined.

A. Stability of the Estimates

Stability of the VAR

Recursive Chow tests suggest the benchmark VAR is stable over the sample period. Figure 12 presents the p-value for the tests under the null hypothesis that the benchmark VARs have no structural breaks, with sequential break dates starting from 2001. Given that the p-values are significantly higher than 5 percent, the null hypothesis of stability cannot be rejected.[9]

Figure 12. Kenya: P-Values for the Recursive Chow Tests for Structural Breaks



Source: IMF staff estimates.

[9] The p-values are computed by bootstrapping.

Stability of the impulse responses over time

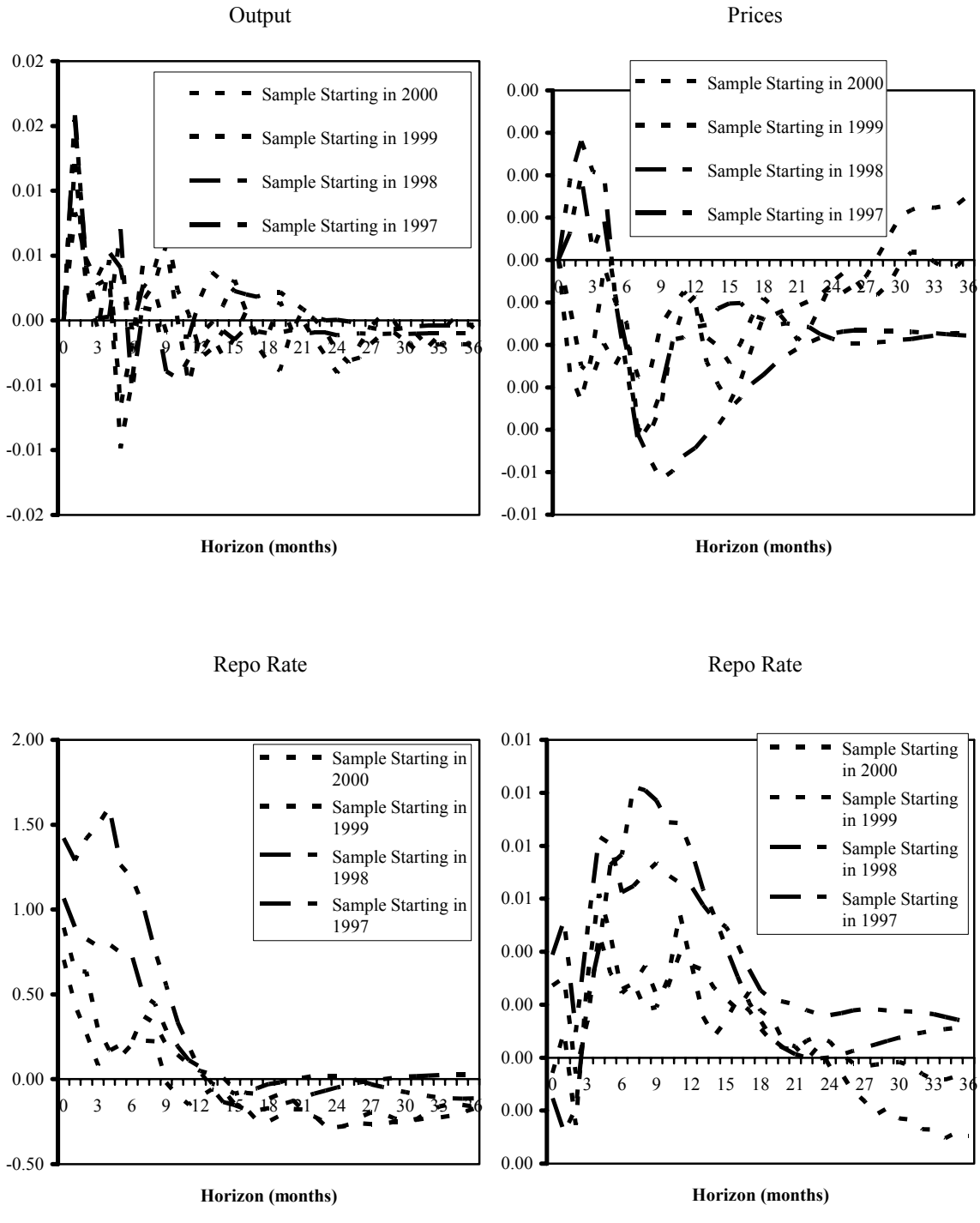
Another way to check robustness of the econometric results presented in Section III is to vary the sample period and examine if the impulse responses change significantly. Figure 13 reports the impulse responses of output, prices, REPO rate, and NEER to a one-standard deviation monetary policy shock using shorter sample periods that start in 1998, 1999, as well as 2000—as opposed to the benchmark sample period starting in 1997. The impulse responses using shorter sample periods are broadly similar to the benchmark case. Specifically, output is sluggish to a monetary policy shock, prices tend to fall following a tightening of the monetary stance, and nominal appreciation tends to follow an increase in the short-term interest rates.

