Toward a Monetary Union in the East African Community

Asymmetric Shocks, Exchange Rates, and Risk-Sharing Mechanisms

Paulo Drummond, Ari Aisen, Emre Alper, Ejona Fuli, and Sébastien Walker

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Overview

In late 2013 the East African Community (EAC) countries (Burundi, Kenya, Rwanda, Tanzania, and Uganda) signed a joint protocol setting out the process and convergence criteria for an EAC monetary union. The signing of the protocol represents a further step toward regional economic integration. It follows ratification of the protocols for a customs union (2005) and the common market (2010). Envisaged in 2024 is the introduction of a common currency to replace the national currencies of member countries.

Economic integration offers numerous benefits; the path toward a common currency, however, will present significant challenges. Implementation of the protocols for the customs union and common market is still far from complete and the convergence criteria for monetary union are ambitious. The institutional framework to monitor and enforce convergence includes the East African Monetary Institute—to be set up by 2015, as a precursor to the East African Central Bank—East African Statistics Bureau and East African Surveillance, Compliance and Enforcement Commission.[1]

Adopting a common currency will entail significant economic changes for the EAC countries. Member countries will benefit from closer integration, and related gains from lower transaction costs, price stabilization, more efficient resource allocation, and improved access to goods, labor, and financial markets—stimulating trade, investment, and economic growth. At the same time, relinquishing independent monetary policy implies having to accept a monetary policy tuned to EAC-area-wide rather than national conditions. The costs associated with this change will reflect the size, nature, and frequency of asymmetric shocks ("susceptibility") as well as the ability of countries to adjust to shocks that are asymmetric with respect to the EAC area through other channels—fiscal policy, labor mobility, and wage and price flexibility ("adaptability").

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[1] For a recent compilation of studies on EAC integration, see Drummond, Wajid, and Williams (2014).

The objectives of this paper are, first, to identify how susceptible are the EAC economies to asymmetric shocks; second, to assess the value of the exchange rate as a shock absorber for these countries; and third, to review adjustment mechanisms that would help ensure a successful experience under a common currency-EAC. While the analysis draws on recent experience, backward-looking measures are imperfect for a forward-looking assessment. The paper thus also draws attention to likely further structural changes in the EAC economies (for example, large oil discoveries in some countries) as well as the intrinsic endogeneity of further integration to the currency union project itself.

The paper main findings are as follows:

- Despite some similarities in the structures of EAC economies, country-specific shocks have been prevalent in the last two decades with economies in the EAC remaining susceptible to asymmetric shocks.

- Evidence on lack of synchronicity of growth rates across countries suggests only limited economic convergence in the last decade, and cluster analysis would seem to suggest that— from an optimal currency area perspective—dissimilarities across the five EAC economies remain large.

- The exchange rates for the EAC appear to absorb real asymmetric shocks in all cases save that of Burundi, highlighting the need for additional tools to stabilize EAC economies once country-specific (nominal) exchange rates are no longer available as shock absorbers. Our results also indicate that, while exchange rate shocks do not seem materially to affect output, they are a source of disturbance to inflation, suggesting that EAC countries should press ahead on their journey to modernize their monetary policy frameworks.

- Against this background, it will be key for the EAC to continue to direct its efforts to design and establish adequate mechanisms that can help member countries adjust to future shocks once the monetary union is consolidated. This includes the usual levers to mitigate costs of common monetary policy such as labor and capital mobility, price and wage flexibility, as well as various risk sharing mechanisms, including fiscal. These levers should be agreed among member countries before the introduction of the single currency to reduce risks and signal early commitment to macroeconomic stability.

The paper is organized as follows. Section II looks into susceptibility to asymmetric shocks through direct correlation of shocks and correlations of real growth rates, so as to capture both asymmetric shocks and dissimilar policy responses to common shocks, and measures of integration and structural features that could make the EAC economies more or less prone to asymmetric shocks (Allard and others 2013; Becker and Mauro, 2006; Bayoumi and Mauro, 1999). Section III identifies the nature of shocks and the ability of the exchange rate to act as a shock absorber (Clarida and Gali, 1994; Borghijs and Kuijs, 2004). As far as we know, this is the first paper to systematically determine the prevalence of asymmetric shocks and the role of the exchange rate as a shock absorber for the EAC.[2] Section IV draws attention to the need for EAC countries to agree on mechanisms, other than monetary policy, for adjusting to shocks—wage and price flexibility, labor and capital mobility, risk sharing mechanisms, and the ability to use fiscal policy counter cyclically. Section V concludes.

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[2] For a recent and extensive review of the existing literature on African currency unions, see Debrun, Masson, and Pattillo (2010).

How Susceptible Are the EAC Economies to Asymmetric Shocks?

This section assesses susceptibility of the EAC countries to asymmetric shocks by first, looking at the similarity of economic structures across the region; second, examining the nature of recent economic shocks; third, estimating idiosyncratic shocks; and fourth, measuring growth dispersion across countries.

How Similar Are the EAC Economies?

Similarity in economic structures might suggest that countries would be susceptible to similar shocks. To explore this concept, we provide some stylized facts on individual EAC countries and the region as a whole. Regional values are based on two alternative synthetic EAC area measures: weighting each EAC country by their purchasing power parity gross domestic product and using simple averages.

Economic structures of the EAC countries are generally diverse in terms of incomes, industrial structures, and social indicators with similarities in few areas (Table 1). The agricultural sector accounts for 23 to 35 percent of the economy in all five countries. Coffee and tea are major exports for Burundi, Kenya, Rwanda, and Uganda. While Tanzania exports mostly gold, tobacco, and coffee, Kenya exports horticultural products as well. Kenya, Tanzania, and Uganda have more diversified exports in recent years. Regarding the financial sector, although there is some differentiation, domestic debt markets are largely underdeveloped with low savings rates and limited investor base. Wang (2010) presents preliminary evidence suggesting that EAC members are financially less open when compared with advanced economies. Moreover, within the EAC Kenya is the most financially open economy, followed by Uganda and Tanzania.

Trade linkages (the proportion of imports and exports to EAC countries as a share of total imports and exports of these countries) have been growing gradually from a very low base.

Linkages are somewhat higher in Burundi, Rwanda, and Uganda. Under the Customs Law of the Protocol on the Establishment of the EAC Customs Union (2005), countries agreed to eliminate tariff, non-tariff, and technical barriers to trade; harmonize and mutually recognize standards; and implement a common trade policy for the EAC. Moreover, they committed to remove measures that restrict movement of services and service suppliers and harmonize standards to ensure acceptability of services traded. As a result, market access and product diversification is improving, and intra-EAC trade is increasing in recent years, helping to stimulate competition in various sectors. Weighted average export diversification in EAC is comparable to the diversification in the West African Economic and Monetary Union (WAEMU) region (3.1 in 2010). Nonetheless, several challenges remain in the form of non-tariff barriers preventing freer movement of goods and services. Roadblocks, delays at border posts, and inconsistent import and export standards are some examples of the existing restrictions clouding prospects for further trade integration within the EAC. Aware of these problems, EAC countries agreed to work together to strengthen customs administration; pursue trade facilitation through harmonized and simplified customs procedures; enhance revenue management by improving EAC tariff regimes and rules of origin; promote custom and trade partnerships; and enhance market access, trade and competitiveness including harmonization of administrative procedures and regulations.

