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Monetary Transmission Mechanism in the East African Community: An Empirical Investigation

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Abstract

Do changes in monetary policy affect inflation and output in the East African Community (EAC)? We find that (i) Monetary Transmission Mechanism (MTM) tends to be generally weak when using standard statistical inferences, but somewhat strong when using non-standard inference methods; (ii) when MTM is present, the precise transmission channels and their importance differ across countries; and (iii) reserve money and the policy rate, two frequently used instruments of monetary policy, sometimes move in directions that exert offsetting expansionary and contractionary effects on inflation—posing challenges to harmonization of monetary policies across the EAC and transition to a future East African Monetary Union. The paper offers some suggestions for strengthening the MTM in the EAC.

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I. INTRODUCTION

The East African Community (EAC) is a regional organization, consisting of Burundi, Kenya, Rwanda, Tanzania, and Uganda, that seeks to integrate the Partner States along economic, social, and political dimensions. Many steps have already taken. The treaty establishing the EAC entered into force in 2000, following its ratification by the original three Partner States—Kenya, Uganda, and Tanzania. A customs union with a common external tariff was established in 2005; Rwanda and Burnundi became full members of the EAC in 2007; the EAC Common Market was created in 2010 and will begin the process of free movement of goods, services, labor, and capital. Modalities for macroeconomic convergence criteria and the supporting institutional infrastructure are being studied and defined across the Partner States. Furthermore, the Heads of the Partner States decided in 2007 to fast track agreements on key protocols of the East African Monetary Union (EAMU) by 2012.

Establishment of the EAMU is expected to usher in key economic benefits by

- enhancing the benefits from the EAC Customs Union and the EAC Common Market and further deepening the integration of East African economies,
- reducing the costs and risks of conducting business transactions across national boundaries; and
- granting the region a single currency and removing the costs of transactions in different currencies and the risk of adverse exchange rate movements for intra-EAC trade.

Successful launch of the EAMU depends, among other things, on effective harmonization of existing monetary policies and operations across the EAC in transition to a future common monetary policy. An important issue for each country is the effectiveness of their monetary transmission mechanism (MTM)—what policy instruments are used in each country and channels through which changes in these instruments are transmitted into changes in real GDP and inflation and the relative importance of each channel.[2] In particular, we need to understand the extent to which MTM differs across EAC countries and reasons for such differences.

A potential finding of significant heterogeneity would pose challenges for harmonization of monetary policies and for the design and conduct of a common monetary policy for the monetary union. For example, a common monetary policy would dictate the use of the same

[2] The focus of MTM is on how it affects output and inflation (Taylor, 1995), though monetary policy also affects other macroeconomic indicators and influenced by them (Bernanke and Gertler, 1995; Ireland, 2008).

instrument across all countries, say use of reserve money, then an expansionary monetary policy—an exogenous positive shock to reserve money for example—should not be expansionary in one country and contractionary in another.

Indeed, study of the MTM has been important not only for the design and effectiveness of monetary policy in countries in transition to a monetary union, but continues to be relevant in countries already in a monetary union (the euro area, the Eastern Caribbean Monetary Union, and two monetary unions in sub-Saharan Africa—SSA: West Africa and Central Africa).[3]

However, the vast empirical literature on monetary transmission has primarily focused on developed economies. The most distinguishing characteristic of MTM in developed countries is the focus on prices (interest rate, exchange rate, and other asset prices) rather than quantities (money, credit, base money, bonds, foreign assets, etc.)[4] In contrast, the prevailing orthodoxy of MTM in low-income countries (LICs) has been its focus on quantities rather than prices. This difference is often attributed to weak institutional frameworks, oligopolistic banking structure, shallow financial markets, and extensive central bank intervention in foreign exchange markets in LICs.

Recently, Mishra, Montiel, and Spilimbergo (2010) revisited the prevailing orthodoxy of MTM in LICs. They provide theoretical arguments about why the bank lending channel might be more effective in LICs than other channels and find this channel either weak or unreliable. Specifically, Mishra, Montiel, and Spilimbergo (2010) provide cross-country evidence of a weak interest rate pass-through[5]—from central bank lending rates to money market rates and from money market rates to commercial banks' lending rates—though they do not empirically investigate the impact of changes in the interest rate or other monetary policy instruments on prices and real output in LICs.

On the other hand, a recent study of SSA finds that monetary policy is perhaps more effective in SSA than commonly believed (IMF, 2010). The study, based on a panel vector autoregression (VAR) of SSA countries in the past decade, finds that a contractionary monetary policy—defined either by (lower) reserve money growth or a (higher) central bank

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[3] See Peersman and Smets (2001) and ECB (2010) for the European Monetary Union; Laurens (2005) for the Eastern Caribbean Currency Union (ECCU); Boogaerde and Tsangarides (2005) for the West African Economic and Monetary Union (WAEMU); and Iossifov and others (2009) for Central African Economic and Monetary Union (CEMAC).

[4] This view is evolving, however. For example, the global financial crisis of 2007–08 has led some to argue for a credit-focused monetary policy in advanced economies and output and inflation goals for monetary policy (Christiano and others, 2010) and for supplementing monetary policy with an active role for macroprudential policies (Bean and others, 2010; Issing, 2011).

[5] See also IMF (2010) for evidence of weak interest rate pass-through in Africa.

discount rate—decreases output growth significantly, but the impact on inflation and its statistical significance depend on the measure of the monetary policy instrument. A decline in reserve money (the operating target for many SSA countries) reduces inflation as expected, though the decline is not statistically different from zero. On the other hand, an increase in the central bank discount rate or policy rate (the operating target for a small number of SSA countries) has a statistically significant impact on inflation, but surprisingly it increases inflation (the so-called "price" puzzle).

These disparate findings on the effects of monetary policy may show the presence of different operating targets across countries and the need to conduct country-specific studies of MTM that control for heterogeneities.

In contrast to these cross-country studies, little is known about MTM in EAC countries; the existing studies have so far used a narrow set of methodologies and data sets. Moreover, no literature review has been conducted covering all EAC countries.

This paper makes three contributions to a study of MTM in the EAC:

- We provide an exhaustive and critical review of the existing empirical literature of MTM in the EAC. This review identifies several important gaps in our knowledge of monetary policy transmission in the EAC.

- We apply the latest methodologies from time-series analysis to each EAC country, including Bayesian VAR (BVAR) and Factor Augmented VAR (FAVAR), two techniques that have not been used previously in studies of MTM in the EAC.

- We use a methodology that quantifies the relative importance of various channels of the MTM in each EAC country.

The outline of this paper is as follows. Section II describes the conduct of monetary policy and the existing institutional framework, which is the starting point for harmonizing the conduct of monetary policy. This section helps motivate how reserve money targeting, the dominant monetary policy framework in the EAC, is implemented in the VAR. Section III describes six channels of the MTM. Section IV provides a review of the empirical literature of MTM in the EAC. Section V describes the various VAR methodologies. Section VI describes the data. Section VII presents the empirical results, including an evaluation of relative strengths and weaknesses of various channels of the MTM in each EAC country. Section VIII concludes the paper.

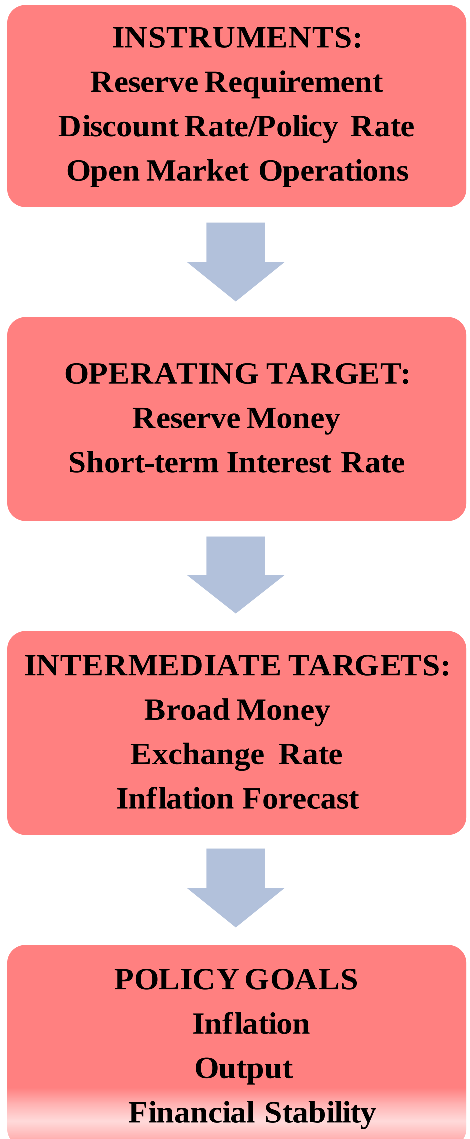
II. Conduct of Monetary Policy in the EAC

A. Instruments, Targets, and Goals

EAC central banks use open market operations as the main instrument of monetary policy implementation but also rely on standing facilities, changes in reserve requirements, required reserve averaging and foreign exchange operations. But differences exist in the application of these instruments among the Partner States' central banks, more so in the computation of the cash reserve requirement. Reserve money is the operating target for monetary policy and broad money is the intermediate target. Price stability is cited as the overriding goal for monetary policy, but central banks also support economic growth and financial stability (Figure 1).

In July 2011, the Central Bank of Uganda declared inflation targeting Lite (IT) as its monetary policy framework. Under an IT framework, inflation forecast is often the intermediate target; and a central bank is targeting an inflation forecast, thus anchoring inflation expectations on the inflation target it hopes to achieve. In November 2011, the Central Bank of Kenya (CBK) adopted a new monetary policy framework that gives more prominence to its policy interest rate though, unlike Uganda, it did not declare a shift to IT Lite. Practices can differ, though, as countries gain experience in the conduct of a new monetary policy framework. The empirical work in this paper excludes these periods of marked shift in the monetary policy framework.

Figure 1: Monetary Policy: Instruments, Targets and Goals

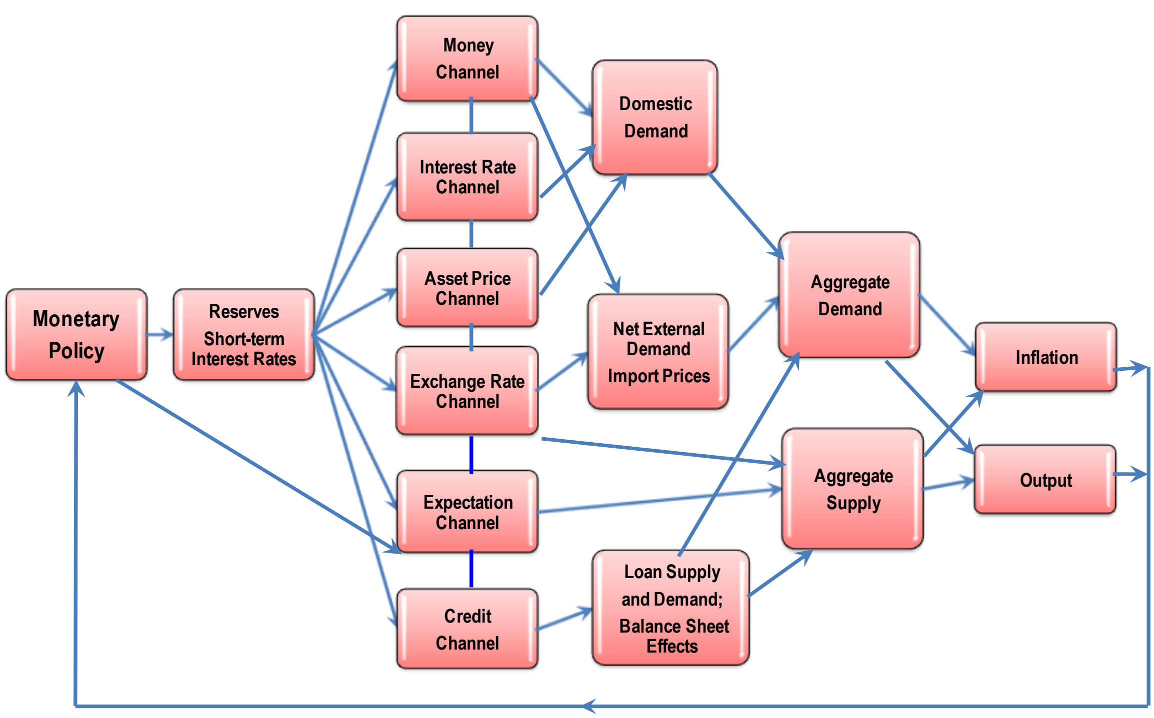


B. Monetary Policy Framework

For the sample period used in this study, all central banks use reserve money targeting—widely known as the Reserve Money Program (RMP) for countries with an IMF program—as their monetary policy framework. Two building blocks of monetary policy formulation in a RMP are as follows. The first involves setting a target for broad money, an intermediate target, which is not under the direct control of the central bank but provides a useful signal about current or prospective movements in inflation and output, and the final monetary policy goals. The second relates the intermediate target to an operating target, which is reserve money. It is under the effective control of the central bank but further from policy goals, a "longer policy lag" than broad money. The target for broad money is set to be consistent with macroeconomic policy goals regarding economic growth and inflation, hence, income velocity. The target for reserve money is set taking into account assumptions about the money multiplier (relating broad money to reserve money) and seasonalities.

In practice, the implementation of the RMP has departed from the standard textbook quantity theory of money and become more flexible during the implementation of monetary policy, sometimes referred to as flexible RMP. This can be done by (i) accommodating shifts in money multipliers and velocity (e.g., money demand shocks, financial deepening) —two factors in part determined by portfolio decisions of individuals—and (ii) incorporating unanticipated shocks to output and inflation (better-than-projected agriculture activities; large shifts in global food and fuel prices) which may cause monetary aggregates to deviate substantially from ex ante monetary targets. Uganda, for example, conducted an actual flexible RMP from September 2009 through June 2011. Increasing use of a small set of high frequency data and regular and sometimes more frequent meetings of Monetary Policy Committees also enable central banks in the region to help fine tune the monetary policy stance throughout the year.

Figure 2. Inside the Black Box of the Monetary Transmission Mechanism



What is often called the MTM is depicted in Figure 2. The figure is a stylized look at the black box of MTM. Some of these channels are present in the EAC; some are not. Some indicators may not apply at this stage, such as lack of a market-determined or a timely survey-based measure of inflation expectations; some channels may require the availability of high-frequency data such as monthly indexes of real economic activities. Figure 2 also shows the feedback rules from output and inflation to monetary policy. It therefore allows for systemic responses of monetary policy to developments in inflation and output. The empirical challenge is to disentangle this endogenous monetary policy response from an exogenous monetary policy. Different models of MTM essentially use different identification criteria to address this challenge. How each channel in the MTM could work is illustrated in Section III.

C. Stability of Money Multiplier and Velocity

Studies on velocity and money multipliers, conducted recently by EAC central banks (mostly unpublished) and the International Growth Center, have reported mixed findings. Money multipliers for Burundi and Rwanda were stable, implying that the second building block of monetary targeting under a RMP works well in these countries; lately, though, large shifts in currency in circulation, entry of new banks, and bank branching in Rwanda have made the implementation of RMP much more challenging. The velocity and the multiplier are unstable in Kenya (Sichei and Kamau, 2010), implying both steps of a RMP program may not work ex-ante but could work with ex-post adjustment that, for example, accommodates instability. The estimated money multiplier is unstable for Uganda in the short run. For Tanzania, the multiplier is stable in the long run, but not in the short run (Adam and Kessy, 2010), whereas velocity is stable (Adam and others, 2010).

We use our measures of nominal GDP, broad money and reserve money to summarize movements in velocity and multiplier for EAC country.[6] Under the null hypothesis that the text book RMP works ex-ante, we expect to see stability or "constancy" of velocity and money multiplier. However, since shocks are present in real world, it is not just stability that matters to a RMP but also the predictability of velocity and money multiplier.

[6] We use the CPI when the GDP deflator is not available to get estimates of the velocity at monthly and quarterly frequencies, given that we have either measures of real GDP at quarterly or monthly frequencies. EAC countries do not report nominal GDP at quarterly frequencies. Therefore, differences to a large degree would reflect differences in CPI vs. GDP deflator. See section VI for data on derivation of data on monthly real GDP.