B. Using Other Variables in the VAR

This subsection examines the robustness of the main results while the VAR framework uses variables other than those in the benchmark. Figure 14 displays the impulse responses to a monetary policy shock that is defined as a temporary, unexpected, and exogenous rise in the interbank rate, rather than the CBK's REPO rate. Figure 15 reports results for a similar exercise when the third endogenous variable is the reserve money—which is the CBK's operating target, rather than the M3X, which is the CBK's intermediate target. The results show that the main conclusions of the paper remain valid.[10]

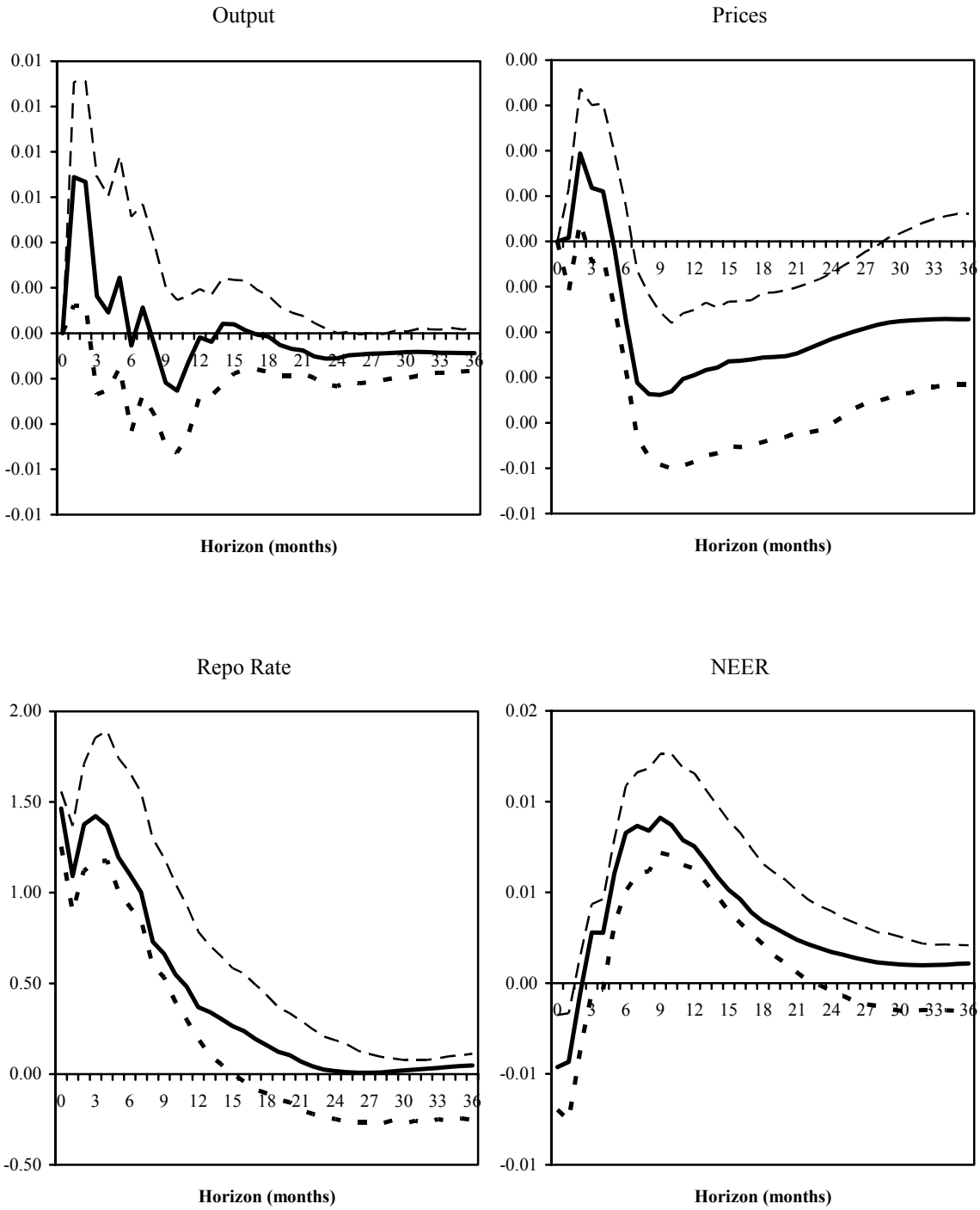
[10] There are also other possibilities of robustness exercises, which have been examined but are not reported here. The results are available from the author upon request.