Despite a *volatile economic environment*, growth has been robust in the EAC. Real GDP growth, averaged about 6 percent for the region during 2009–13, with individual country growth rates in the range of 4 (Burundi) to 7 percent (Rwanda and Tanzania). Growth volatility has tended to be high in all EAC countries, more so in Kenya and Uganda reflecting the impact of the 2011 East Africa drought. Average inflation rate in the region during 2009–13 was slightly below double digits with individual inflation rates varying from about 6 percent in Rwanda to about 11 percent in Tanzania and Uganda.

Overall *fiscal and external deficits* are sizeable in all EAC economies, mostly reflecting large infrastructure spending and associated capital goods imports, especially in Burundi, Tanzania, and Uganda.

Recent *natural resource discoveries* in Kenya, Tanzania, and Uganda may lead to higher export values and lower external deficits in the medium term, although the full impact is difficult to quantify (Box 1). Export concentration in these countries is also expected to rise and the balance of trade dynamics would move in the opposite direction to their neighbors'—who are largely importers of oil. This may pose challenges on dealing with asymmetric shocks within the

monetary union. For example, during periods of lower global oil and gas prices, Kenya, Tanzania, and Uganda would favor pushing for looser monetary policy and lower interest rates compared to Burundi and Rwanda.

Box 1. Natural Resource Discoveries in the East African Community

Kenya: According to Tullow, a main investor in Kenyan oil fields, estimated reserves are above the 600 millions of barrels of oil equivalent, comparable to Equatorial Guinea and the Republic of Congo. If this metric is confirmed, it could bring Kenya's external current account to surplus soon after exploitation starts with the potential to further accelerate economic growth and reduce drought-related and geopolitical risks. Kenya could become self-sufficient in 3–5 years and a net exporter in 5–10 years.

Tanzania: Tanzania has good prospects of becoming a major producer and exporter of natural gas. Exploration results indicate that recoverable deep offshore gas resources amount to at least 24–26 trillion cubic feet. The discoveries are scattered over a large geographical area, which will increase the development cost, including the requirement of an extensive pipeline network. A final decision on whether to develop a large-scale liquefied natural gas project using offshore gas resources may not be made by the natural gas companies until 2016, with production to begin no earlier than 2020. The liquefied gas would be exported but with a significant share of the gas allocated for domestic supply.

Uganda: The potential of commercial oil fields in Uganda was confirmed in 2006. Although development of the sector has been marked by delays and uncertainty, oil-exploration activities have continued in the Albertine Graben in western Uganda, and current reserves are estimated at 3.5 billion barrels. This figure places Uganda among the 30 largest in the world and fourth in sub-Saharan Africa behind Nigeria, Angola, and South Sudan.

Sources: IMF Staff Reports: Kenya (2014), Tanzania (2014), and Uganda (2013).

Table 1. East African Community Stylized Facts
(2013 unless noted otherwise)

	Burundi	Kenya	Rwanda	Tanzania	Uganda	EAC$_1$[4]	EAC$_2$[5]
Growth and economic structure							
GDP growth (average 2009–13, %)	4.3	5.8	6.7	6.7	5.0	6.0	5.7
GDP growth volatility (standard deviation, 2009–13, %)	0.5	2.4	1.1	0.4	1.5	1.4	1.2
Agriculture value added (% of GDP)[1]	34.7	27.1	33.0	27.6	23.4	27.0	29.1
Annual CPI inflation (average 2009–13, %)	8.9	8.8	5.7	11.2	11.0	9.9	9.1
CPI inflation volatility (standard deviation, 2009–13, %)	4.6	3.9	3.1	3.7	6.3	4.3	4.3
Trade							
Export diversification index[2]	4.0	2.5	4.0	2.6	2.3	2.6	3.1
Trade openness (% of GDP)	40.2	49.3	50.6	66.5	51.1	55.4	51.5
Trade linkages (% of total trade, average 2009–13)[3]	18.8	8.7	30.4	6.6	22.0	12.7	17.3
Trade linkages (% of total trade)[3]	22.7	7.7	30.3	5.6	22.4	12.3	17.7
Internal and external balance							
Overall fiscal balance (% of GDP)	−1.7	−5.7	−4.5	−4.0	−4.1	−4.6	−4.0
Current account (% of GDP)	−20.7	−8.7	−7.1	−13.8	−8.5	−10.6	−11.8
International reserves (months of imports)	3.4	4.1	4.4	3.7	4.2	4.0	4.0
GDP PPP Weight (%, 2013)	2.4	34.0	6.9	33.6	23.1	...	...
GDP PPP Weight (%, 1990)	4.5	45.6	6.4	28.7	14.7	...	...

[1] Latest available data are from 2012.
[2] 2010 figures from IMF–DFID database. Higher values denote higher concentration of exports.
[3] The proportion of imports from and exports to EAC countries as a share of total imports and exports of these countries. IMF staff calculations based on the quarterly values of imports and exports are measured in U.S. dollars.
[4] Weighted averages of the five EAC countries using GDP PPP (purchasing power parity) as weights.
[5] Simple average of the five EAC countries.
Sources: IMF *World Economic Outlook*, and World Development Indicators, World Bank.

Estimates of Idiosyncratic Shocks

We next investigate the prevalence of idiosyncratic shocks for the five EAC countries by first estimating country-specific growth shocks that are not explained either by EAC area-wide growth shocks[3] or by country-specific cyclical components. For each EAC country, to eliminate own-country effects, we calculate the synthetic EAC-area economy as a weighted average of the remaining four countries' economies, using as weights countries' GDP measured in purchasing power parity (PPP), that change each year. We define country-specific and EAC-wide growth shocks as the residuals from a quarterly regression of the country's growth rate over eight lags. By using eight consecutive lags, we intend to remove any cyclical components of the economies and capture only the shocks to the economy.

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[3] This section follows the analysis in Allard and others (2013) for euro area economies.

Specifically, we regress country-specific and EAC-wide growth rates on their own lags extending to eight quarters (1) and (3).

(1) $X_{i,t} = \alpha_0 + \alpha_1 X_{i,t-1} + \alpha_2 X_{i,t-2} + \cdots + \alpha_8 X_{i,t-8} + \varepsilon_i$

(2) $X_{\frac{EAC}{Xi,t}} = \sum_{j=1}^{4} w_{j,t} * X_{j,t}, j \neq i$

$X_{\frac{EAC}{Xi,t}}$ is the synthetic EAC economy that excludes country X_i.

(3) $X_{EAC/X_{i,t}} = \beta_0 + \beta_1 X_{i,t-1} + \beta_2 X_{i,t-2} + \cdots + \beta_8 X_{i,t-8} + \varepsilon_{EAC/X_{i,t}}$

We then regress the country-specific residuals (shocks) from (1) on the EAC area-wide residuals (shocks) from (3).