Figure 3. Velocity and Money

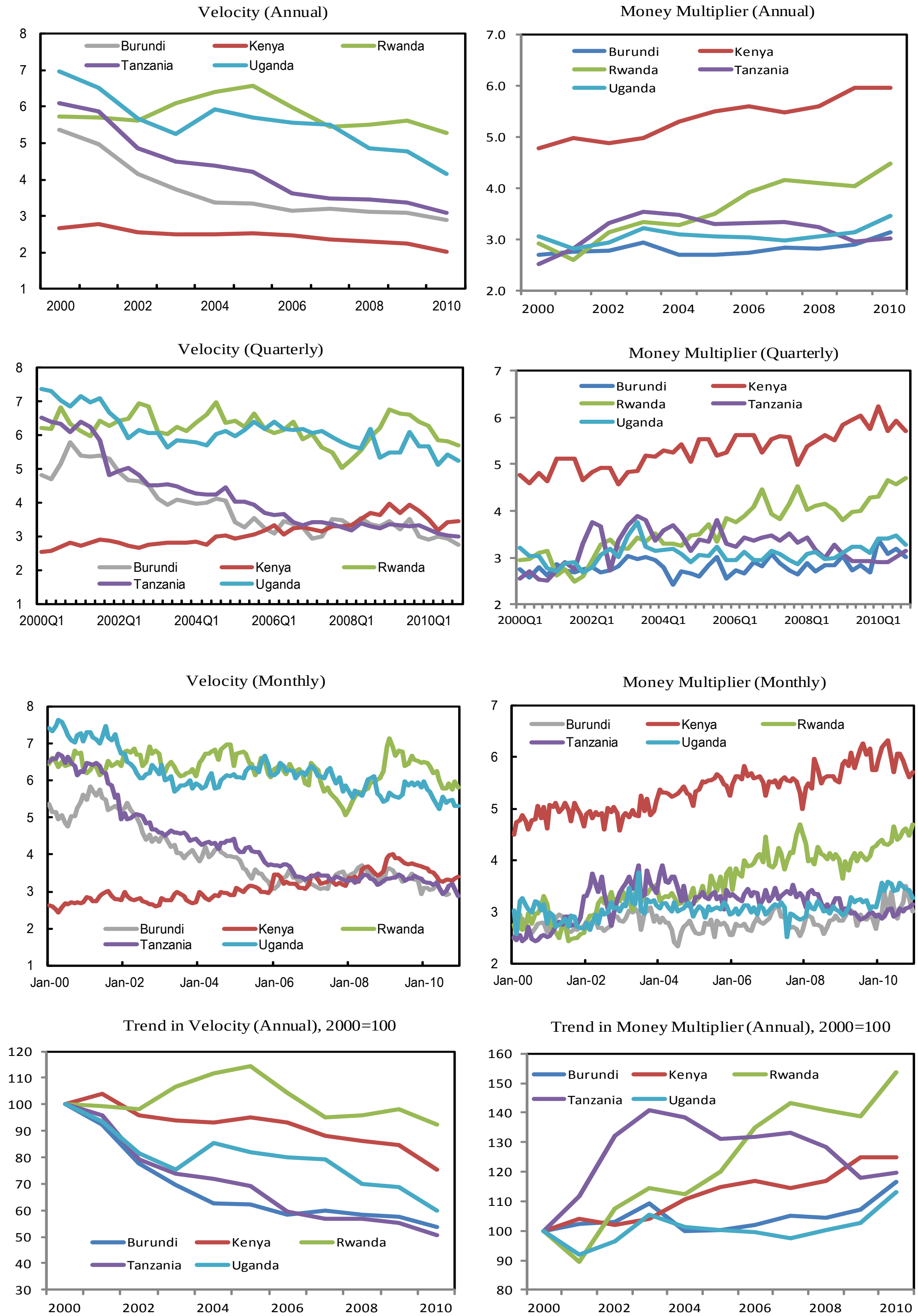


Table 1. Decomposition of the Money Multiplier and Velocity in the EAC

Decomposition of Velocity, January 2000- December 2010

	Average Monthly Growth			Variance[1,2]		-2Cov.[1,2]	Corr.[2]	
	v	GDP	BM	GDP	BM	GDP,BM	GDP,BM	BM,v
Burundi	-0.4	1.0	1.5	31	75	-5.5	0.1	-0.8
Kenya	-0.1	0.9	1.0	47	49	3.6	0.0	-0.7
Rwanda	0.0	1.3	1.4	18	83	-1.1	0.0	-0.9
Tanzania	-0.6	1.1	1.7	28	71	0.4	0.0	-0.8
Uganda	-0.2	1.3	1.5	17	76	6.1	-0.1	-0.9

[1] In percent of total variance of velocity.

[2] Variables defined in first differences of log levels.v, GDP and BM refer to income velocity of broad money, nominal GDP and broad money.Cov and Corr refer to covariance and correlation coefficient, respectively between variables listed in each column.

Decomposition of Money Multiplier, January 2000-December 2010

	Average Monthly Growth			Variance[1,2]		-2Cov.[1,2]	Corr.[2]
	m	BM	RM	BM	RM	BM,RM	BM,RM
Burundi	0.3	1.5	1.5	38	151	-88.0	0.6
Kenya	0.3	1.0	0.9	12	107	-18.9	0.3
Rwanda	0.6	1.4	1.0	25	99	-24.3	0.2
Tanzania	0.3	1.7	1.6	16	96	-11.4	0.1
Uganda	0.3	1.5	1.6	16	99	-15.0	0.2

[1] In percent of total variance of money multiplier.

[2] Variables are in first differences of log levels. m, BM, and RM refer to broad money multiplier, broad money and reserve money, respectively. Cov and Corr refer to covariance and correlation coefficient, respectively between variables listed in each column.

Using the data set we have compiled for all EAC countries for this paper, we find mixed evidence on the stability and predictability of velocity and money multiplier (Table 1, Figure 3) and significant cross- country heterogeneity:

- All EAC countries show declines in velocity and increases in money multiplier, consistent with increase in monetization or financial deepening experienced by all countries.[7] Therefore, neither velocity nor multiplier is stable, "constant" parameters, but both are predictable.[8]

[7] An upward trend in velocity for Kenya at monthly and quarterly frequency seems to be driven by use of CPI to arrive at nominal GDP at these frequencies. This does not seem to be a problem in other EAC countries.

[8] Correlation coefficient between velocity and lagged velocity exceeds 0.6 for each country, while correlation coefficient between money multiplier and lagged money multiplier exceeds 0.65 for all but two EAC countries (Burundi and Uganda have correlation coefficients of 0.4 and 0.3, respectively).

- Rwanda has the most stable velocity in the EAC, followed by Kenya and Uganda, while Tanzania and Burundi show the largest decline in velocity (a decline of 6.7 percent and 5.7 percent a year, respectively, based on annual data) and the most predictability. [9]

- Tanzania has the most stable multiplier. Rwanda and Kenya have the most pronounced upward trend in money multiplier, ending up with multipliers in excess of 4 ½ and 5 ½, respectively while multipliers for other EAC countries cluster between 2 ½ and 3 ½.

- Most of the volatility in velocity is due to volatility in broad money rather than GDP, with Rwanda showing the highest broad money volatility and Kenya the lowest.

- Most of the volatility in the multiplier is due to volatility in reserve money rather than broad money, with Burundi showing the largest volatility for reserve money and Tanzania the smallest.

III. Channels of Monetary Transmission Mechanism

Regardless of the monetary policy framework used in practice, a central banker would like to know how changes in monetary policy instruments affect inflation and output, and the timing and size of such effects.

Traditionally, the effects of monetary policy actions are thought to be transmitted via money or credit channels—the so-called money versus credit view of monetary policy. In the former, changes in the nominal quantity of money affect spending directly, whereas in the latter case, open market operations induce changes in interest rates that affect spending; in some models, credit rationing and financial accelerator can have additional effects on output and prices as well. Most models rely on some form of nominal price or wage rigidity to draw the hypothesized links between money, interest rates, and output. We now cover in more detail how each channel works.

A. Money Channel

This channel is perhaps the oldest one that effectively assumes changes in reserve money are transmitted to broad money via the money multiplier; that banks are in the business of creating inside money. But this argument also assumes a role for individuals holding components of broad money, currency in circulation, and various forms of deposits. The

[9] Persistent decline in velocity does not necessarily mean an unstable demand for money so long as velocity shocks can be accounted for by other determinants of money demand such as interest rate, exchange rate (see Adam and others, 2010).

money view of monetary policy assumes aggregate demand moves in line with money balances used to finance transactions and affect the split of nominal GDP between real GDP and the price level. It is this idea that forms the basis for broad money representing the intermediate target in many central bankers' money-focused monetary policies (Mishkin, 1998).

B. Interest Rate Channel

The interest rate channel has been the traditional channel of monetary policy since the first developments in macroeconomic theory. This channel can be summarized in the standard Keynesian IS-LM framework, whereby an expansionary monetary policy leads to a fall in the real interest rate, thus decreasing the cost of capital and stimulating investment, which then results in an increase in aggregate demand and output. It is important to note that real spending decisions are only affected by changes in the real interest rate, whereas the monetary policy authority has direct control only over the short-term nominal interest rate. The crucial factor linking the monetary base with the real interest rate and ultimately determining the effectiveness of the interest rate channel is the slow adjustment of the price level. "Price stickiness" causes movements in the monetary policy rate to have a significant effect on short-term real interest rates. In addition, the rational expectations hypothesis of the term structure suggests that long-run real interest rates are determined by expectations about future short-term real interest rates. The monetary policy authority is therefore able to use short-term policy rates to influence long-run real interest rates through price stickiness and the term structure, which then affect the real economy.

C. Exchange Rate Channel

In small, open economies, one of the most important monetary policy channels is the exchange rate channel. The extent to which monetary policy can affect movements in the exchange rate is largely influenced by the theory of uncovered interest rate parity (UIP). This simple theoretical relationship suggests that the expected future changes in the nominal exchange rate are related to the difference between the domestic and foreign interest rate. In theory, the UIP enables the monetary policy authority to influence the exchange rate, which in turn affects the relative prices of domestic and foreign goods, thus affecting net exports and output. For example, a cut in the monetary policy rate would make domestic deposits less attractive compared to foreign deposits leading to a fall in the demand for domestic currency. As a result, the domestic currency would depreciate, which would make domestic goods cheaper compared to foreign goods leading to an increase in net exports and total output. The effectiveness of the exchange rate channel is determined by the UIP condition, whose empirical validity has often been subject to criticism. As a result, many authors suggest that the UIP condition should be augmented with a risk-premium term implying that foreign investors upon buying domestic financial assets require compensation not only for expected depreciation, but also for holding domestic assets.

D. Credit Channel

Asymmetric information in financial markets provides the basis for the credit channel of monetary transmission. Bernanke and Gertler (1995) offer a detailed description of how imperfections in credit markets may cause a monetary contraction to lead to an increase in the external finance premium faced by borrowers and to a decrease in the loan supply. It is important to note that the credit channel is often referred to as an amplifier of traditional monetary channels rather than a stand-alone mechanism. Economists usually distinguish between two types of credit channels stemming from imperfections in financial markets: the bank-lending channel and the balance-sheet channel. The bank-lending channel is based on the assumption that a monetary contraction, which decreases bank reserves and bank deposits, lowers the quality of bank loans available. The balance-sheet channel is related to the effects monetary policy can exert on the net worth of businesses and households. A monetary contraction decreases the net worth of a firm through its cash flows and the value of its collateral, thus leading to a higher external finance premium associated with more severe moral hazard problems. This in turn would reduce the level of lending, investment, and output.

E. Asset Price Channel

Traditional monetary theory suggests that monetary contraction, through an increase in the discount rate of financial assets, may lead to a fall in asset prices, which will then further affect the real economy. Mishkin (1995) singles out two main mechanisms through which monetary policy shocks are propagated by changes in equity prices. First, the theory of Tobin's q suggests that when equities are cheap relative to the replacement cost of capital, firms do not want to issue new equities to purchase investment goods, leading to a decline in investment. Second, equity prices may have substantial wealth effects on consumption because of the permanent income hypothesis. A rise in stock prices increases the value of financial wealth, thus increasing the lifetime resources of households as well as the demand for consumption and output. A similar mechanism is applied to prices of other assets such as housing which is a substantial component of wealth. Therefore, MTM also operates through land and housing price channels.

F. Expectation Channel

Because modern monetary policy analysis is based on forward-looking and rational economic agents, the expectation channel is in effect fundamental to the working of all channels of MTM. In practice, this channel is mainly operational in developed economies with well-functioning and deep financial markets. For example, expectations of future changes in the policy rate can immediately affect medium and long-term interest rates. Monetary policy can also guide economic agents' expectations of future inflation and thus influence price developments. Inflation expectations matter in two important areas. First, they influence the level of the real interest rate and thus determine the impact of any specific nominal interest rate. Second, they influence price and money wage-setting behavior and feed through into actual inflation in subsequent periods. Similarly, changes in the monetary policy stance can influence expectations about the future course of real economic activities by affecting inflationary expectations and the ex ante real rate and guiding the future course of economic activities.

IV. Review of the Empirical Literature on MTM in EAC

We have conducted an exhaustive literature search using published and unpublished materials found in journals and on the World Wide Web. Specific details of our review is shown in Appendix I. Some papers may not have been refereed in academic journals or have been published since then. Our review shows that there are more studies of MTM conducted on Kenya than other EAC countries.

Before describing individual studies, our literature review shows that MTM is strong in Kenya, though only for prices, while it is generally weak in the rest of the EAC for either output or price.

A. Kenya

Cheng (2006) applied both recursive and non-recursive structural vector autoregression (SVAR) to monthly data in Kenya for 1997–2005 and found some evidence for the presence of the traditional transmission channels. A contractionary monetary policy—an exogenous increase in the short-term interest rate, the measure of monetary policy used in the paper—leads to an initial increase in the price level (the price puzzle) followed by a falling price level that is statistically significant for about two years following the shock. In response to a contractionary monetary policy, output rises initially (an “output” puzzle) but falls eventually, though the decline is not statistically significant. Shocks to the interest rate explain a much larger fraction of inflation (30 percent) than output (10 percent), consistent with the results from the impulse response analysis (IRA). Positive shocks to interest rates lead initially to a depreciated exchange rate but the exchange rate eventually appreciates for about two years, which suggests the presence of the strong impact of exchange rate pass-through to inflation.

In a similar fashion, Maturu, Maana, and Kisinguh (2010) applied the same methodology as Cheng (2006) to study MTM in Kenya using quarterly data from a more recent period (2000–2010). In contrast to Cheng (2006), Maturu, Maana, and Kisinguh (2010) regard M3 as the monetary policy instrument. They find that an exogenous shock to M3, an expansionary monetary policy, has no effect on real output, but leads to rising prices for almost 18 months, which is also statistically significant. A positive shock to the interest rate leads to falling prices, much like Cheng but the effect is not statistically significant, in marked contrast to Cheng’s finding. A shock to M3 explains as much of inflation variability as a shock to interest rate in Cheng’s. Both studies apply the non-recursive SVAR model of Kim and

Roubini (2000), and find that results are the same as the recursive model. Neither study explores the relative importance of various channels of MTM though Maturu, Maana, and Kisinguh (2010) make an attempt, but the methodology does not pin down the channels.

Buigut (2009) estimated a three-variable recursive VAR for 1984–2006 for three EAC countries (Kenya, Tanzania, Uganda) separately. The VAR used annual data on real output, price level, and short-term interest rate. The main finding is that the interest rate transmission mechanism is weak in all three countries—a shock to the interest rate has no statistically significant effect on either inflation or real output. The finding of weak transmission mechanism could be due to several factors: (i) The study uses a sample that includes too few observations for empirical analyses, resulting in few degrees of freedom; (ii) it does not provide standard diagnostics for the estimated VARs to further judge the reliability of the results; and (iii) it includes periods of substantial changes in monetary policy implementation, financial deepening, and other structural shifts in each economy which may have contributed to large uncertainty surrounding the effectiveness of monetary policy.

In addition, Buigut (2010) applied a vector error correction model (VECM) to annual data on Kenya for 1979–2008, and found evidence for the "price puzzle" (Sims, 1992), that is, contractionary monetary policy leads to a rise in the consumer price index (CPI) level. In addition, the paper shows that monetary policy tightening leads to a fall in the quantity of loans and an increase in lending rates, thus confirming the presence of a positive bank-lending channel. However, one cannot conclude whether these findings are statistically significant, since no confidence bounds are shown for impulse responses.

In contrast to the aggregate analysis of the credit channel of Buigut (2010), Sichei and Njenga (2010) use annual data on 37 banks in Kenya 2001–2008 to investigate whether monetary policy has differential effects on banks of varying size and ownership structure and whether the credit channel is more operative through loan demand or loan supply. They find that demand for credit is not responsive to changes in lending rates regardless of the size and ownership structure of banks, but banks contract loan supply in response to monetary tightening, indicating the presence of credit rationing. These findings suggest that monetary policy in Kenya works primarily through quantities (credit) rather than its price (the lending rate), though the study does not explore the direct impact of changes in bank credit on either the price level or output.

The role of financial innovation in the effectiveness of monetary policy in Kenya was studied by Misati and others (2010). The paper applied single equation methods to monthly data for 1996–2007, and showed that financial innovations, proxied by ratio of M2 to M1 and bank assets to GDP, have weakened monetary policy transmission in Kenya by reducing the impact of the repo rate on output. The impact of the repo rate on inflation in the face of changing financial innovation is not investigated.