Figure 13. Kenya: Impulse Responses Using Different Sample Periods



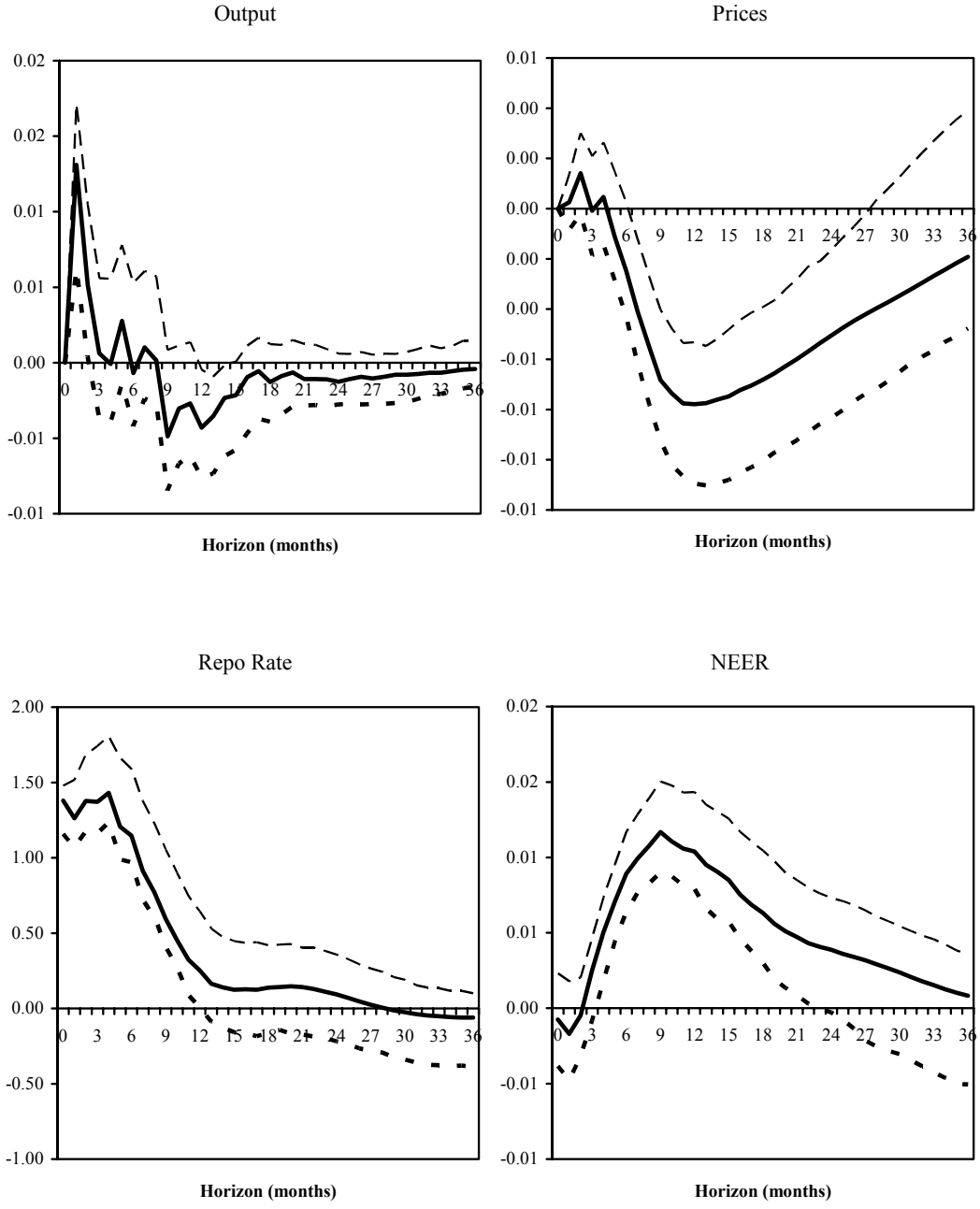
Source: IMF staff esimates

Figure 14. Kenya: Impulse Responses to a Rise in the Interbank Rate,
Estimation Period: January 1997-June 2005



Source: IMF staff estimates.
Note: The dotted and broken lines show the 95 percent confidence band, derived by bootstrapping. See Hall (1992).

Figure 15. Kenya: Impulse Responses when the Third Endogeneous Variable is the Reserve Money, Estimation Period: January 1997-June 2005



Source: IMF staff estimates.
Note: The dotted and broken lines show the 95 percent confidence band, derived by bootstrapping. See Hall (1992).

REFERENCES

Aron, J., and J. Muellbauer, 2002. "Interest rate effects on output: evidence from a GDP forecasting model for South Africa." *IMF Staff Papers* 49 (November, *IMF Annual Research Conference*): 185-213.

Berdin, Don, and Gerard O'Reilly, 2004, "An Analysis of the Transmission Mechanism of Monetary Policy in Ireland," *Applied Economics,* Vol 35, pp. 49-58.

Brischetto, Andrea, and Graham Voss, 1999, "A Structural Vector Autoregression Model of Monetary Policy in Australia, *" Reserve Bank of Australia,* Research Discussion Paper, 1999-11.