(4) $\varepsilon_{i,t} = \frac{\gamma_0 + \gamma_1 \varepsilon_{EAC}}{X_{i,t}} + \Phi_{i,t}$

The residual from this latter regression ($\widehat{\Phi}_{i,t}$) are the idiosyncratic shocks of each country.

These idiosyncratic shocks for each country, displayed as a heat map in Figure 1, indicate that the EAC countries have been subject to frequent and substantial country-specific shocks during 1990–2013. The heat map categorizes these idiosyncratic shocks based on their magnitudes. A real growth shock is classified as "high" if it is more than 1.5 percentage points; "medium" if between 1.5 to 0.75 percentage points; and "low" if below 0.75 percentage point.

Figure 1. Country-Specific Growth Shocks
(percentage points)

| < -1.5 | -1.5 to -0.75 | -0.75 to 0.75 | 0.75 to 1.5 | > 1.5 |
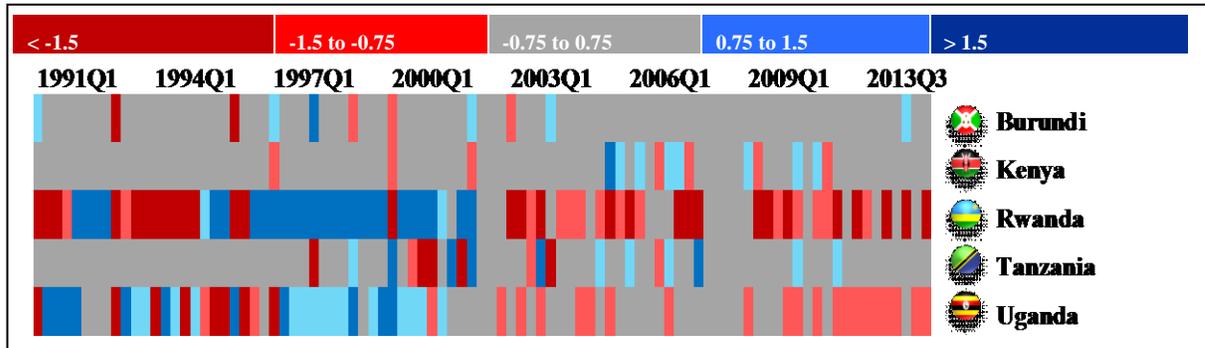
Source: IMF staff calculations.

During 1990–2013, the most prominent shocks to growth reflect political instability/conflict, terms of trade, aid, and supply fluctuations. Compared with other countries in the region, Burundi's growth shocks coincide more with regional shocks. Kenya's observed shocks reflect droughts (1997, 2007, and 2011) and aid flow disruptions during the 1995–99 period. In Rwanda, the frequent and high magnitudes of shocks reflect the genocide in the mid-1990s. The end of the conflict was marked by a significant rise in growth rates, reflected in the heat map. Tanzania suffered from a terms of trade shock in the early 1990s and in early 2000s, drought with a high negative impact on agriculture and the energy sector. In contrast to other EAC countries, Uganda did not suffer from large frequent negative growth shocks in the 1990s. A single negative shock in the early 1990s is associated with a decline in the terms of trade. However, in the recent years the country has suffered from the East Africa drought.

Output Drops and Decelerations

We next evaluate the frequency and duration of output drops and growth decelerations in the five EAC countries using quarterly data for 1990–2013. For each country, we identify an output drop as an event that starts in the quarter in which GDP declines, and ends when the GDP returns to its pre-event level. In addition, an output drop has to satisfy two conditions: the duration of the event must be at least two years, and the output loss must be at least 5 percent of the pre-event GDP (Mauro and Becker, 2006). For each country, we also define an episode of

real growth deceleration as an event in which real growth rates lie within the lowest 30th percentile and persist for at least five consecutive quarters.

All EAC countries have experienced one output drop during 1990–2013 (Table 2). Burundi suffered from the longest and the most costly output drop while Kenya had the shortest and least costly one. Growth decelerations, however, have been more frequent with an average of 2.6 episodes in the region. The length of the event varies from 1.5 years in Uganda to 3.5 years in Burundi (Table 2).

Table 2. Output Drops and Decelerations, 1990–2013					
	Burundi	Kenya	Rwanda	Tanzania	Uganda
Output Drops					
Frequency (in % of country years)	11.3%	1.4%	4.3%	3.4%	1.5%
Duration (in years)	16.3	2.0	6.3	5.0	2.3
Average annual output loss (in % of pre-event GDP)	14.6%	0.7%	46.1%	13.9%	8.9%
Growth Deceleration					
Episodes of growth deceleration	2	3	2	4	2
Average length (in years)	3.5	2.2	2.4	1.9	1.5
30th growth rate percentile	0.9%	2.4%	3.2%	2.5%	6.0%
Sources: IMF, International Financial Statistics; and IMF staff calculations.					

Dispersion of Growth Rates among EAC Countries

We next analyze the dispersion of growth rates among the EAC countries. Figure 2 suggests a high degree of dispersion during the 1990s and early 2000s, consistent with the findings from Figure 1. The dispersion of growth however, declined from about 7 percent in 2003 to 4 percent in 2013, indicating some convergence in the last decade.

We next investigate the evolution of cross-country correlations of real growth rates in the EAC. Figure 3 plots pairwise correlations for the EAC countries during the period 1990–99 against those during 2000–13. The red markers depict correlations between a country and the corresponding synthetic EAC economy excluding the same country. These are all close to zero especially in the later period, reflecting little regional co-movement of growth. The blue markers depict cross correlations between individual countries. While only the Rwanda–Uganda pair shows a relatively strong correlation, other pairs have improved over time in terms of the sign and magnitude of correlations. Burundi–Kenya, Tanzania–Uganda, and Burundi–Tanzania

moved from being negatively correlated in the earlier period, to being positively correlated in the later period. Half of the bilateral country correlations show no significant change, indicating that countries are potentially subject to asymmetric shocks and policies. Overall this evidence suggests moderate increase in business cycle synchronization in the EAC in recent years.

Figure 2. Growth Rate Dispersion in EAC Countries
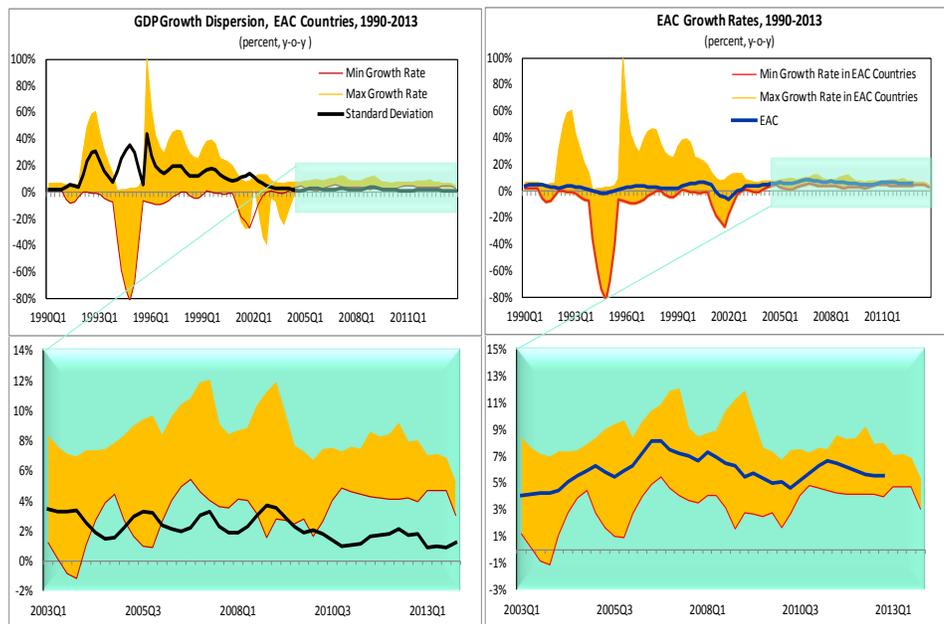
Source: IMF staff estimates and projections.