B. Tanzania

Buigut (2009) applied structural VAR methods to annual data for Tanzania in 1984–2005, and found evidence that interest rate shocks have weak and insignificant effects on output and inflation. Too few observations in this study may account for the large confidence bounds.

In a more extensive study of MTM in Tanzania and using monthly data from January 2002–September 2010, Montiel and others (2012) find that reserve money has a statistically significant effect on the price level in a recursive VAR model, but the effect is not economically significant. When a structural VAR model is used, the statistical significance of the price level disappears. Monetary policy was also found to have no output effects.

However, a recent study of inflation that used a single-equation approach found that broad money affects inflation both in the short run and long run, and the effects are statistically significant (Adam and others, 2012). This study suggests that parsimonious models may stand a better chance of uncovering statistically significant results than VARs, but their disadvantage is that they ignore the interaction with other variables that have been left out of the regression. Specifically, single equation models tend to rely heavily on weak exogeneity, which obscures the true source of a shock.

C. Uganda

Peiris (2005) employed a six-variable recursive VAR model and found that a shock to M2 increases the price level, but a shock to interest rate has no effects. However, it is not possible to evaluate the statistical significance of these results because no confidence intervals are shown in this study for impulse responses.

On the other hand, Saxegaard (2006) employed threshold VAR techniques to study quarterly data on Uganda for 1990–2004 and found that contraction in the money supply has a significantly negative impact on CPI inflation, and the impact becomes bigger when involuntary excess liquidity of commercial banks is low. In contrast, Mugume (2011) applied structural VAR models to quarterly data for 1999–2009, and found all channels of monetary transmission to be ineffective. In particular, the interest rate channel remains weak, even though there is some evidence for a transmission of treasury bill rate changes to lending interest rates.

D. Rwanda and Burundi

A number of studies (Sayinzoga and Simson, 2006; Rutayisire, 2010) have analyzed the stability of money demand functions, but none of them have explicitly analyzed monetary policy transmission. Similarly, to our knowledge, there have been no published studies on monetary transmission for Burundi.

V. EMPIRICAL METHODOLOGY

We use vector autoregression (VAR) models which are the most widely used methodology to analyze MTM. The use of VARs for monetary policy analysis started with the seminal work of Sims (1980) and its recursive methodology has been used widely. In fact most studies of MTM in LICs as reviewed by Mishra, Montiel, and Spilimbergo (2010) have used VARs, with the majority of studies using recursive VARs. Studies of MTM in developed economies also continue to use VARs and its variants, as reviewed extensively by Christiano, Eichenbaum and Evans (1999) for the United States, Weber, Gerke, and Worms (2009) for the euro area, and more recently by Boivin, Kiley and Mishkin (2011) for the United States and other G7 economies.[10]

We use three variants of SVARs to study the MTM in the EAC: standard recursive SVARs, Bayesian VARs, and factor-augmented VARs. Recursive SVARs assume a recursive relationship between errors of a reduced-form VAR and remain the most widely used methodology in the literature on MTM. However, this method may suffer from problems of over-parameterization and misspecification, which may undermine the robustness of the empirical results. To tackle these problems, two additional methods are applied. First, the standard ordinary least squares (OLS) estimation of the recursive structural VAR is replaced by Bayesian estimation techniques (Litterman, 1986). Bayesian methods provide an effective treatment for problems of over-parameterization by the use of prior information.[11]

Secondly, factor methods are used that allow for the use of information contained in other variables while simultaneously reducing the number of parameters in the VAR. Each variant is estimated for each country separately, allowing for country-specific dynamics in the evolution of the MTM. Factor-augmented VARs (FAVAR) are estimated following Bernanke, Boivin, and Eliasz (2005). These methods assume a larger information set is being used by central bankers and different estimation methods that provide useful checks on robustness of the results from the recursive SVAR models.

[10] There are nevertheless alternative methods for monetary policy analysis such as dynamic stochastic general equilibrium (DSGE) models that impose a more theoretically motivated structure on the data (see Christiano, Trabandt, and Walentin (2010) for a recent review.). Owing to increasing computational capacity, these models have become widely used among central bankers and have produced some promising results for low-income countries as well (Berg and others, 2010; O'Connell, 2011).

[11] See Chapter 10 of Canova (2007) for a detailed review of Bayesian VARs, and how these methods may be useful for shrinking the parameter space of the model

A. Recursive Structural VAR

The true structure of the economy is approximated by the following reduced form model:

$$Y_t = A_1 Y_{t-1} + ... + A_q Y_{t-q} + BZ_t + B_1 Z_{t-1} + ... + B_p Z_{t-q} + u_t \quad (1)$$

Where t=1,...,T, Y_t is an $M \times 1$ vector of endogenous time series variables, contains the intercept, time trend and other deterministic terms, Z is a vector of exogenous variables,[12] u_t is a vector of reduced form residuals, A_i and B_i are matrices of coefficients, p and q are non-negative integers denoting the number of lags included in the model. The variance-covariance matrix Σ is written as $\Sigma = Eu_t u_t^{'}$. Consistent estimates of A_i, B, and Σ are obtained by using ordinary least squares. Once the estimates are obtained, one has to recover the parameters of the structural form model that can be written as

$$C_0 Y_t = C_1 Y_{t-1} + ... + C_q Y_{t-q} + DZ_t + \varepsilon_t \quad (2)$$

where C_i and D are matrices of parameters underlying the structure of the economy. ε_t is a vector of the structural economic shocks, and the corresponding variance covariance matrix is written as $W = E\varepsilon_t \varepsilon_t^{'}$. The relationship between the reduced form and structural form parameters can be written as

$$A_i = C_0^{-1} C_i, \quad \varepsilon_t = C_0 u_t \quad (3)$$

There is a similar relationship between variance-covariance matrixes of the reduced form and the structural form model: $\Sigma = C_0^{-1} W \left(C_0^{-1}\right)^{'}$. The lack of information about the contemporaneous parameter matrix, C_0, gives rise to the identification problems often encountered in the structural VAR literature. This is associated with the fact that the number of estimated parameters in the reduced form model (1) is smaller than the number of parameters in the structural form model (2). To resolve this issue, and to move from the estimated reduced form model to the structural model, certain restrictions have to be imposed on the structural parameters, otherwise the structural form model (2) cannot be identified.

[12] Exogenous variables will always enter all VAR models contemporaneously, and their lagged values will not be considered in the paper. Based on additional estimation results, the inclusion of lagged exogenous variables does not change our findings. These results are available upon request.

The identification scheme follows the original paper by Sims (1980), whereby Choleski decomposition is applied to the contemporaneous parameter matrix, C_0. The ordering of the newly obtained triangular matrix is written as follows:

$$\begin{bmatrix} \varepsilon_t^{\,y} \\ \varepsilon_t^{\,p} \\ \varepsilon_t^{\,m} \\ \varepsilon_t^{\,r} \\ \varepsilon_t^{\,c} \\ \varepsilon_t^{\,e} \end{bmatrix} = \begin{bmatrix} 1 & 0 & 0 & 0 & 0 & 0 \\ g_{21} & 1 & 0 & 0 & 0 & 0 \\ g_{31} & g_{32} & 1 & 0 & 0 & 0 \\ g_{41} & g_{42} & g_{43} & 1 & 0 & 0 \\ g_{51} & g_{52} & g_{53} & g_{54} & 1 & 0 \\ g_{61} & g_{62} & g_{63} & g_{64} & g_{65} & 1 \end{bmatrix} \begin{bmatrix} u_t^{\,y} \\ u_t^{\,p} \\ u_t^{\,m} \\ u_t^{\,r} \\ u_t^{\,c} \\ u_t^{\,e} \end{bmatrix} \tag{4}$$

We use the following notation for each variable: output (y), price level (p), reserve money (m), policy interest rate or other short-term interest rate (r), credit to private sector (c), and the exchange rate (e). The choice of these variables reflects the transmission channels in the black box discussed earlier.

The econometric identification of monetary policy shocks is crucial to any model specification, including VARs. The VAR identification exercise we follow is explained below. It is similar to many studies used in the context of VARs in advanced economies including Sims (1992) and Christiano, Eichenbaum and Evans (1999), but we have modified to take into account the institutional context of the conduct of monetary policy in the EAC through either the RMP or the flexible RMP.

- The ordering y, p, m, r, c, and e, means that output and price level react to an innovation in reserve money with a lag, or, alternatively, reserve money responds contemporaneously to innovations in output and prices. This assumption is reasonable for "slow-moving" macroeconomic variables such as output and prices.

- Consistent with the RMP for all EAC, reserve money is considered the main instrument of monetary policy. So shocks to reserve money are considered shocks to monetary policy, i.e., the reserve money innovation after controlling for VAR innovation in output and price level.

- The policy rate or a measure of the interest rate is ordered after reserve money. This is consistent with the practice that the policy rate or other interest rates (e.g., T-bill rate against which policy rates may be benchmarked) are increasingly being used by EAC central banks as an additional instrument to signal changes in monetary policy stance. This identification assumption is also consistent with the conduct of flexible RMP in some EAC countries such as Uganda and perhaps Rwanda. Whether the interest rate plays a significant role over and beyond reserve money is an empirical issue that is investigated empirically in our VAR modeling. We should note that in an inflation-targeting monetary policy framework, the policy rate would be the operating target and reserve money would not play a role. In this case, one simply drops reserve money from the above VAR.

- Placing the interest rate after reserve money also reflects the idea that central banks change the policy rate after first choosing the reserve money path. If the reserve money path cannot be changed within a quarter or a month, say owing to pre-agreed targets, changing the policy rate often gives additional flexibility to monetary authorities to signal changes in monetary policy. Monetary authorities cannot choose quantities (reserve money) and prices (interest rate), because choosing one implies that the other is endogenous. Countries choosing prices and quantities simultaneously have given up on the signaling role of reserve money and the interest rate and undermine effectiveness of monetary policy.

- Credit to private sector is placed after the policy rate because commercial banks react with a delay to grant loans and change loan terms following a shock to monetary policy. So credit is allowed to response to changes in policy rate and reserve money. The ordering also allows a loosening of monetary policy to be transmitted to credit expansion and a subsequent impact on inflation and output with a lag, i.e., whether a credit channel is effective. Note that since the model is not identifying demand or supply shocks, a credit shock is an outcome of both supply and demand.

- Finally, the exchange rate is placed last because it responds to innovation in macrofundamentals contemporaneously. In EAC countries with an actual peg, this channel will not be as effective as others where the exchange rate is market determined and responds to market fundamentals.

B. Bayesian VAR

One of the shortcomings of the benchmark VAR is the generous parameterization of the model.[13] Bayesian (BVAR) estimation provides an effective way of dealing with the problem of over-parameterization by using previously acquired information. We follow Canova (2007) and Koop and Korobilis (2009) to address problems of possible overfitting by using Bayesian methods. These methods offer an efficient way of shrinking the parameter space through prior distributions on VAR coefficients and the estimated variance-covariance matrix of reduced-form residuals.

To illustrate the framework of the BVAR model, we rewrite the reduced-form VAR model defined by equation (1) by introducing the following compact matrix notation:

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[13] For example, the benchmark VAR with six endogenous, four exogenous variables and two lags would require the estimation of more than 100 parameters.

$$y = (I_M \otimes X)\alpha + \varepsilon \tag{6}$$

where $X = [x_1, x_2 ... x_T]$ is a $T \times K$ data matrix with $K = 1 + Mq$. Each element of X contains the contemporaneous values of all independent variables, as $x_t = (1, Y'_{t-1}, ..., Y'_{t-q}, Z_t)$. In addition, α is a $KM \times 1$ vector containing all the parameters in the coefficient matrices $A = (A_1, ..., A_q, B)$, so α is defined as $\alpha = vec(A)$. The distributional assumption of the variance-covariance matrix is $\varepsilon \sim N(0, \Sigma \otimes I_T)$, whereas the likelihood function corresponding to equation (6) can be derived from the sampling density, $p(y \mid \alpha, V)$, taking the following form:

$$\alpha \mid \Sigma, y \sim N\left(\hat{\alpha}, \Sigma \otimes (X'X)^{-1}\right) \tag{7}$$

To define a prior distribution for α, we use Minnesota priors developed by Doan, Litterman, and Sims (1984) and Litterman (1986) that involve approximating the variance covariance matrix, Σ, with an estimate, $\hat{\Sigma}$. As a result, priors need to be formed only for α, which takes the following form:

$$\alpha \sim N(\overline{\alpha}_{Mn}, \overline{V}_{Mn}) \tag{8}$$

The Minnesota prior involves setting the elements of the parameter-prior, $\overline{\alpha}_{Mn}$, and the covariance-prior, $\overline{V}_{Mn}$, in a way that is most sensible in the empirical context. For example, when data on the EAC countries are in levels, it is sensible to believe that the variables are random walk, hence setting the prior mean for the coefficient on the first own lag to be 0.9 could be supported. In addition, the Minnesota prior assumes the prior variance-covariance matrix, $\overline{V}_{Mn}$, is diagonal, implying there is no relationship among the coefficients of the various VAR equations. In addition, the diagonal elements of the prior variance-covariance matrix are such that the most recent lags of a variable are expected to contain more information about the variable's current value than earlier lags. Moreover, lags of other variables are assumed to have less information than lags of own variables.[14]

An advantage of the Minnesota prior is that the resulting posterior of the parameter vector, α has a normal distribution. This allows us to calculate the posterior mean of the estimates without having to resort to different sampling techniques (e.g., Gibbs-sampling), which also

[14] We closely follow Section 10.2.2 in Canova (2007), which provides a more technical discussion of BVARs with Minnesota priors. It also explains how the tightness of the prior distribution is controlled by various hyperparameters.

reduces computational time substantially. The recursive identification scheme used for the benchmark SVAR is preserved in the BVAR specification.

C. Factor-Augmented VAR

So far we only considered low-dimensional VAR models, whereby the number of variables used is unlikely to span the information sets contained in other time series for the EAC countries. This omission could be tackled by adding more variables to the VAR, but this would aggravate the problem of high dimensionality and over-parameterization of the model. FAVAR models apply the idea of principal component analysis to shrink the parameter space by identifying common factors from a set of variables. FAVARs therefore have the advantage of addressing problems of over-parameterization while simultaneously using more information compared to the benchmark SVAR.

In addition, FAVAR models may tackle two problems encountered with implementing monetary targeting or other monetary policy frameworks familiar to central bankers. First, central bankers may not concur that there exists a reliable and strong relationship between the targeted policy variable and monetary policy goals. Second, the target variable, such as monetary aggregates, may not be controlled effectively by the central bank. Central bankers are therefore aware that they should not rigidly follow money targeting and use multiple aggregate targets within a monetary targeting framework. This point has been recognized by those who study experiences with monetary policy frameworks in an international context (e.g., Mishkin, 1998). Therefore, not only monetary aggregates but also interest rates are allowed to enter the information set of a central banker or a monetary reaction function. This formalizes the notion that the central bank will not be a strict money growth targetter but may also use interest rate and, indeed, many other economic indicators to guide monetary policy toward achieving its goals.

To circumvent this problem, the most recent empirical macroeconomic literature on monetary transmission has relied on FAVAR models pioneered by Stock and Watson (1999, 2002). To extend the reduced-form VAR model with the factor structure, following Bernanke, Boivin, and Eliasz (2005), we rewrite equation (1) as

$$\begin{pmatrix} Y_t \\ F_t \end{pmatrix} = \phi_1(L)\begin{pmatrix} Y_{t-1} \\ F_{t-1} \end{pmatrix} + \dots + \phi_q(L)\begin{pmatrix} Y_{t-q} \\ F_{t-q} \end{pmatrix} + u_t \qquad (9)$$

where F_t is $N \times 1$ vector factors and $\emptyset_i$ are polynomial lags. Note that equation (9) cannot directly be estimated, because the factors F_t are unobservable. However, we can use the information on a variety of economic time series, contained in the information matrix, Γ_t, which takes the following form:

$$\Gamma_t = \Lambda^f F_t + \Lambda^y Y_t + e_t \tag{10}$$

where Γ_t is a $P \times 1$ matrix, Λ^f is a $P \times N$ matrix of factor loadings, Λ^y is $P \times M$, and e_t is and $P \times 1$ matrix of error terms are factor loadings. Following Stock and Watson (2002), equation (10) is called a *dynamic factor model* and can be estimated using a two-step estimation procedure.

In the first step, principal component analysis is used to construct a variable that captures the largest common variation in a set of variables. In the context of the EAC countries, we extract the first principal component from all the exogenous variables used in the benchmark SVAR, leading to the use of only one exogenous variable in the FAVAR, instead of four exogenous variables as used in the benchmark SVAR. In addition, we construct an endogenous variable by extracting the first principal component from a number of monetary indicators such as credit, M1, M2, and other variables left out of the benchmark SVAR. Once these two factors are constructed by using static principal component analysis,[15] the FAVAR model (9) can be estimated by standard methods in VAR.