Christiano, L., M. Eichenbaum, and C. Evans, 2000, "Monetary Policy Shocks: What Have We Learned and to What End?" in *Handbook of Macroeconomics* (Amsterdam: North Holland).

Durevall, Dick, and Ndung'u, Njuguna, 1997, "A Dynamic Model of Inflation for Kenya, 1974-1996," IMF Working Paper No. 99/97 (Washington: International Monetary Fund).

Hall, P., 1992, *The Bootstrap and Edgeworth Expansion*, Springer, New York.

Kim, Soyoung, and Nouriel Roubini, 2000, "Exchange Rate Anomalies in the Industrial Countries: A Solution with a Structural VAR Approach," *Journal of Monetary Economics,"* pp. 561-568.

Peersman, Gert and Frank Smets, 2003, "The Monetary Transmission Mechanism in the Euro Area: Evidence from VAR Analysis," *Monetary Transmission Mechanism in the Euro Area,* Cambridge University Press.

Saxegaard, Magnus, 2006, "Excess Liquidity and the Effectiveness of Monetary Policy: Evidence from Sub-Saharan Africa," IMF Working Paper, No. 06/115 (Washington: International Monetary Fund).

Sims, Christopher, 1980, "Macroeconomics and Reality," *Econometrica, 48(1),* 1-48

Sims, Christopher, and Zha, 1998, "Does Monetary Policy Generate Recessions?" *Federal Reserve Bank of Atlanta Working Paper 98-12.*