Figure 3. Growth Correlations, 1990–2013

Pairwise Growth Correlations, EAC Countries
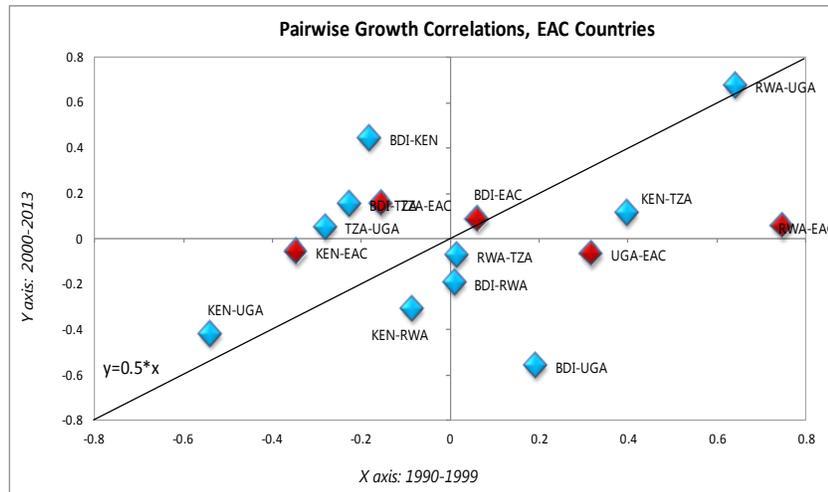
Source: IMF staff calculations.

Clustering Based on Principal Component Analysis[4]

We next investigate economic similarities among EAC economies, based on principal component analysis applied to annual data on a set of indicators during 1990–2013.[5] The objective is to uncover whether, compared to other low-income countries in sub-Saharan Africa (SSA), significant heterogeneities exist among EAC economies. For this purpose we partition 22 countries[6] into different groups using four indicators suggested by the optimal currency area

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[4] We also apply hierarchical clustering and fuzzy clustering techniques to the same set of variables for the low-income SSA countries. Results from these techniques are similar to those from the principal components analysis and are available from the authors upon request.

[5] See Qureshi and Tsangarides (2006) for a discussion of the methodology.

[6] The 22 low-income countries not classified as oil-exporters are Benin, Burkina Faso, Central African Republic, Comoros, Côte d'Ivoire, Ethiopia, The Gambia, Guinea, Guinea-Bissau, Madagascar, Malawi, Mali, Mozambique, Niger, São Tomé and Principe, Sierra Leone, and Togo, as well as the five EAC countries.

literature: business cycle synchronization, regional trade intensity, trade openness, and real exchange rate volatility. In addition, we analyze the evolution of groups by dividing the sample into two periods: 1990–99 and 2000–13.

The results point to significant and persistent heterogeneity among EAC economies. Figure 4 shows the emerging clusters in low-income SSA countries. Each big circle represents a cluster, and the inner circle within it represents the center of the cluster. The placement of the clusters gives an idea about the distances or similarities between them and the placement of the countries indicates the similarities within a cluster. While there seems to be some patterns in group formation (for example, Burundi, Rwanda, and Uganda, belong to the same group in both periods), the level of dissimilarities between the five EAC economies remains large.

Figure 4. Clustering of Low-Income Countries in SSA: Principal Components Analysis
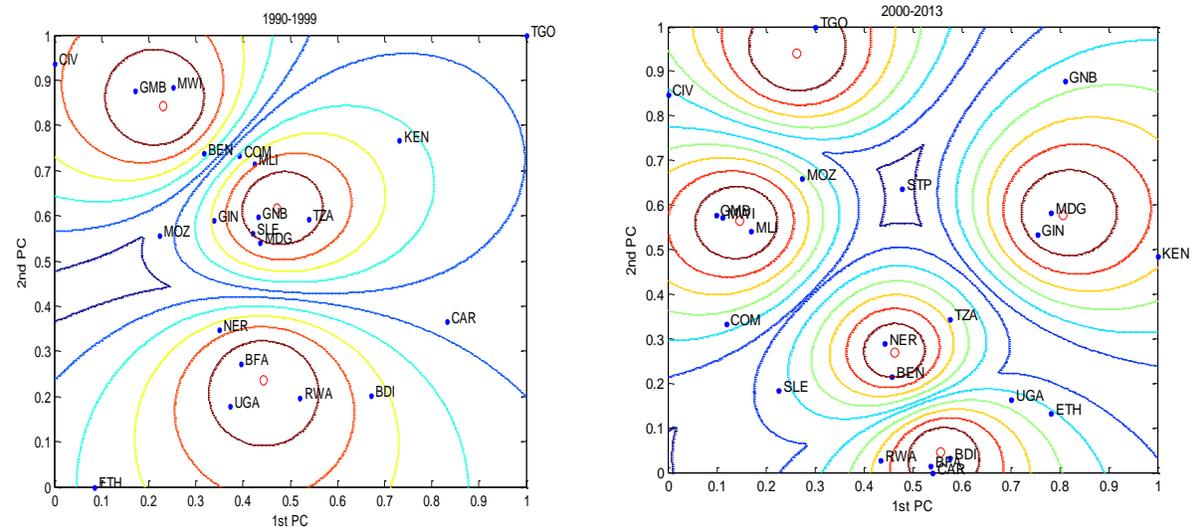
Source: IMF staff calculations.

In sum, despite some economic similarities, the EAC economies have been susceptible to asymmetric shocks and country-specific output drops. However, we find the dispersion of growth rates across EAC countries declined in the last decade, suggesting a move toward economic convergence.

<table>
<tr><td>**2**</td><td># Does the Exchange Rate Cause or Absorb Shocks in the EAC Countries?</td></tr>
</table>

When joining a currency union, countries give up control of their national currencies and can no longer count on the nominal exchange rate to stabilize their economies in the face of country-specific shocks. Nonetheless, joining a currency union may entail benefits if the exchange rate is itself a significant source of shocks. Whether the nominal exchange rate has a greater tendency to absorb or cause shocks is therefore a central consideration in weighing up the costs and benefits of a currency union.