VI. DATA

Estimation of a monthly VAR model requires compilation of measures of money, price level, asset prices, and GDP at monthly frequencies. Data on the first three indicators were obtained from IMF databases, national authorities, and staff estimates.

However, GDP data are available only at quarterly frequencies for all EAC countries but Burundi.

At best we may have 10 years of quarterly data for each country except Burundi. The starting date for each country's quarterly national accounts is as follows: Kenya (2000 Q1), Rwanda (2006 Q1), Uganda (1999 Q4), and Tanzania (2001 Q1). This data set amounts to 40 observations at the maximum, which may not offer sufficient degrees of freedom for statistical inference given the nature of time lags and the number of variables needed even for a small, low order VAR.[16]

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[15] Note that we follow the static principal component approach proposed by Stock and Watson (2002), which does not account for the possible autocorrelation in the variables. A natural extension of the analysis would therefore be to address this problem by using dynamic principal component methods as in Forni and others (2005).

[16] As suggested earlier, a six-variable VAR with a constant, a time trend, two lags of each variable plus contemporaneous values of our four exogenous variables results in estimation of 18 parameters, leaving only 22 degrees of freedom at maximum.

We need to generate proxies for real GDP at quarterly frequency for Rwanda before 2006 Q1 and for Burundi for all time periods. Our strategy is as follows. For Rwanda, in the years before 2006 Q1 for which quarterly GDP data are not available, seasonality factors of quarterly data post-2006 are applied to annual real GDP to interpolate to quarterly frequency. For Burundi, because its production structure is similar to Rwanda's, we generate a quarterly series of real GDP by applying Rwanda's quarterly seasonality factors to Burundi's annual GDP data.

Monthly estimates of GDP are then derived for all EAC countries by interpolating quarterly GDP data using a cubic spline, a widely used technique.[17] Finally, the monthly estimates are seasonally adjusted using the X-12 ARIMA method.

The benchmark model is estimated from January 2000 through December 2010 on log levels, except for interest rate series, which are in percent. This is a widely used specification in the literature. Use of levels rather than first differences preserves any long-run relationship, if present, and does not affect statistical inference (Sims, Stock, and Watson, 1990).

An SVAR model consisting of six endogenous and four exogenous variables is estimated for each country. The six endogenous variables are real GDP, CPI, reserve money, short-term interest rate, credit to private sector, and the nominal effective exchange rate (NEER). The four exogenous variables that affect endogenous variables are a global oil price index, a global food price index, U.S. federal funds rate, and U.S. industrial production. The latter two are proxies for global demand conditions, while global food and fuel prices are expected to affect, among other things, inflation and output beyond external demand factors.

To check for the robustness of our results, the BVAR model is applied to the dataset explained above. In addition, FAVAR methods are used by adopting principal component methods as follows. The first principal component of the four exogenous variables is used as an exogenous variable. The first principal component of two endogenous variables (credit and NEER) and additional variables, M1, M2, M3,[18] are constructed. This essentially leads to the estimation of a VAR with five endogenous variables and one exogenous variable, hence reducing the parameter space and mitigating problems of over-parameterization. Finally, the benchmark SVAR model specification will be estimated on a longer sample for each country going back to the mid-1990s.

[17] Many studies of MTM in advanced countries also use interpolated monthly GDP data; see Bernanke, Boivin and Eliasz (2005).

[18] M3 is not used in the FAVAR for Burundi, because the data is not available.

VII. Empirical Results

The benchmark results for each EAC country are obtained by estimating country specific SVAR models from January 2000 to December 2010, using recursive identification methods described by equation (4).

For all countries, we chose the VAR lag length using the standard lag length selection criteria (Akaike, Shwartz, Hannan-Quinn, Final Prediction Error, etc). We found a maximum lag length of three, which was also sufficient to render serially uncorrelated VAR errors. In contrast, most empirical work on MTM in advanced countries uses six to twelve lags for monthly data, or two to four quarters for quarterly data. While some may expect that monetary policy takes time to have its effects in the EAC, this prior seems to be based entirely on the experience of advanced countries and the conventional wisdom, driven in part from Friedman's early work that "lags in monetary policy are long and variable." Adding more lags beyond three months, which we also did, results in increasing problems of over-parameterization, associated with larger confidence bounds for impulse responses, reflecting the increase in noise and imprecision.

Having said this, we should also point out that the effects of monetary policy in some EAC countries do last beyond three months because cumulative effects are only built up over time and show up in cumulative impulse responses. However, the main difference with impulse responses in advanced countries is that effects of monetary policy in the EAC are short lived. If a confidence interval for impulse responses includes zero, then monetary policy has no statistically significant effect on either prices or output. In other words, the MTM is weak. As the horizon is expanded beyond six months, impulse responses become wider, rendering either economically insignificant results, statistically insignificant results, or both. Of course, we may choose to have a weaker inference standard than the conventional confidence intervals of plus and minus two standard errors (a 95 percent confidence interval).

If we opt, for example, for a 90 percent confidence interval it could increase the Type II error (probability of accepting a false hypothesis, that MTM is strong when it is in fact weak). Appendix II reports the 95 percent confidence interval, showing that MTM is weak in the EAC. The results reported below use a 90 percent confidence interval, showing a somewhat stronger MTM.

We also often found hetroscedasticity in monthly data and in some cases we could reduce hetroscedasticity by adding as many "intervention" dummies as possible but this also distorts the results significantly. We decided not to pursue this line of research further.[19]

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[19] Our technique of adding intervention dummies is akin to Professor David Hendry's saturated dummy variable approach to regression. In our case, we found it impossible to give any interpretation of dummy variables and did not want to impart additional noise to the MTM. Monetary policy in the real world has to deal with data irregularities and unusual shifts (e.g., a poor harvest or a large drop in other sectors). Nevertheless, we tried a

(continued…)

Using quarterly data produces significantly less heteroscedasticity owing to data averaging, but we also loose significant degrees of freedom. So we decided not to pursue this line of research either.

A. Burundi

The first row of Figure 4 displays the impulse responses of output and prices to a one standard deviation positive shock in reserve money (monetary loosening) in our baseline recursive model, while the second row depicts those to a positive shock in the policy rate (monetary tightening). Because of the lack of a structured interbank market, we use the T-bill rate as the policy interest rate in the baseline VAR for Burundi. One lag was selected by the Akaike, Schwartz, and Hannan-Quinn information criteria. However, we proceeded with 2 lags to avoid serial correlation of residuals at the first lag order

We find that output responds positively and significantly to a shock in reserve money, albeit with a considerable lag that spans almost a year. Its response to a shock in the T-bill rate is prompt (peaking in 6 months) and sustained over a longer time though not statistically significant. Nesting our recursive VAR into a FAVAR model, however, generates relatively muted impulse responses of output to shocks in both reserve money and T-bill rate and a more pronounced response of prices to an interest rate shock. This perhaps illustrates the instability of MTM in Burundi. See Appendix III for comparison of results obtained using the two different models.

As shown in Appendix II, output moves in tandem with exchange rates, i.e. an appreciation of the nominal effective exchange has an expansionary effect on the economy. This contradicts the Keynesian argument in which an expansionary monetary policy leads to a depreciating currency, and this positively affects output through an increase in net exports. This phenomenon may in part be explained by the appreciation pressures generated by large inflows, which are further channeled into investment. Additionally, given Burundi's large trade deficit, an appreciating exchange rate would increase the net worth of domestic assets, and thereby their purchasing power, creating space for further consumption and investment.

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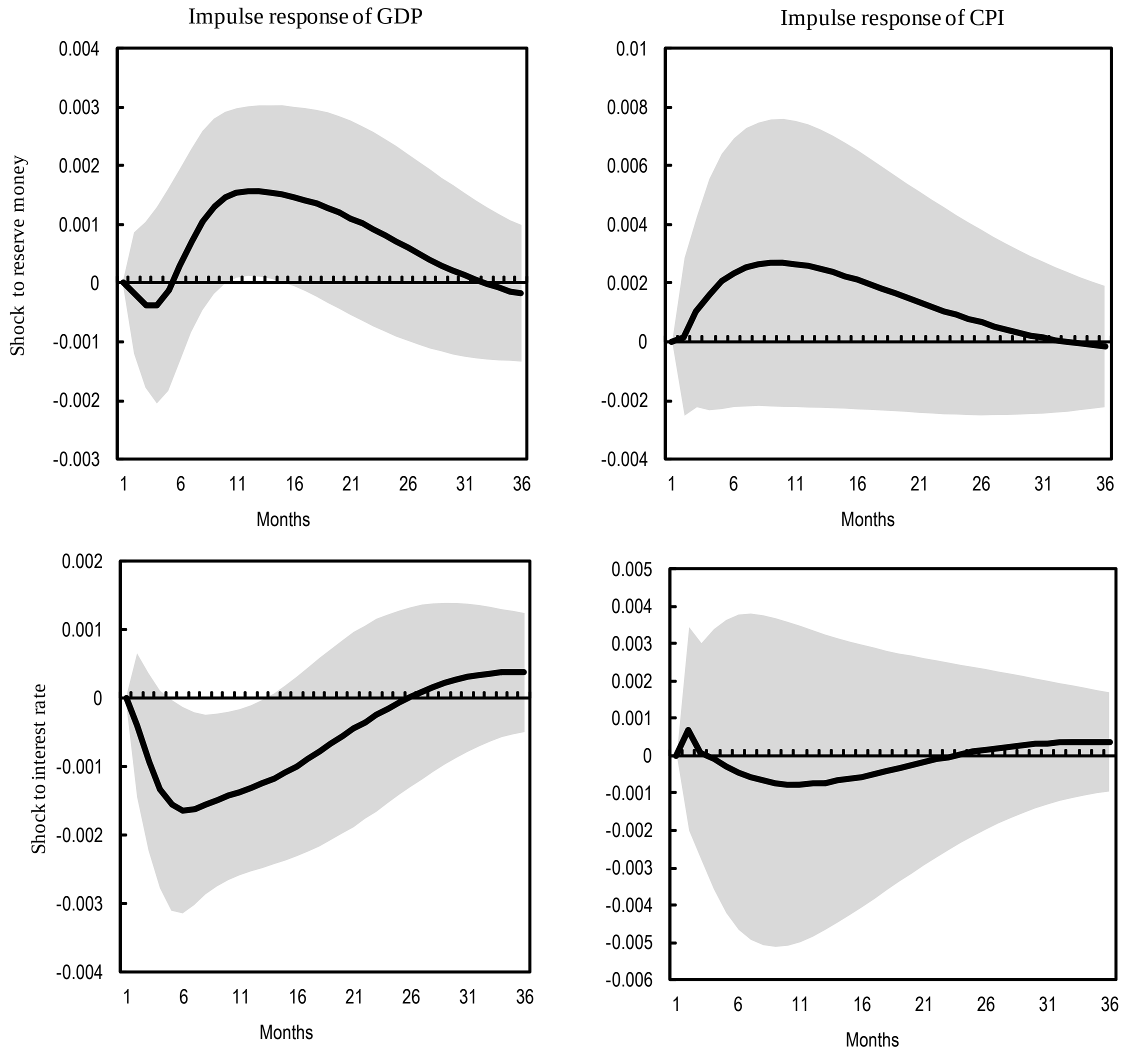
large number of intervention dummies for Uganda. Many more dummies were needed than just accounting for an occasional poor harvest or drought to produce homoscedastic errors.

Figure 4. SVAR Impulse Responses for Burundi



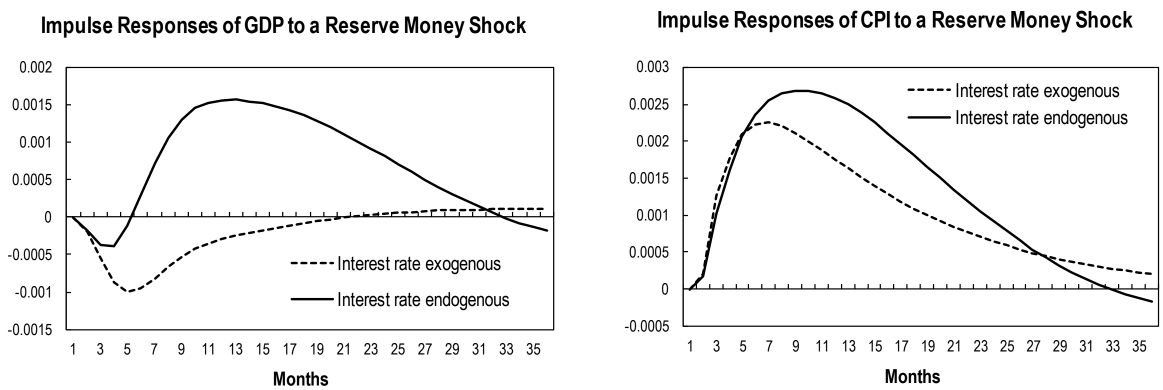
Note: Shocks are one standard deviation; vertical axes are percentages, horizontal axes are months, and the shaded areas denote the 90% confidence bands.

To ascertain the relative strength of the interest rate channel, we re-run the VAR with the T-bill rate exogenized, i.e., lagged values of the T-bill rate are treated as exogenous variables in a smaller VAR involving GDP, CPI, reserve money, credit, and NEER (Figure 5). Such a procedure generates a VAR identical to the original, except that it blocks off any responses within the VAR that pass through the interest rate.[20] Activating the interest rate channel in this fashion morphs a negative impulse response of output to innovations in reserve money to a positive (and statistically significant) response. The channel also has a positive impact on prices. We note that this considerable swing is only captured when using the T-bill rate as opposed to the indicative discount rate. Similar dynamics can be observed even when the

[20] See Morsink and Bayoumi (2001) for this approach.

credit and exchange rate channels are inactivated, demonstrating the robustness of the interest rate channel in Burundi. We therefore conclude that movements in interest rates amplify the impact of reserve money on output and the price level. Interest rate therefore appears to be a transmission channel, but the effect is not statistically significant, given the direct impact of interest rate on either output or the price level.

Figure 5. Testing the Interest Rate Channel in Burundi



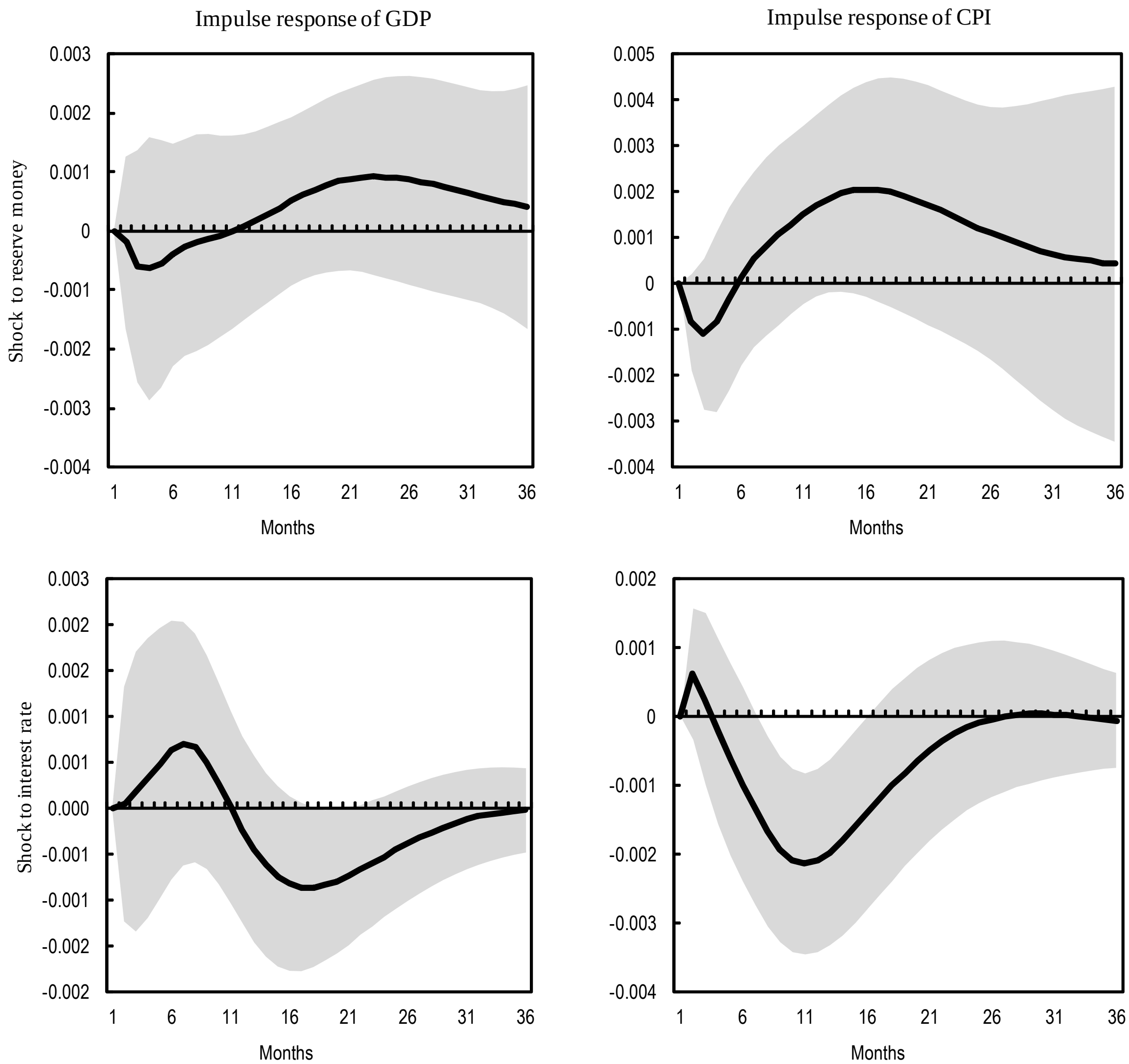
Note: The solid lines show the impulse responses from the benchmark SVAR with six endogenous variables; the dashed lines show the impulse responses from the SVAR with five endogenous variables.