Results from the previous section suggest that the EAC economies have been subject to asymmetric shocks. Hence, the exchange rate could potentially play a role as an important shock absorber to mitigate the macroeconomic impact of external shocks. Following Artis and Ehrman (2006), we assess whether exchange rates in the EAC have tended to absorb shocks or contributed to fluctuations in output using structural VARs.[1] This methodology is applicable for cases in which the exchange rate regime is not necessarily a pure float. In what follows we review the extent of exchange-rate management since 1990 and before proceeding with our structural VAR analysis.

Our empirical results indicate that EAC exchange rates[2] mostly absorb real asymmetric shocks evident in the previous section with the exception of Burundi. This highlights the need for additional tools to stabilize the EAC economies once country-specific (nominal) exchange rates

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[1] We also present results treating Kenya as the "anchor" country within the EAC, and evaluating the role of the exchange rate between the Kenyan shilling and the currencies of the other four countries (Appendix 2).

[2] We use bilateral nominal exchange rates in the EAC with respect to the U.S. dollar. The EAC currencies are the Burundian franc, Kenyan shilling, Rwandan franc, Tanzanian shilling, and Ugandan shilling.

are no longer available as shock absorbers. We also report that while exchange-rate shocks do not seem to affect output, they are a source of disturbances to inflation. This suggests that EAC countries should press ahead on their journey toward modernizing their monetary policy frameworks, to help anchor inflation expectations in the interim before the currency union is established.

The Extent of Exchange-Rate Management in EAC Countries

Previous empirical works on the exchange-rate regime assessment in the EAC agree that there have been periods of exchange-rate intervention to various degrees in all five EAC countries in recent decades.[3] Indicators of how the de facto exchange-rate regimes have evolved are notably provided in the IMF's *Annual Report on Exchange Arrangements and Exchange Restrictions* and in Ilzetzki, Reinhart, and Rogoff (2010) (IRR, Appendix I).

Figure 5 shows exchange-rate regime classifications and actual nominal and real exchange rate movements for the five EAC countries.[4] For both classifications, a higher code indicates a more flexible exchange rate. Based on the two classifications, all EAC currencies have been subject to significant interventions until very recently. The clear trend has been for all five currencies to depreciate against the U.S. dollar in nominal terms since 1990 while in real terms, the EAC currencies have been more stable against the U.S. dollar[5].

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[3] For instance, see Slavov (2013).

[4] The complete list of classification codes is given in Appendix I.

[5] The currencies of the other four countries have mostly been depreciating against the Kenyan shilling over the period considered, but these exchange rates have generally been more stable than those between the EAC currencies and the U.S. dollar. In real terms the four EAC currencies have been more volatile against the Kenyan shilling.

Figure 5. Exchange-Rate Classification in EAC Countries

IRR Classification

BDI · · · · KEN —— RWA — — TZA — · — UGA

IMF Classification

BDI · · · · KEN —— RWA — — TZA — · — UGA

Real Exchange Rate
(USD per national currency, 1990M1=100)

BDI · · · · KEN —— RWA — — TZA — · — UGA

Nominal Exchange Rate
(USD per national currency, 1990M1=100)

BDI · · · · KEN —— RWA — — TZA — · — UGA
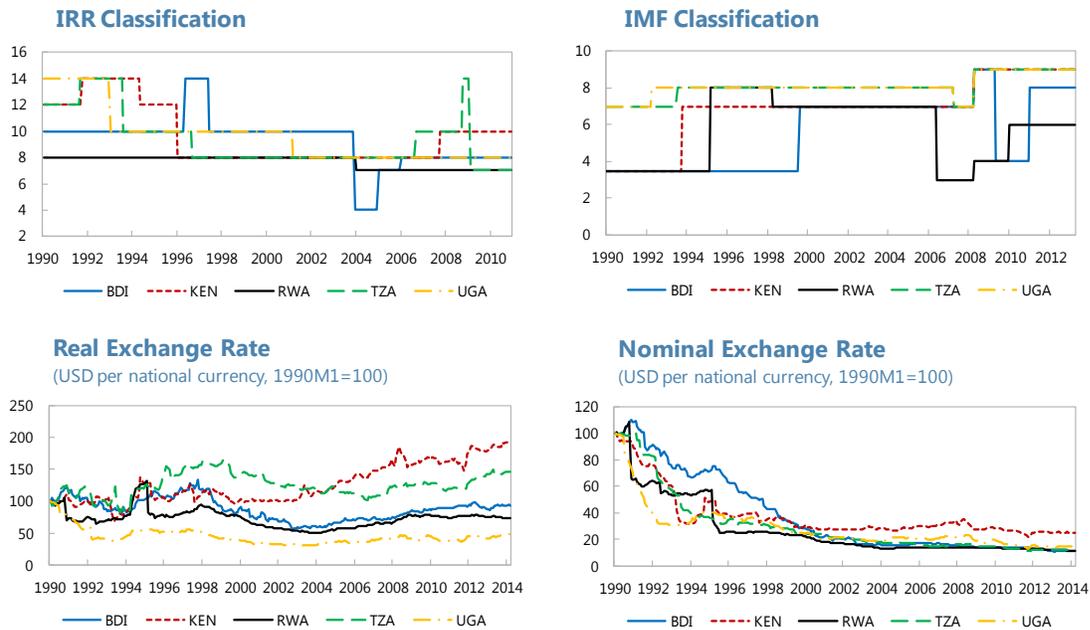
Source: IMF staff calculations.

Even limited intervention in the form of "volatility management" is problematic for investigating whether the exchange rate has tended to cause or absorb shocks if one does not take explicit account of such interventions. Therefore, there is an overwhelming case to be made for using an approach that *does* take explicit account of exchange-rate interventions.

Methodology

Our methodology closely follows that of Artis and Ehrmann (2006), which itself draws upon the contributions of Blanchard and Quah (1989) and Smets (1997). The methodology assumes capital mobility and functioning financial markets and provides a useful framework to study macroeconomic effects of shocks under various exchange-rate regimes.

The vector of endogenous variables x_t is given by

$$(5)\ x_t = [\Delta y_t\ r_t^*\ r_t\ \Delta p_t\ \Delta e_t]',$$

in which Δy_t is the change in log output; r_t^* is the nominal interest rate of the foreign country; r_t is the domestic nominal interest rate; Δp_t is the change in log prices; and Δe_t is the change in the log of the nominal exchange rate, defined in terms of foreign currency units per domestic currency, so that an increase in e_t is a domestic appreciation. Output is measured by GDP; the nominal interest rate is measured by the three-month Treasury bill rate[6] for all countries except the United States, for which we use the federal funds rate; and prices are measured by the consumer price index (CPI). We use a quarterly data set with seasonally adjusted variables, so the variables in first differences of logs correspond to quarter-over-quarter growth rates. In line with Artis and Ehrmann, we include a linear trend and oil price shocks in the model (the latter are assumed exogenous for the countries under consideration, so this does not require any further identifying restrictions).

The structural VAR model is given by

$$(6)\ A_0 x_t = A\ L)x_{t-1} + \varepsilon_t,$$

with $\varepsilon_t \sim N(0, \Sigma_\varepsilon)$, and in which A_0 is a 5×5 matrix of coefficients and $A(L)$ is the matrix lag polynomial. The vector of structural shocks is

$$(7)\ \varepsilon_t = \left[\varepsilon_t^s\ \varepsilon_t^d\ \varepsilon_t^{m*}\ \varepsilon_t^m\ \varepsilon_t^e\right]',$$

in which ε_t^s is a supply shock, ε_t^d is a demand shock, ε_t^{m*} is a foreign monetary policy shock, ε_t^m is a domestic monetary policy shock, and ε_t^e is an exchange-rate shock. The supply and demand shocks are referred to as "real" shocks and the remainder as "nominal" shocks. The reduced form of the structural model is

$$(8)\ x_t = A_0^{-1}A(L)x_{t-1} + A_0^{-1}\varepsilon_t.$$

The residuals from the reduced form can be used to retrieve the structural shocks in the structural model once a sufficient number of identifying restrictions is imposed. A first series of restrictions are imposed by assuming that the five structural shocks are uncorrelated and have unit variance, so that $\Sigma_\varepsilon = I$. Following Blanchard and Quah (1989), the supply shock is then identified as the only one that can have a permanent effect on output. The demand shock and the supply shock are assumed to be the only shocks that affect output contemporaneously,

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[6] Specifically, 90- or 91-day Treasury bill rate, depending on the country.

identifying the demand shock. The nominal shocks may thus affect output temporarily and with a lag. The foreign monetary policy shock is identified by assuming that the *foreign* interest rate does not react to *domestic* monetary policy shocks or to the exchange rate between the currencies of the foreign and the home country. This means, for example, that monetary policymakers at the Federal Reserve do not take into account Ugandan interest rates or the exchange rate between the U.S. dollar and the Ugandan shilling. It is sufficient to impose this restriction only contemporaneously for the model to be just-identified, once the remaining restrictions have been imposed.

A final restriction is imposed following Smets (1997) to distinguish between the domestic monetary policy and the exchange rate shock. To do so, we estimate the weight ω which central banks place on the exchange rate when setting monetary policy (Appendix II). Once all other shocks are identified, and the exchange rate and interest rate (reduced form) residuals have been "purged" of the effect of these shocks, the remaining unexplained components of the exchange rate and interest rate are determined entirely by the domestic monetary policy shock and the exchange rate shock.[7] Thus,

$$(9) \quad u_t^r = \alpha_1 \varepsilon_t^m + \alpha_2 \varepsilon_t^e,$$

and

$$(10) \quad u_t^e = \beta_1 \varepsilon_t^m + \beta_2 \varepsilon_t^e,$$

in which u_t^r and u_t^e are, respectively, the unexplained parts of the domestic interest rate and the exchange rate once the effects of the supply, demand, and foreign monetary policy shocks have been removed from the exchange-rate and interest-rate residuals. Solving for the structural domestic monetary policy shock gives

$$(11) \quad \varepsilon_t^m = \frac{\beta_2}{\alpha_1\beta_2 - \alpha_2\beta_1} u_t^r + \frac{\alpha_2}{\alpha_1\beta_2 - \alpha_2\beta_1} u_t^e,$$

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[7] To purge the reduced form residuals (RFRs) we regressed the RFRs on the shocks that we wish to "purge out," and keep the residuals from this equation for the subsequent analysis. In other words, we take the RFRs and regress them on the demand shock, the supply shock, and the foreign interest-rate shock. We then use the residuals from this last equation and use in the final regression to estimate ω.

and normalizing the sum of the weights on u_t^r and u_t^e to unity leads to

$$(12) \quad \varepsilon_t^m = (1 - \omega)u_t^r + \omega u_t^e$$

with

$$(13) \quad \omega = -\frac{\alpha_2}{\beta_2 - \alpha_2}.$$

The extreme case of $\omega = \alpha_2 = 0$ corresponds to pure interest rate targeting (so that no weight is placed on exchange-rate shocks in the central bank's short-run reaction function), while the other extreme of $\omega = 1$ and $\beta_2 = 0$ corresponds to pure exchange-rate targeting (where there is a one-to-one correspondence between domestic monetary policy shocks and exchange-rate innovations, as exchange market disturbances are prevented from affecting the exchange rate). In between 0 and 1, there exists a range of intermediate cases.

Following Smets (1997), ω is estimated by rearranging the equation for ε_t^m to give the non-linear regression model:

$$(14) \quad u_t^r = -\frac{\omega}{1-\omega} u_t^e + \frac{1}{1-\omega} \varepsilon_t^m,$$

in which the (observable) residual u_t^r is regressed on the (observable) residual u_t^e, and $1/(1 - \omega)\varepsilon_t^m$ is an error term. Since ε_t^m is a component of u_t^e, the explanatory variable and the error term are correlated in this regression model. We therefore use Hansen's (1982) generalized method of moments (GMM) estimator, with instruments chosen following the same logic as Smets (1997). When estimating the SVAR in U.S. dollars, we use shocks to the Canadian three-month Treasury bill rate and shocks to the Canadian dollar–U.S. dollar exchange rate as instruments.[8] These shocks are obtained by regressing the variables on their own lags and lags of the variables in the VAR[9], and on the contemporaneous estimated supply and demand shocks.

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[8] When estimating for the four EAC countries to Kenya, we use shocks to the U.S. federal funds rate and shocks to the U.S. dollar–Kenyan shilling exchange rate as instruments.

[9] Discussion of the number of lags is in Appendix II.

Empirical Results

Impulse responses and variance decompositions

The theoretical framework underpinning Artis and Ehrmann's analysis is a Mundell-Fleming-Dornbusch model as in Obstfeld (1985). In such a model, under capital mobility and functioning financial markets, the predicted responses of the endogenous variables to the various shocks are as follows.

- A positive supply shock should be followed by higher output, lower domestic interest rates, lower prices, and a real exchange rate depreciation (Clarida and Galí, 1994). However, the effect on the nominal exchange rate is ambiguous (Borghijs and Kuijs, 2004).[10] When the foreign economy is subject to a symmetric supply shock, the foreign interest rates should also fall in response to the domestic supply shock. (Note that this does not in any way imply that domestic shocks *cause* foreign interest rate responses.)

- A positive demand shock should be followed by higher output, higher domestic interest rates, higher prices, and a real exchange rate appreciation (Clarida and Galí, 1994). The effect on the nominal exchange rate should also be ambiguous, given that a nominal depreciation accompanied by a large enough increase in relative domestic prices would still yield a real appreciation. In the case where the foreign economy is subject to a symmetric demand shock, the foreign interest rates should also rise in response to the domestic demand shock. (The same caveat as in the previous bullet point applies.)

- A positive foreign monetary policy shock (contraction) should lead to a rise in the foreign interest rate. The response of the other variables depends on the response of the domestic monetary authorities (Artis and Ehrmann, 2000).

- A positive domestic monetary policy shock (contraction) should be followed by lower output, lower prices, and a nominal appreciation (Clarida and Galí, 1994).

- An exchange-rate shock that leads to an appreciation should be followed by lower output, lower domestic interest rates, and lower prices.