B. Kenya

The results of the benchmark model with recursive identification are shown in Figure 6, which displays the impulse responses of GDP and CPI to a one standard deviation shock to reserve money and the repo rate.[21] Similar to Cheng (2006), the results suggest that a positive shock to the policy rate has a significant and persistent effect on CPI which peaks 9 to 11 months after the shock. A positive shock to reserve money has a positive impact on CPI that is in line with economic theory and peaks later at 15 months, later than an interest rate shock. Both types of shocks have no statistically significant effect on GDP.

[21] The time series switches to reverse the repo rate from June 2009 onward. Re-running the VARs that end in May 2009 does not change the results.

Figure 6. SVAR Impulse Response for Kenya

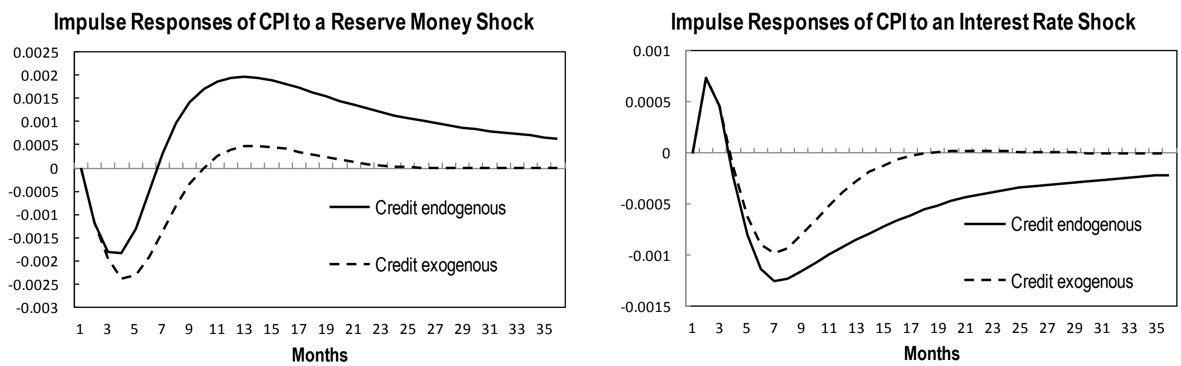


Note: Shocks are one standard deviation; vertical axes are percentages, horizontal axes are months, and the shaded areas denote the 90% confidence bands.

Appendix II includes the complete set of impulse responses, allowing for a more detailed analysis of monetary policy transmission in Kenya. Figure 2 in Appendix II suggests that a shock to both reserve money and the policy rate has a significant impact on NEER and credit, whereas a shock to NEER corresponding to an unexpected nominal exchange rate appreciation and a shock to credit corresponding to an unexpected credit expansion both have a significant impact on CPI. Since the two shocks are by construction orthogonal, these results can be interpreted as indirect evidence on the existence of an exchange rate and credit channel of monetary policy.

To undertake a direct assessment of the NEER and credit channels, we carry out the following exercise: we analyze the effects of a monetary policy shock in a VAR in which the target variable associated with the given channel is endogenous, and then compare these results to those obtained by running a VAR in which the same target variable is exogenous. This exercise essentially involves comparing the effects of monetary policy shocks in a 5-variable VAR including GDP, CPI, reserve money, interest rate, and credit with the those obtained by a 4-variable VAR where credit is made exogenous. Figure 7 reports on these results and confirms that allowing for the endogenous presence of the credit variable increases the impact of a monetary policy shock on CPI.

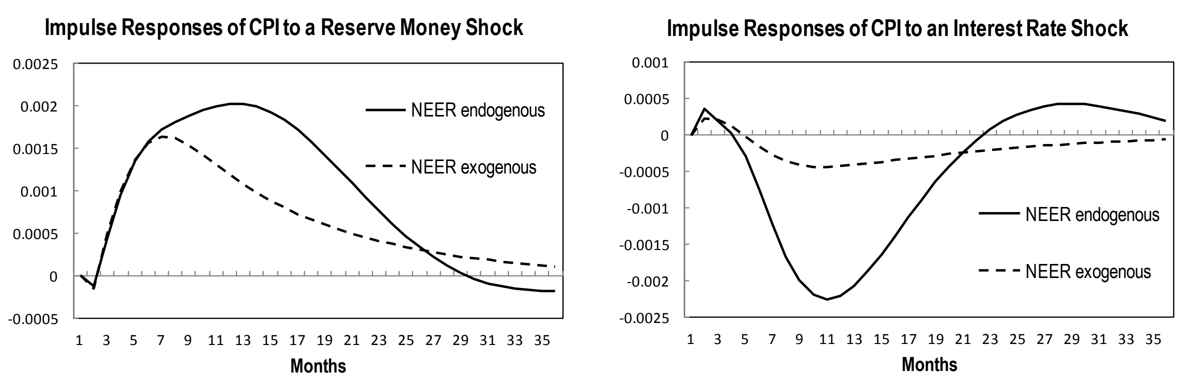
Figure 7. Testing the Credit Channel in Kenya



Note: The solid lines show the impulse responses from the benchmark SVAR with six endogenous variables; the dashed lines show the impulse responses from the SVAR with five endogenous variables.

The results associated with the exchange rate channel are shown in Figure 8. The endogenous presence of the NEER magnifies the impact of both types of monetary policy shock, though the presence of the exchange rate channel seems more pronounced in a policy shock. Previous studies (Cheng, 2006) have shown that Kenya's nominal exchange rate is highly sensitive to changes in the short-term interest rate, which then affects the overall price level through import prices. The right panel of Figure 8 can be seen as a direct evidence for this.

Figure 8. Testing the Exchange Rate Channel in Kenya



Note: The solid lines show the impulse responses from the benchmark SVAR with six endogenous variables; the dashed lines show the impulse responses from the SVAR with five endogenous variables.

This exogeneity-endogeneity exercise has been used to test for other channels of monetary policy transmission as well, but none of them had any significant impact on the way monetary policy shocks affect the CPI.

C. Rwanda

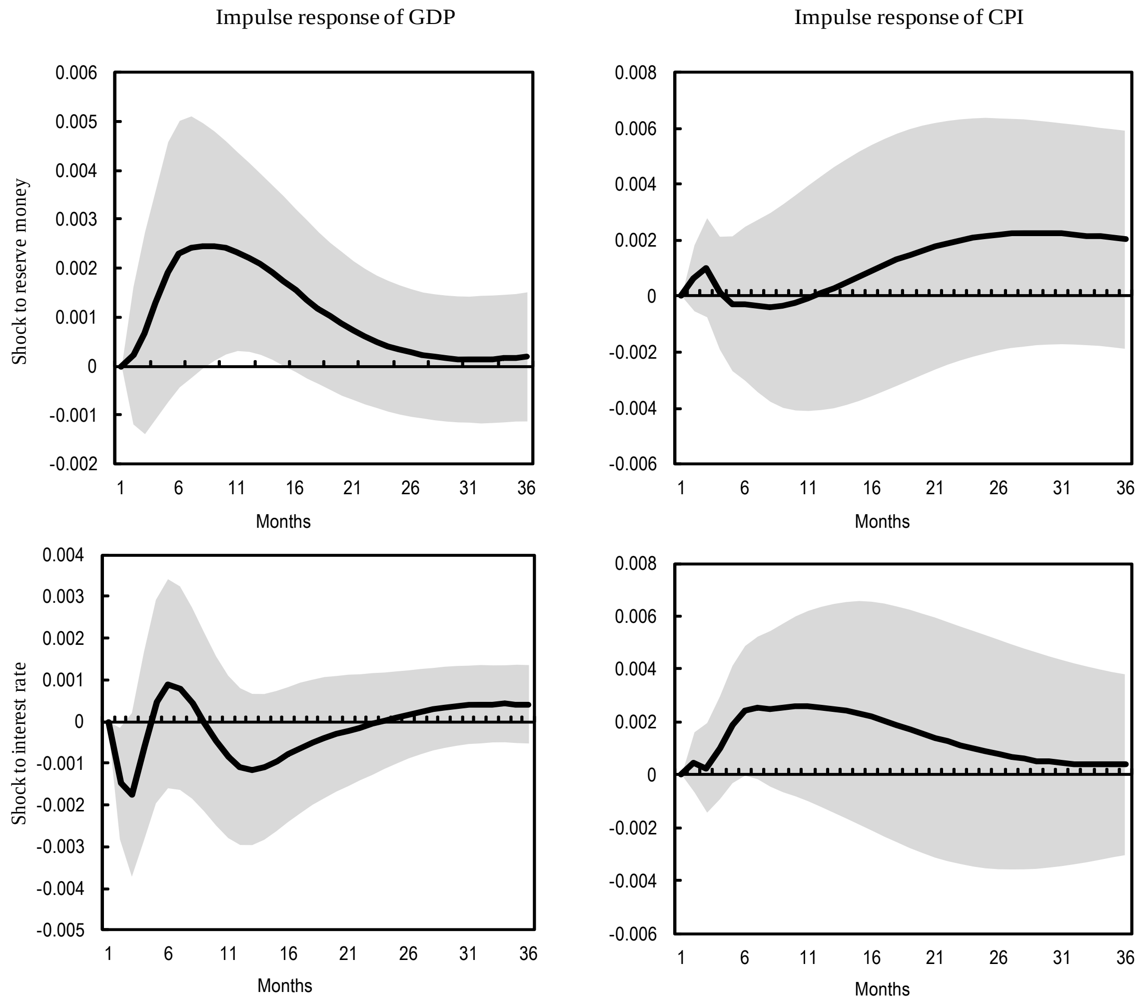
A reserve money shock induces a positive and statistically significant output effect, but no price effect. A positive response of prices to a shock in the key repo rate[22] is counter intuitive, a price puzzle that lasts for quite some time. The FAVAR approach (Appendix III) not only confirms the positive response of output to a shock in the monetary base but also reduces the extent of the price puzzle in our recursive specification, alluding to the success of the factor-augmented model in extracting pertinent information from the expanded dataset of macroeconomic variables.[23]

A shock to private sector credit has a significant effect on output for the first 5 months and on the price level for the first 15 months, both of which are statistically significant. As shown in Figure 3 in Appendix II the significant influence of reserve money on private sector credit sector also suggests that it may be an important channel in monetary transmission. To examine this further, we reran the VAR with lags of private sector credit exogenized, and compared it to our baseline results (Figure 10). This exercise confirms that the credit channel in Rwanda is indeed strong. The credit channel seems to be stronger statistically for the response of GDP to a reserve money shock than the response of CPI to a reserve money shock.

[22] Time-series spliced with discount rate prior to Jan 2007.

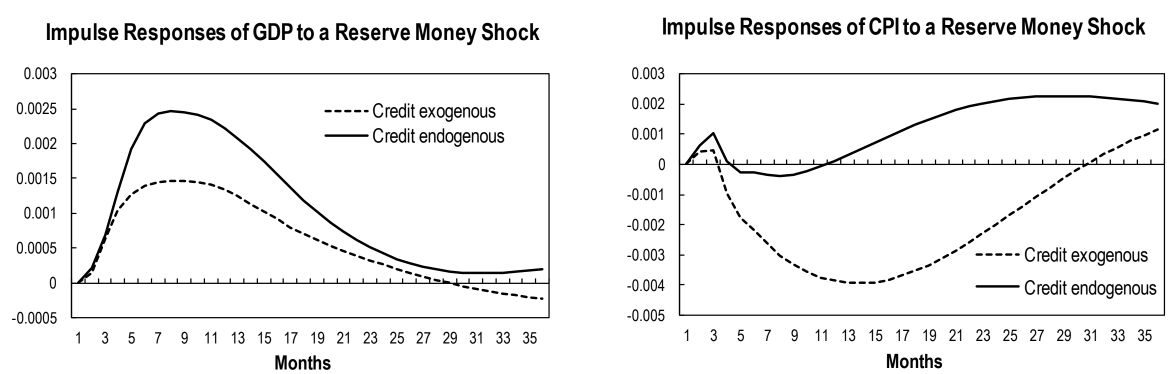
[23] Sensitivity tests employed to check for robustness include accounting for historical periods, including lags of exogenous variables, excluding exogenous variables, replacing policy rate with the lending rate.

Figure 9. SVAR Impulse Response for Rwanda



Note: Shocks are one standard deviation; vertical axes are percentages, horizontal axes are months, and the shaded areas denote the 90% confidence bands.

Figure 10. Testing the Credit Channel in Rwanda



Note: The solid lines show the impulse responses from the benchmark SVAR with six endogenous variables; the dashed lines show the impulse responses from the SVAR with five endogenous variables.

D. Tanzania

In a recursive VAR model estimated for 2000–2010, a positive shock to reserve money increases the CPI in the first year and half though the effect is not statistically significant. However, this impact becomes highly significant when the VAR is estimated over the longer period (1993m1–2010m12) in our baseline recursive structure. We reach similar conclusions using BVAR and FAVAR (see Appendix III Figure 4). Under a FAVAR a shock to reserve money has statistically significant positive output effects consistent with a central bank (the Bank of Tanzania) using a much larger information set (including credit and broad money aggregates, commodity prices) than that in the baseline VAR for the conduct of monetary policy.

Using either sample period, a positive shock to the interest rate increases the CPI, the so-called price puzzle that was also evident in Rwanda and partly in Kenya, but the impact is not statistically significant. In fact, the confidence interval for all impulse responses for output and price level include zero which indicates weak monetary transmission.

These findings are similar to those of Montiel and others (2012) for Tanzania who employ recursive and non-recursive VARs. These authors attribute the weak MTM to shallowness of financial markets and the oligopolistic structure of the banking system. Although these factors may play a role, the weak MTM can also result in spite of a stable velocity (Adam and others, 2012) if money multiplier is unstable in the short run, a result found by Adam and Kessy (2010).

However, other possibilities should not be ruled out either. For example, our findings on stability of the money multiplier and velocity in Section II.C showed that the money multiplier is relatively stable but velocity is relatively unstable, opposite of that found by Adam and Kessy (2010. Our findings are consistent with the interpretation that shocks to reserve money are transmitted to money; but transmission from money to prices or output is weak because shifts in velocity, caused perhaps by financial innovations, may attenuate any aggregate demand effects. The finding of a strong effect of money on prices in the short run and long run, as reported by Adam and others (2012), could be due to addition of error correction terms or disequilibrium in various markets to an otherwise standard money demand that may have corrected shifts in velocity, thus restoring the role of reserve money as an inflation anchor in Tanzania's RMP.[24]

Other reasons exist for the weak MTM in Tanzania, given our VAR results and those of Montiel and others (2012). For example, the exchange rate channel could play a role in Tanzania, as in Kenya, but presence of capital controls can be limiting its usefulness.