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[10] Note that in the in the Balassa-Samuelson framework, a supply shock leads to a permanent appreciation of the *real* exchange rate. For example, see Gauthier and Tessier (2002).

The impulse response functions for our SVARs are plotted in Appendix III, and the corresponding forecast error variance decompositions are shown in Appendix IV. Almost all of the responses that are statistically significant (according to the bootstrapped 90 percent confidence bands around the impulse response functions) are as predicted above.

Supply and demand shocks

Symmetric supply or demand shocks require symmetric responses of foreign and domestic monetary authorities. Hence, if foreign and domestic interest rates react in a similar way to the domestic supply or demand shocks, these real shocks should be symmetric between the two countries; otherwise, they are asymmetric. The impulse responses for the EAC countries compared with the United States (Figure 6) show asymmetric responses of foreign and domestic interest rates to supply and demand shocks (if the responses are significant at all). [11]

Where real shocks are asymmetric, there is a potential role for the exchange rate to act as an absorber of such shocks. The nominal exchange rate does not react to either supply or demand shocks in the case of Burundi. For Kenya, the impulse response functions show a clear appreciation following a positive supply shock and a clear nominal depreciation following a positive demand shock, and the variance decompositions (Figure 7) show that supply and demand shocks together account for about 80 percent of the forecast error variance of the exchange rate at all horizons up to five years ahead. The same is true of Rwanda, albeit with a lower initial share of the forecast error variance for supply and demand shocks in the first year, and a higher share thereafter. For Tanzania and Uganda, the exchange rates seem to exhibit a similar tendency, although the responses are of borderline statistical significance; nonetheless, supply and demand shocks account for a material share of the exchange rate forecast error variance at longer time horizons.[12]

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[11] This result also holds when Kenya is taken as the foreign country, for the remaining EAC countries with the exception of Tanzania. This, in itself, warns of possible risks to Burundi, Rwanda, and Uganda once they join a currency union with Kenya and Tanzania (and vice versa).

[12] In the estimations involving the four EAC countries' bilateral exchange rates with the Kenyan shilling, neither Burundi's nor Tanzania's exchange rate reacts to real shocks reflecting that shocks to Kenya and Tanzania appear broadly symmetric. Rwanda and Uganda's exchange rates exhibit a significant reaction to these shocks for at least part of the periods shown on the impulse response functions, and supply and demand shocks account for a material share of the exchange rate forecast error variance at most time horizons.

Figure 6. Response of the Exchange Rate to Supply and Demand Shocks in EAC
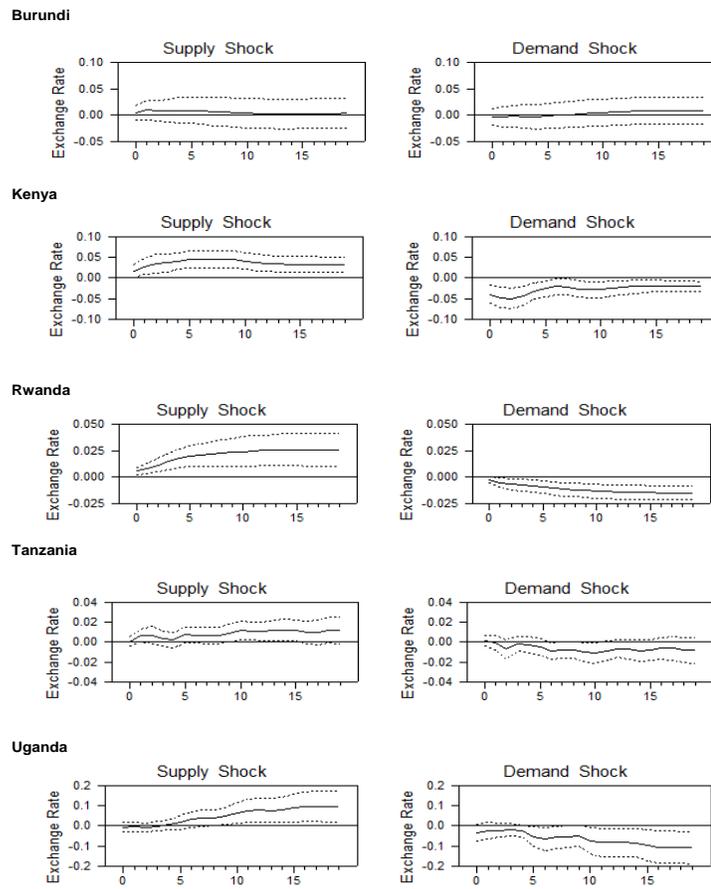
Source: IMF staff calculations.

Figure 7. Variance Decomposition of Output, Price, and the Exchange Rate

Burundi

	Quarter	Supply	Demand	Exch. rate
Output	4	66.24	27.34	2.63
	20	87.6	6.84	2.54
Prices	4	1.65	10.7	45.68
	20	27.85	8.67	28
Exhange Rate	4	3.71	0.37	82.42
	20	1.16	1.11	73.85

Kenya

	Step	Supply	Demand	Exch. rate
Output	4	94.55	5.28	0.05
	20	98.71	0.84	0.1
Prices	4	21.59	43.61	25.05
	20	33.96	18.79	25.87
Exhange Rate	4	26.4	57.96	6.9
	20	49.19	29.84	2.36

Rwanda

	Step	Supply	Demand	Exch. rate
Output	4	52.83	25.64	1.38
	20	88.61	4.85	0.37
Prices	4	2.88	4.4	82.78
	20	10.97	7.52	62.58
Exhange Rate	4	53.29	15.35	1.24
	20	72.46	21.95	1.81

Tanzania

	Step	Supply	Demand	Exch. rate
Output	4	81.8	16.21	1.33
	20	63.64	10.96	12.25
Prices	4	16.28	67.59	3.63
	20	20.21	61.78	6.12
Exhange Rate	4	6.16	3.32	77.12
	20	21.04	12.79	48.23

Uganda

	Step	Supply	Demand	Exch. rate
Output	4	95.79	3.14	1.03
	20	96.15	1.61	0.85
Prices	4	23.68	54.56	7.63
	20	38.4	51.82	2.12
Exhange Rate	4	0.75	12.71	57.41
	20	24.63	33.06	17.24

Source: IMF staff calculations.

Overall, these results suggest that the exchange rate does act as an absorber of real shocks in EAC countries, with the exception of Burundi.

Exchange rate shocks

The exchange rate does not react significantly to its own shocks, displaying low persistence, in the case of Kenya or Rwanda (Figure 7). Burundi, Tanzania, and Uganda's exchange rates all seem vulnerable to their own shocks, albeit to varying degrees. Whichever country is considered, the exchange-rate shock consistently has little-or-no effect on output; a possible exception appears to be Tanzania's exchange rate, but the exchange rate shock accounts for at most only 12.25 percent of the forecast error variance of output. Additionally, the exchange-rate shock does generally have a significant impact on the price level, again to varying degrees. On the whole, this finding suggests that the exchange rate can be a source of shocks to inflation in EAC countries, but not to output (Figure 8).