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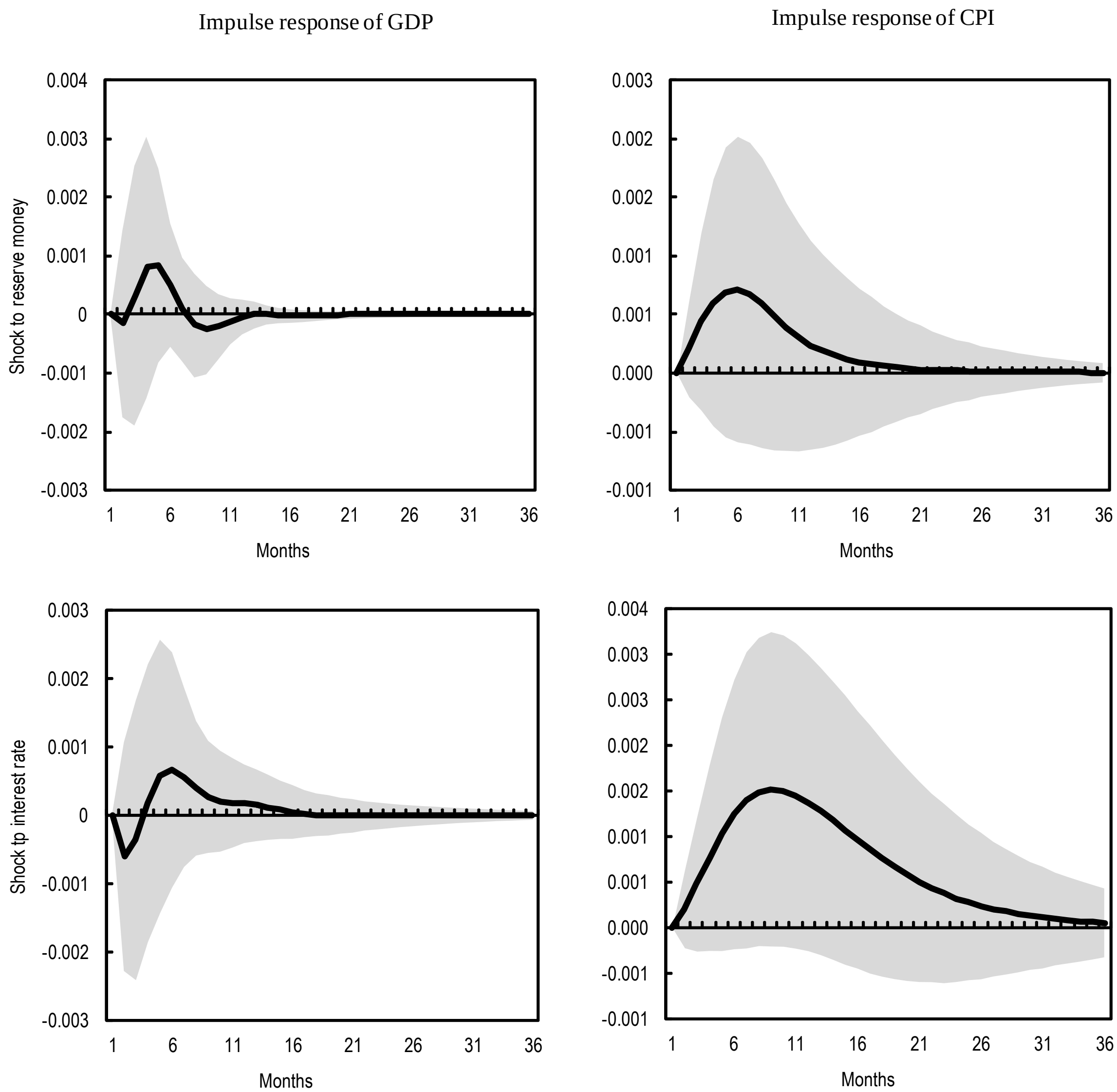
[24] This result is not unique to Tanzania. For example, covering a group of 17 Sub-Saharan African countries, Barnichon and Peiris (2008) show that the real money gap has a statistically significant contemporaneous impact on inflation.

Removal of capital control by 2015, an objective of the Tanzanian authorities, should strengthen the role of the exchange rate and the interest rate channels.

Figure 11. SVAR Impulse Responses for Tanzania

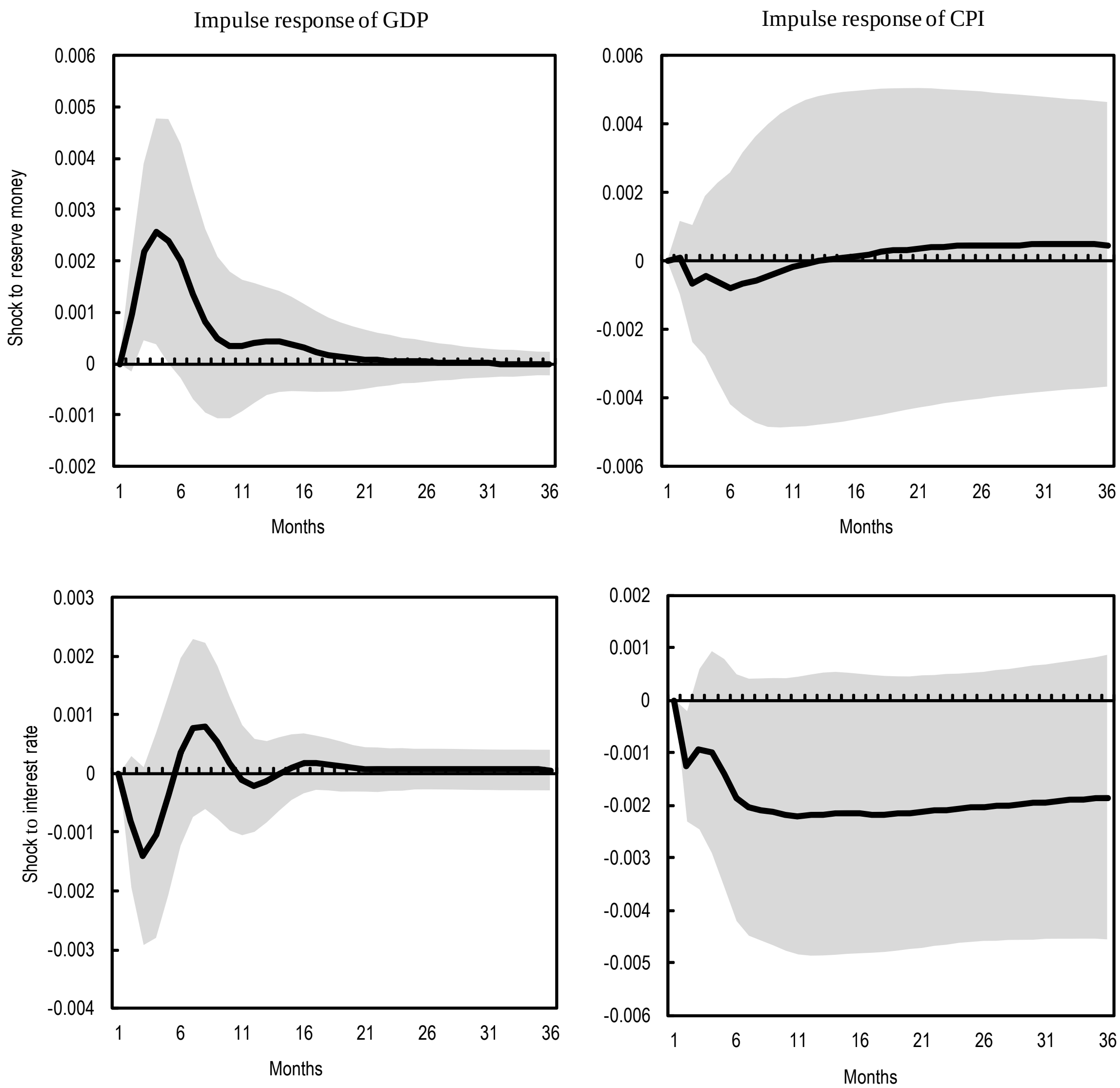


Note: Shocks are one standard deviation; vertical axes are percentages, horizontal axes are months, and the shaded areas denote the 90% confidence bands.

E. Uganda

As in Rwanda, Uganda's output responds significantly to positive shocks to reserve money over the short term, while leaving prices unfettered. This mechanism is sustained even when exogenous variables are dropped from the model. Conversely, a positive shock to the policy rate (bank rate to commercial banks) has an ambiguous affect on output, but a persistent deflationary impact on prices. Estimating the VAR with five lags, as opposed to three in the baseline specification, generates a more pronounced impulse response of CPI to innovations in the policy rate. The results of the FAVAR specification (see Appendix III) generally mimic the dynamics of the baseline specification, with one important difference: the interest rate increases reduce inflation under a FAVAR more than simple SVAR or BVAR, perhaps showing that the Central Bank of Uganda uses a much larger information set in deciding interest rate changes.[25] Our findings are in marked contrast to Mugume (2011) who finds that all monetary transmission channels are inactive in Uganda.

Figure 12. SVAR Impulse Responses for Uganda



Note: Shocks are one standard deviation; vertical axes are percentages, horizontal axes are months, and the shaded areas denote the 90% confidence bands.

[25] It is also worth noting that fitting our baseline recursive VAR on a longer time frame (September 1995 to December 2010) increases the magnitude and life of the shocks drastically, suggesting that transmission channels have withered over time.

F. Results from Variance Decomposition

It is important to quantify the relative importance of shocks in variability of inflation and output and not just the mean dynamics, which is what the impulse responses suggest. Results from variance decomposition of the estimated VARs show

- Changes in output are more due to shocks to reserve money than to the interest rate. This is the largest in Uganda and Rwanda, a finding that is consistent with our impulse response analysis.

- Inflation is more due to shocks to the interest rate than shocks to reserve money. This is more pronounced in Tanzania and Uganda. The result is surprising for Tanzania because it runs counter to the findings from impulse response analysis but consistent with impulse response analysis for Uganda.

Table 2. Variance Decomposition

	GDP		CPI	
	Reserve Money	Interest Rate	Reserve Money	Interest Rate
Burundi	8.3	7.6	4.5	0.3
Kenya	5.4	3.8	19.3	12.8
Rwanda	12.7	3.1	3.9	4.4
Tanzania	0.7	0.7	1.4	11.1
Uganda	11.8	2.7	0.3	7.2

Each entry shows percent of variance in GDP or CPI accounted by shocks to reserve money and interest rate in the estimated baseline SVAR for each country at 36 month horizon.

VIII. Discussion and Conclusions

As in emerging or frontier market economies, some EAC countries have begun conducting monetary policy through prices (interest rates) rather than quantities (monetary aggregates), although adherence to any stated targeting rule varies across countries. As in developed countries, the shift away from a money-focused monetary policy seems to be taking place as a result of , among others, possible structural shifts in money demand and money multiplier as well as deepening of the financial sector and openness of the economy to international flows.

Some EAC countries have found it operationally relevant to work with a flexible reserve money program, which takes into account shifts in velocity and multiplier and other exogenous shocks that affect monetary targets. Uganda, for example, implemented a flexible RMP from September 2009 through June 2011 that delinked short-term liquidity from structural liquidity management. Uganda have shifted formally to an inflation-targeting Lite monetary policy framework with a direct focus on prices (short-term interest rate as the operating target) rather than on quantities (reserve money) while continuing to monitor developments in monetary and credit aggregates, external environment, output gap, and inflationary expectations.

In some EAC countries and during particular episodes, monetary policy may have been conducted by simultaneously choosing both prices and quantities. Such an approach, common in countries with shallow financial markets and limited experience with competitive auctions of central bank liquidity papers, tends to undermine development in the interbank markets and reduces the role of interest rates and exchange rates in the MTM.

Kenya and, to some extent, Tanzania and Rwanda have also started relying more on changes in the policy rate to guide monetary policy while continuing to use direct instruments (e.g., changes in reserve requirement ratio) to alter monetary policy conditions. Complicating the problem further has been the role of commercial banks because banks' lending rates tend to be sticky and not responsive to changes in the policy rate. The credit channel will take time as banks learn to work within a new monetary policy framework.

A. Interpreting and Summing Up Our Results

We summarize and interpret our results as follows, using a 90 percent confidence interval in evaluating statistical inference of impulse responses:

- An expansionary monetary policy (a positive shock to reserve money) increases output significantly in Burundi, Rwanda, and Uganda but has no statistically significant effect on prices in any of the EAC countries. These results are consistent with the presence of a flat short-run aggregate supply curve in the EAC. An unstable money multiplier or unstable income velocity of money does not seem to have affected the MTM in Burundi, Rwanda, and Uganda, at least compared to output. Even if velocity is unstable, the finding of strong output effects from shocks to reserve money shows that shifts in velocity have not been large enough and/or in the wrong direction to offset the expansionary effects of reserve money on output.

- Monetary policy, as measured by shocks to reserve money, has short lags in Uganda (statistically significant output effects for the first six months only) but long lags in Burundi and Rwanda (statistically significant output effects from 6 to 15 months).

- An expansionary monetary policy (a negative shock to the policy rate) increases prices significantly in Kenya and Uganda and output in Burundi, Kenya, and Rwanda.

- Monetary policy, as measured by shocks to the policy rate, has long lags for prices and output for all countries (varying from 5 months in Burundi to some 36 months in Uganda). Rwanda has the shortest lag (3 to 5 months).

- Channels of MTM differ across the EAC, with exchange rate and credit channels being important in Kenya, credit in Rwanda, and interest rate in Burundi.

- The policy rate seems to matter more to evolution of prices in countries with deeper financial markets and a more competitive banking system like Kenya and Uganda.

- Interest rates typically decline in response to a positive shock to reserve money, an effect that is statistically significant at a 90 percent confidence interval in three countries (Burundi, Kenya, and Uganda). So movements in money and interest rates are consistent with each other.

- What explains the lack of significance in the other EAC countries (Tanzania and Rwanda)? The negative response of the interest rate to a positive shock in reserve money should strengthen the contractionary (expansionary) effect of a negative (positive) shock to reserve money, but we find that a shock to reserve money and the policy rate sometimes move in directions that exert expansionary and contractionary impulses, resulting in statistically insignificant impact of either reserve money or policy rate on prices. This interpretation seems to explain our findings for Tanzania and Rwanda. This finding may also indicate that attempts to choose simultaneously prices (interest rate) and quantities (reserve money) that are inconsistent with each other can weaken the MTM, the role of interest rate, and development of market-determined interest rates and exchange rates.

B. Confronting the Challenges

Strengthening MTM in the EAC requires, among other things, addressing the following factors and policies, some of which are developmental in nature and would take time to implement:

- *Ensure that monetary targets and interest rate policy are consistent* with each other. Interest rate plays a supporting role in a money-focused monetary policy if reserve money continues to be the operating target. In theory, interest rate is endogenous when money is being targeted and should be allowed to play such a role.

- A *high share of currency in circulation in reserve money* reduces the role a central bank can play in affecting cost conditions in the economy. As a result, regulating a small part of reserve money, namely, bank reserves, will not be as effective. An interest rate-focused monetary policy may not suffer from the same fate.

- A *large informal economy* reduces the role monetary policy can play in influencing cost conditions in financing economic activities, a factor that could go hand in hand with a higher share of currency in circulation. The size of an informal economy and share of currency in circulation could become less of a binding constraint if interest rates fully reflect liquidity conditions and monetary policy and the public becomes aware of the cost of holding idle money balances.

- *A low financial depth* or *low access to finance* reduces the scope and reach of monetary policy.

- *A shallow and limited integration of interbank FX and money markets* reduces effectiveness of the exchange rate and interbank interest rates in transmitting changes in monetary policy.

- *Limited competition in the banking sector* can reduce interest rate pass-through because actions by monetary authorities may not be fully transmitted to changes in credit availability, loan rates, or deposit rates.

- *High commercial bank excess reserves* reduce the role a central bank can play in regulating the market for bank reserves, hence, liquidity in the economy. Banks can simply draw on these balances to lend, which may undo central bank actions.

- *Capital controls can weaken MTM.* Presence of significant *capital controls* can make the exchange rate channel or interest rate channel ineffective because the exchange rate and interest rate may not respond to changes in market fundamentals and capital flows may cease to operate effectively in both directions.

- *High quality and high frequency data can help*. The noise in the data generating process for the EAC and LICs may be responsible for a weak MTM. This may make it harder to isolate the effects of monetary policy, and lack of timely data may lead to policy errors. Clearly, improvements in data availability, particularly at high frequency, can give meaningful signals to central bankers and the public, hence, allowing timely responses to developments in economic activities.

Given the observed heterogeneity in MTM in the EAC and the above challenges, EAC countries also need to confront transitional issues as they move toward a common monetary policy within a future East African Monetary Union. Specifically, the following questions are relevant to the transition process:

- How should one measure monetary policy stance across five countries with different monetary policy instruments in each country?

- What does it mean to tighten or loosen monetary policy across the EAC, when an increase in an instrument tightens monetary policy stance in one but loosens in another?

- To what extent do impacts of monetary policy on inflation and output depend on specific transmission channels? If the impact on output and prices is consistent with principles of monetary economics , should we care if the transmission channel is different across countries?

- Would monetary policy be a blunt instrument (i.e., calling for large changes in the policy rate) if factors of production are not sufficiently mobile across national boundaries which would be the case if a fully functional common market is not operational? Alternatively, to what extent setting of monetary policy needs to be conditioned by progress in common market?

- What should be the pace of deepening domestic financial markets, given the existing disparities? Can the EAC countries with narrow financial markets simply piggy back on those with deeper markets?

Finally, more research, including use of other methodologies besides VARs, would clearly aid our understanding of MTM in the EAC.

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Appendix I. Literature Review on Monetary Transmission Mechanism in the EAC

Country	Paper	Methodology	Data and Transformations	Main Findings
Kenya	Cheng (2006)	Five variable recursive and structural VARs (following Kim and Roubini, 2000). A monetary policy shock is indentified as a shock to interest rate.	Monthly data (January 1997– June 2005) in log levels for all variables except interest rate: real GDP, CPI, broad monetary aggregate (reserve money and M3), short-term interest rate (Repo rate, interbank rate) nominal effective exchange rate (NEER), oil price, U.S. federal funds rate, and U.S. commodity prices. The first five variables are endogenous with ordering as listed in the recursive VAR; the last three variables are exogenous.	A monetary contraction (a positive shock to interest rate) (i) does not have a statistically significant effect on output; (ii) lowers prices persistently after an initial increase in inflation; (iii) leads to an initial depreciation of the exchange rate followed by an appreciation that persists for almost two years and is statistically significant. Shocks to interest rate account for 33 percent of the forecast error variance of inflation, 50 percent of forecast error variance of NEER, and 10 percent of forecast error variance of output.
	Maturu, Maana, and Kisinguh (2010)	Five variable recursive and structural VARs (following Kim and Roubini, 2000). Monetary policy shock is identified primarily as a shock to M3.	Quarterly data (2000Q1–2010Q2) in log levels for all variables except interest rate: real GDP, CPI, monetary aggregates (M3, reserve money), interest rate (repo rate, interbank rate), NEER, oil price, commodity price index, and U.S. federal fund rate. The first five variables are endogenous with ordering as listed in the recursive VAR; the last three variables are exogenous.	A monetary contraction (a negative shock to M3) (i) decreases output and is marginally significant, (ii) leads to a lower price level which is statistically significant for almost four years, (iii) leads to an appreciation of the exchange rate though it is not statistically different from zero; and (iv) increases the interest rate but it is not statistically different from zero. Shocks to M3 account for 30 percent of forecast error variance inflation but only 4 percent of forecast error variance of output.
	Buigut (2010)	A five-variable VECM. Monetary policy shock is identified as a shock to T-bill rate.	Annual data (1979–2008) in log level except CPI in first difference of log: real GDP, real private sector credit, lending rate, T-bill rate.	A positive shock to T-bill rate has positive but transitory effects on inflation (price puzzle), small negative impact on real GDP, and leads to a permanent fall in loan quantity while loan rates respond positively. Impulse

Country	Paper	Methodology	Data and Transformations	Main Findings
				responses are shown with no confidence bounds.
	Misati, Lucas, Anne, and Shem (2010)	Single equation methods: ARDL and 2SLS. Dependent variable: output gap. Monetary policy instrument is real repo rate.	Monthly data (1996m1–2007m2): real repo rate, measures of financial innovation (ratio of bank asset to GDP, ratio of M3 to M1), and output gap.	Coefficient on real interest rate is negative and statistically significant, indicating contractionary monetary effects. The coefficient on the interaction of real interest rate and measures of financial innovation is positive and statistically significant, thus moderating effect of negative interest rate.
	Sichei and Njenga (2010)	Static panel data estimation: 3SLS	Annual data (2001–2008) in log levels for 37 banks: private credit, private deposit, total bank reserves, prudential and liquidity measures, and total capital ratio.	(i) Strong evidence for the bank-lending channel through quantities rather than lending rate; (ii) credit of small, less capitalized and less liquid foreign-owned banks is more responsive to lending rate.
Tanzania, Kenya, and Uganda	Buigut (2009)	Three-variable recursive VAR A monetary policy shock is indentified as a shock to interest rate.	Annual data (1984–2005) in log levels: real GDP, CPI inflation, and T-bill rate (discount rate for Tanzania). The variables are ordered in the recursive VAR as listed above.	Weak interest rate channel: interest rate shock has insignificant effects on output and inflation in all three countries.
All EAC countries	Baldini, Poplawski-Ribeiro (2011)	Three-variable recursive VAR. Monetary policy shock is indentified primarily as a shock to reserve money.	Annual data (1980–2005) in log levels and first difference of logs: real GDP, CPI (GDP deflator), and reserve money (discount rate). Variables are ordered as listed above.	A positive shock to reserve money has positive and negative effects on inflation, depending on the horizon in all EAC countries except for Burundi, which shows a positive effect. No confidence bounds are shown for impulse responses. Shocks to reserve money account for 4 percent of inflation forecast error variance in Rwanda, 5 percent in Burundi, 13 percent in Uganda, 15 percent in Tanzania, and 31 percent in Kenya.
Tanzania	Montiel and others	VAR	Monthly data (December 2001– May 2010) in log	A positive shock to reserve money (an expansionary

Country	Paper	Methodology	Data and Transformations	Main Findings
	(2012)		levels; four VARs: two recursive (three- and six-variables) and two non-recursive (three- and six-variables). Ordering in three-variable recursive VAR: exchange rate, reserve money, and price level; ordering in the six-variable VAR: exchange rate, broad money, reserve money, loan rate, price level, and output	monetary policy) increases the price level in both recursive models; effects are statistically significant but not economically; no output effect in either VAR. In the non-recursive VAR, there are no statistically significant price or output effects.
Uganda	Saxegaard (2006)	Threshold VAR	Quarterly data (1990Q1–2004Q2) in log levels: deposit rate, lending rate, ratio of excess reserves to total deposits, private credit to GDP ratio, except real GDP for which output gap is used.	(i) The presence of excess reserves lowers the negative effect of monetary contraction on inflation, thus weakening monetary transmission; (ii) excess reserves are high, implying low transmission in Uganda.
	Mugume (2011)	Five variable non-recursive VAR Monetary policy shock is indentified as a shock to interest rate (91 day T-bill rate).	Quarterly data (1999q1–2009q1) in first difference of log except for interest rate which is in levels: real GDP, CPI, broad money, three-month T-bill rate (lending rate), nominal exchange rate, credit to private sector.	A contractionary monetary policy drives output and inflation down. Only output effect is significant, lasting up to two quarters. Interest rate, credit, and exchange rate channels are weak. Innovation in M2 has no statistically significant effect on output and inflation.
	Peiris (2005)	Six-variable recursive VAR	Monthly data (1993m6–2004m6) in log difference: international oil prices, coffee price, output gap, exchange rate, monetary aggregate (or interest rate) and consumer prices. Variables are ordered as listed above.	A 1 percent increase in M2 leads to a 0.2 percent rise in core inflation in three months. Interest rate has no effect.

Appendix II. Full Set of SVAR Impulse Responses

Figure 1. SVAR Responses for Burundi

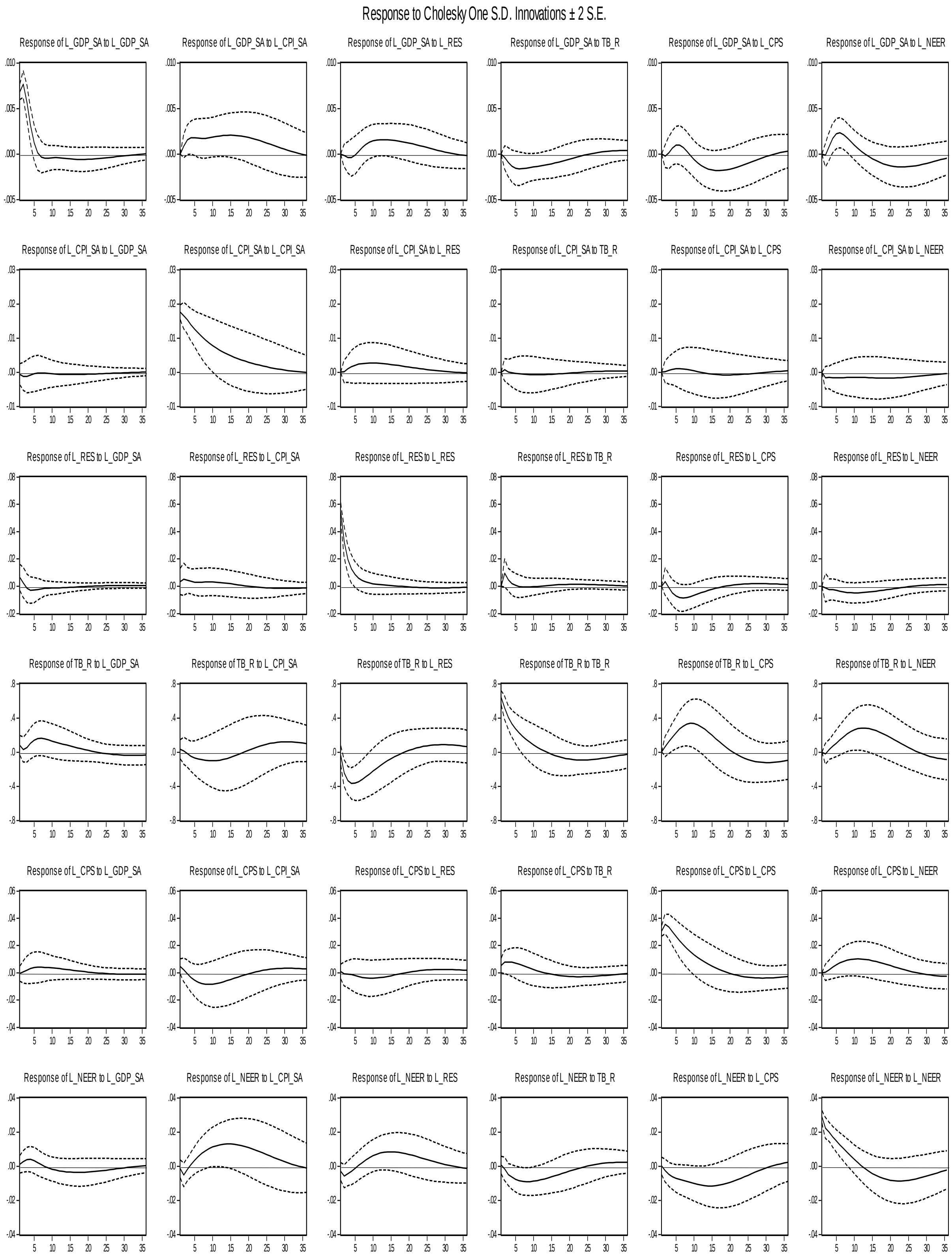


Figure 2. SVAR Responses for Kenya

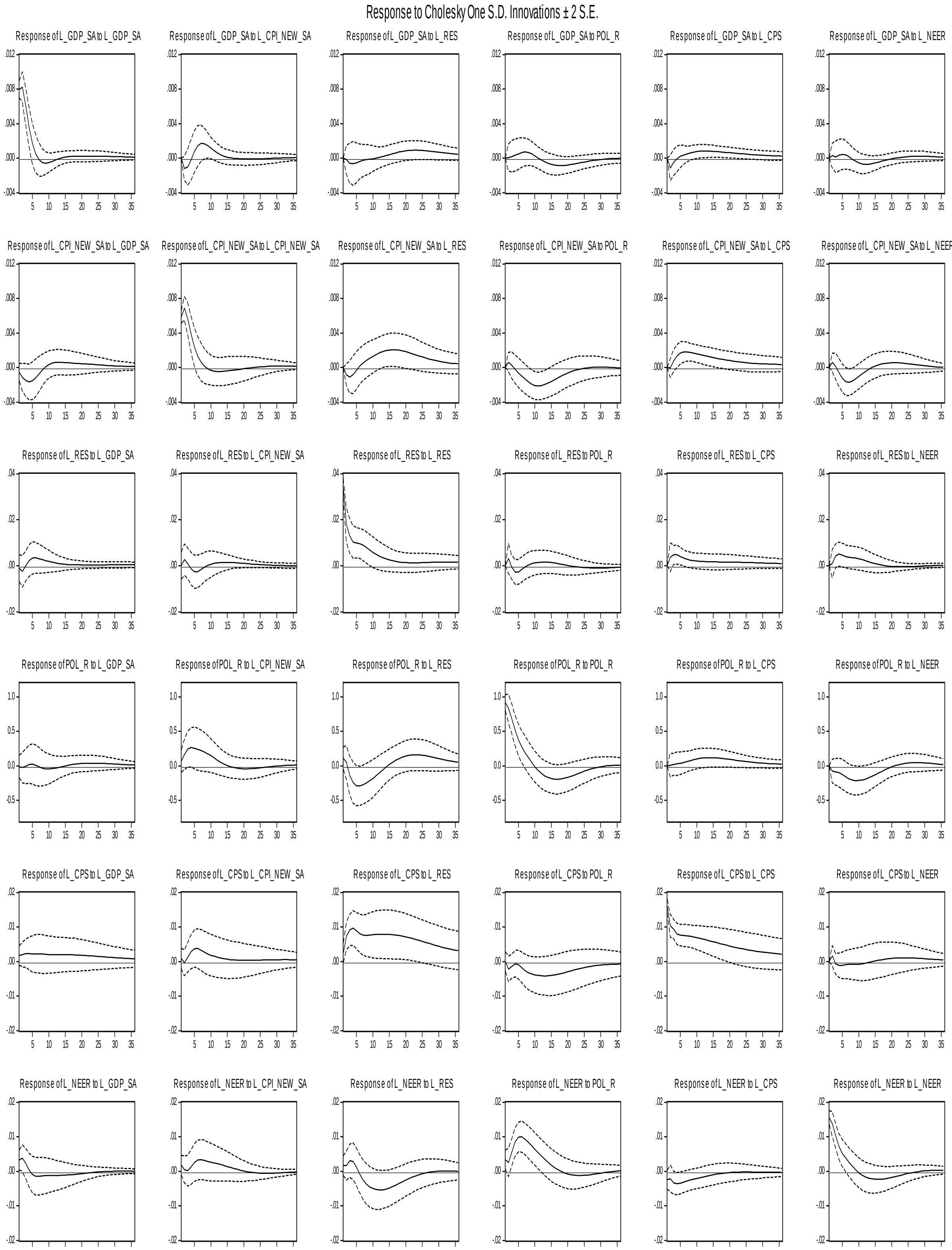


Figure 3. SVAR Responses for Rwanda

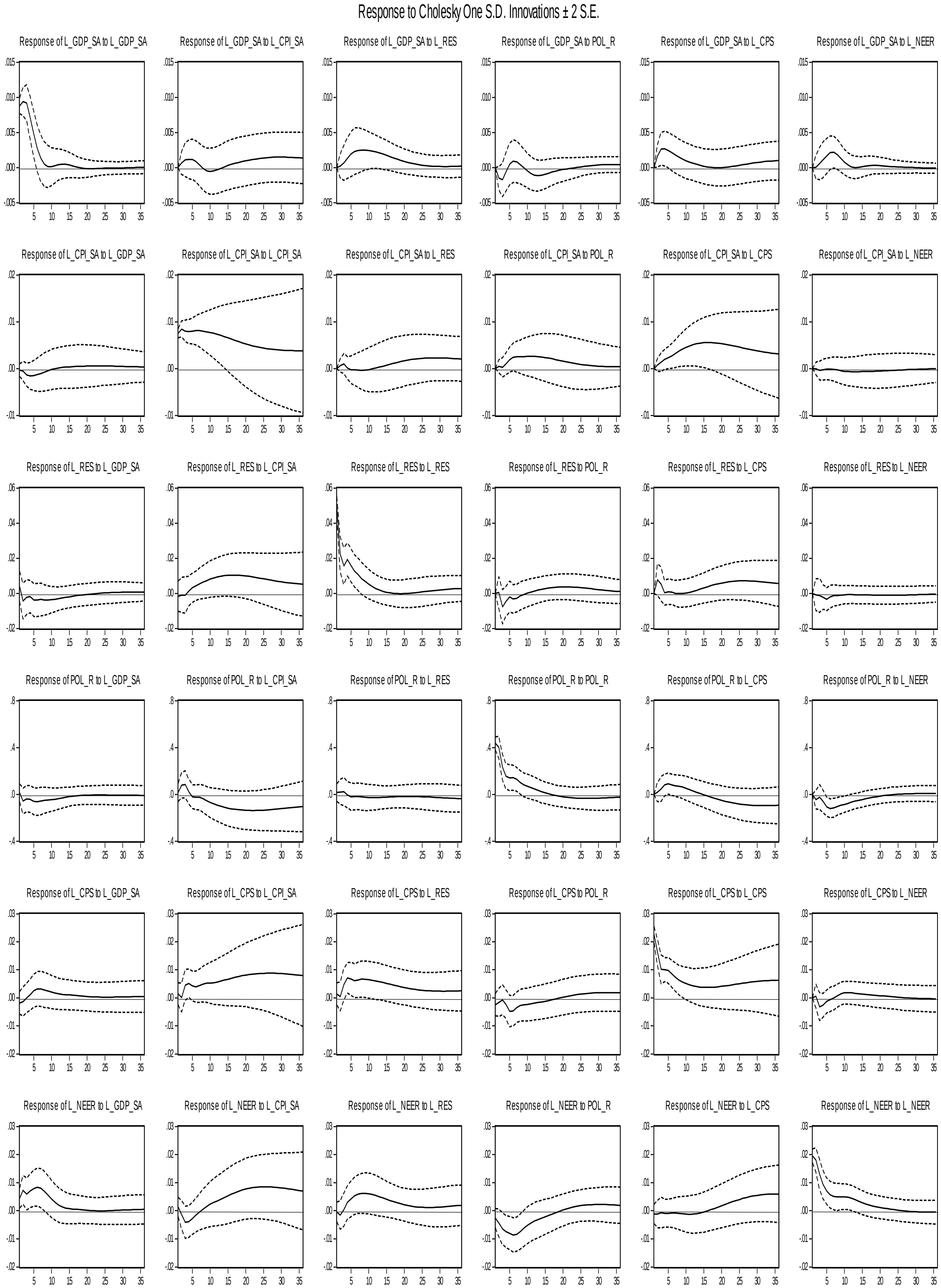


Figure 4. SVAR Responses for Tanzania

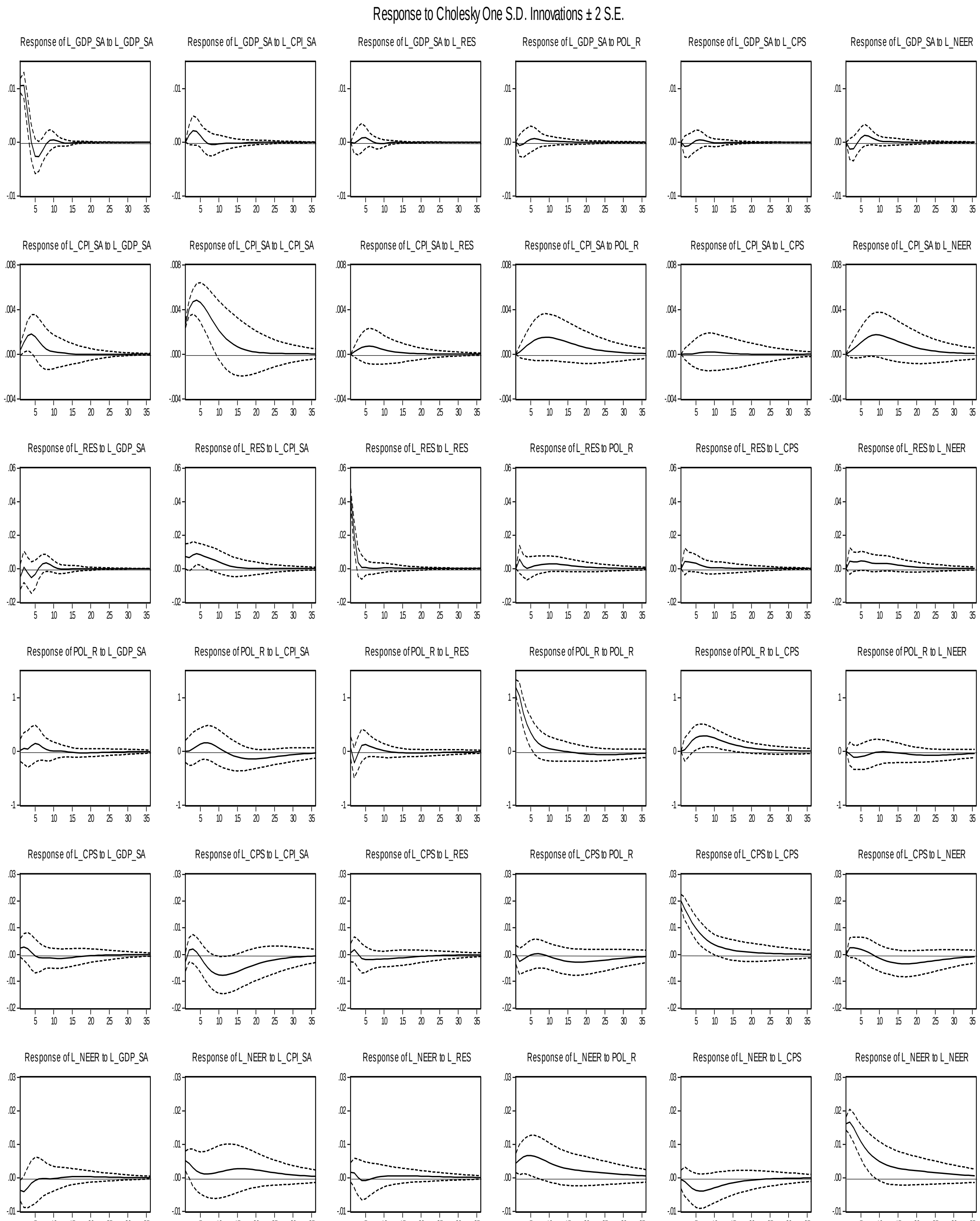
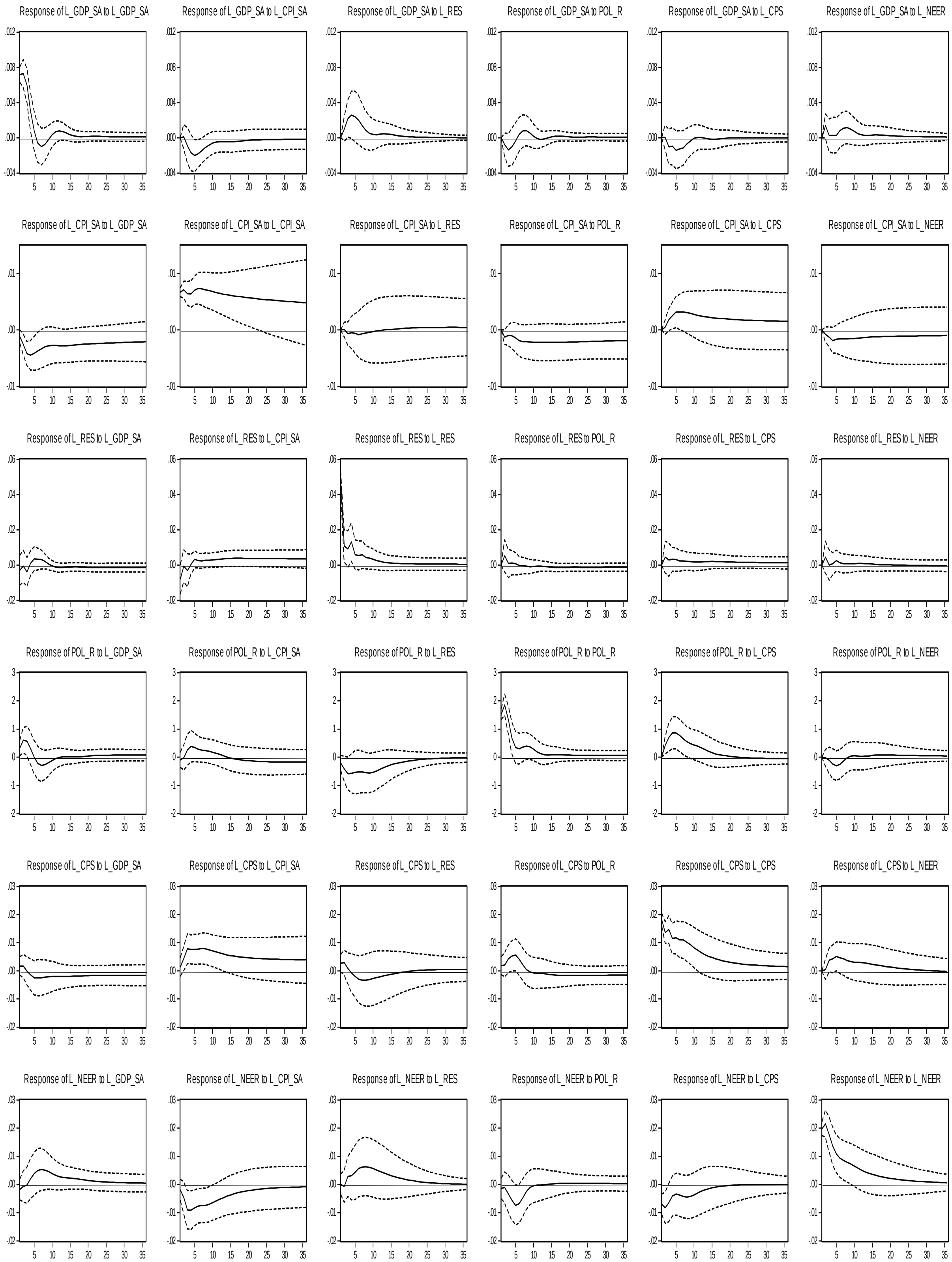


Figure 5. SVAR Responses for Uganda

Response to Cholesky One S.D. Innovations ± 2 S.E.



APPENDIX III. FAVAR AND BVAR RESULTS

Figure 1. Comparing Variants of VARs for Burundi

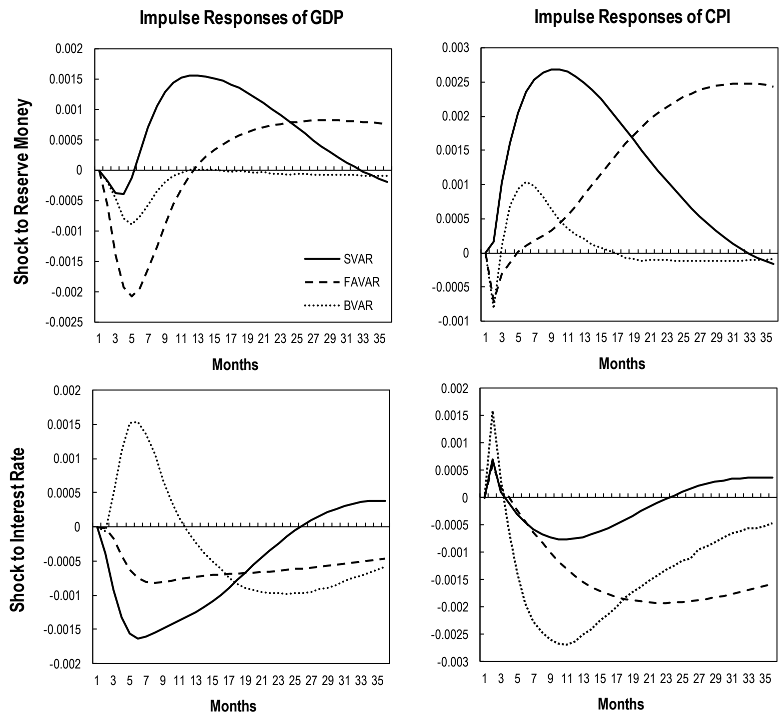


Figure 2. Comparing Variants of VARs for Kenya

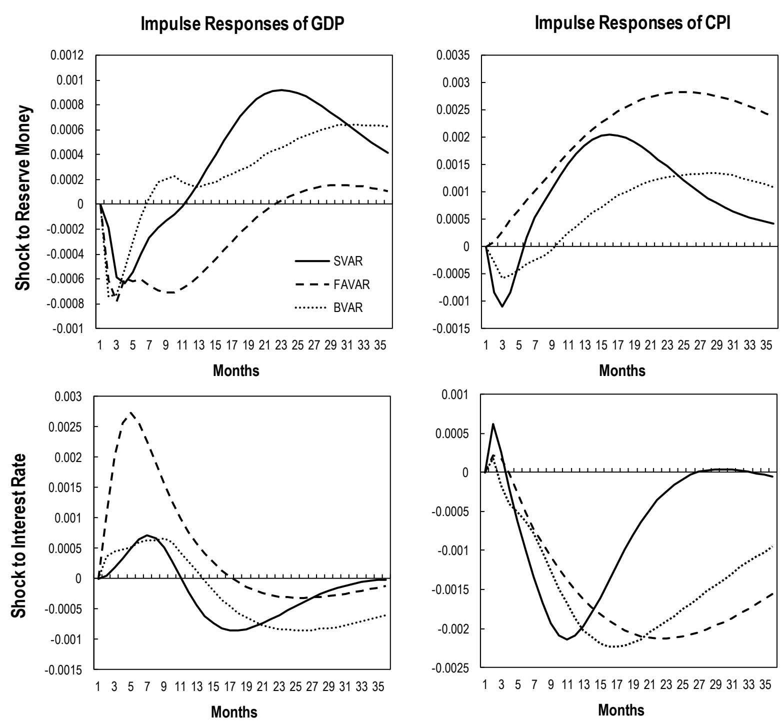


Figure 3. Comparing Variants of VARs for Rwanda

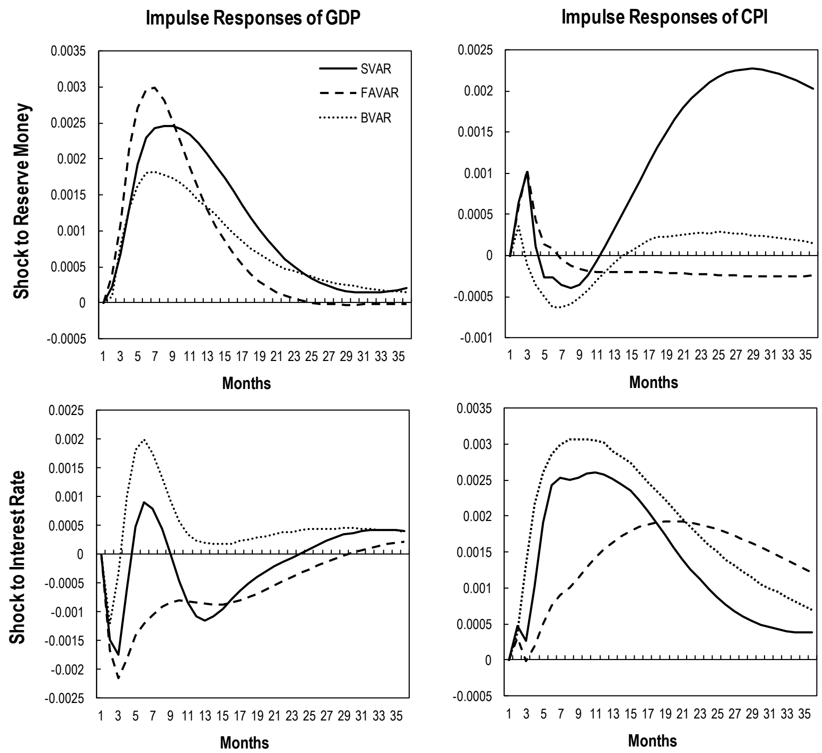


Figure 4. Comparing Variants of VARs for Tanzania

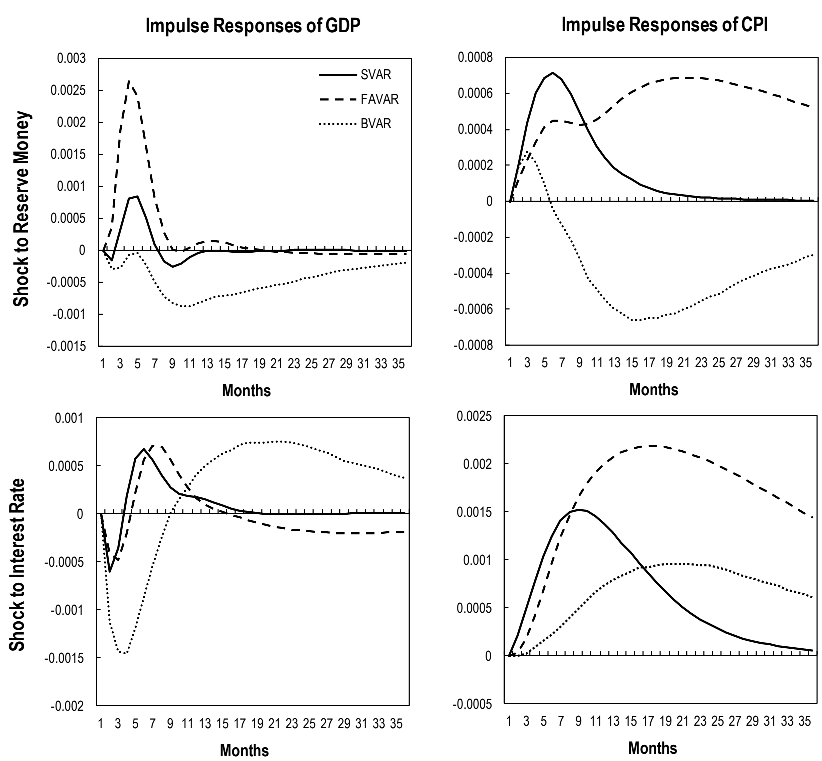


Figure 5. Comparing Variants of VARs for Uganda