Figure 8. Response of Output and Price to Exchange-Rate Shocks in the EAC
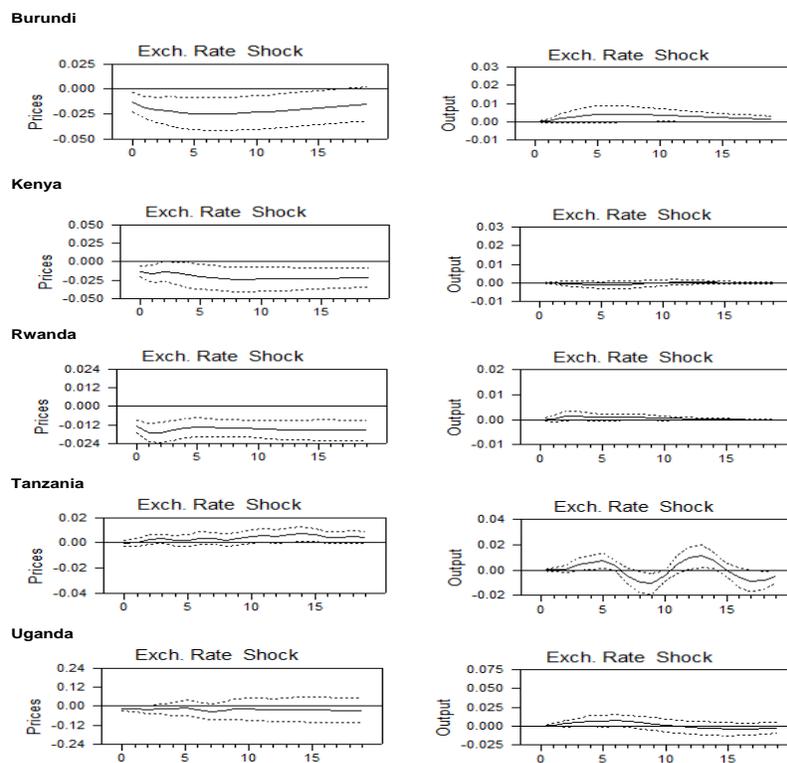
Source: IMF staff calculations.

This section investigates whether bilateral exchange rates have tended to cause or absorb shocks in the EAC countries. Our results suggest that real (supply and demand) shocks are asymmetric in all cases. Moreover, the exchange rate appears to absorb these real asymmetric shocks in all cases save that of Burundi. These results highlight the need for additional tools to stabilize the EAC economies once country-specific (nominal) exchange rates are no longer available as shock absorbers. Specifically, they highlight the need to progress on further integration especially in implementing labor mobility in the region, and institutional changes to promote risk sharing among members. Our results also indicate that, while exchange rate shocks do not seem materially to affect output, they are a source of disturbances to inflation, suggesting that EAC countries should press ahead on their journey toward inflation targeting.

3 Risk Sharing and Other Mechanisms to Mitigate the Impact of Shocks

The previous sections described some of the challenges that are likely to emerge in the lead up to the EAC Monetary Union. First, there is wide prevalence of asymmetric shocks in the member countries. Second, the exchange rate has been playing a pivotal role in the macroeconomic adjustment following these shocks. While deeper economic integration can over time lessen somewhat the probability of occurrence of asymmetric shocks, EAC countries will still likely continue to be exposed to these shocks for quite some time as their economies are in a constant structural flux (for example, oil and other natural resources)[1] requiring policy responses.

These important stylized facts make it imperative for the EAC to adequately design mechanisms to adjust to shocks on the way to monetary union. Some of the traditional levers to mitigate the costs of common monetary policy include labor and capital mobility, price and wage flexibility, and various risk-sharing mechanisms. These levers would have to be agreed on among member countries before the introduction of the single currency to reduce risks and signal early commitment to macroeconomic stability and the union.

Fortunately, the EAC authorities are aware of these challenges, and work is underway to reach agreements on policies to mitigate the effects of asymmetric shocks.[2] This section will first review

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[1] See Wills and van der Ploeg (forthcoming) for a discussion on the effects of large hydrocarbon discoveries on the EAC economies including policy recommendations to address these effects before the introduction of the monetary union.

[2] The preamble of the Protocol of the Establishment of the EAC Common Market, ratified in 2010, states that the objective of the Common Market is the realization of accelerated economic growth and development through the attainment of free movement of goods and services, persons, labor, the rights of establishment and residence, and the free movement of capital.

the current status of EAC-wide agreements to promote integration and facilitate the introduction of shock-adjustment mechanisms. Secondly, it will use the evolving experience of other monetary unions to support future discussions within the EAC. Finally, the section will conclude by providing policy recommendations that might be helpful for the EAC in its design of a monetary union.

Current Status

Price and wage flexibility

Guided by market principles, prices and wages in the EAC are generally flexible. Price-setting is largely free of government controls, and anecdotal evidence suggests that wages are largely flexible as the majority of people in the EAC are small-scale farmers and/or employed in the informal sector.[3] To further ensure price flexibility and competition within the EAC, partner states have agreed to allow free cross-border movement of goods and services.[4] These important initiatives can help pave the way for higher trade integration, competition, and price flexibility within the EAC.[5] Regarding wages, as discussed in the following section, removing any restrictions to the free movement of workers remains critical to ensuring greater wage flexibility.

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[3] While labor data are not readily available, using data from the 1990s from five sub-Saharan countries including Uganda and Tanzania, Kingdon, Sandefur, and Teal (2006) argue that wages do adjust to shocks to unemployment. However, labor-market rigidity is prevalent with persistent wage differentials between formal and informal sectors pointing to deep labor-market segmentation with high formal-sector wages independent of labor productivity or skills.

[4] The free movement of goods is governed by the Customs Law of the Protocol on the Establishment of the EAC Customs Union, which came into effect in 2005, with the objective to deepen the integration process through liberalization and promotion of intra-regional trade; promoting efficiency in production in response to intra-region competition among businesses; enhancing domestic, cross-border, and foreign investment; and fostering industrial diversification with a view to enhance economic development.

[5] Progress status reports on the elimination of non-tariff barriers are available at the EAC secretariat website http://www.eac.int/trade/index.php?option=com_docman&task=cat_view&gid=47&Itemid=49.

Labor and capital mobility

Anecdotal evidence suggests that labor and capital have become more mobile in recent years**.** Recognizing the importance of labor mobility, the EAC Common Market Protocol establishes that governments should guarantee the free movement of workers and their dependents, citizens of any of the partner states, within their territories. Partner states shall also ensure that workers should not be discriminated on the basis of their nationalities in relation to employment, remuneration, and other conditions of work and employment, and be entitled to rights and benefits of social security as accorded to workers of the host partner state. Furthermore, partner states agreed to mutually recognize academic and professional qualifications; harmonize labor policies, laws, and programs; guarantee the right to access and use of land and premises; and establish residence and self-employment. In regard to capital mobility, partner states agreed to eliminate all restrictions on the free movement of capital and payments connected to such movement. The implementation of the agreements resulted in significant progress including the adoption of common travel documents, work permits and fees for education and tourism; creation of common negotiating frameworks; harmonization of academic and professional qualifications and transport facilitating instruments; and freer movement of capital.

Challenges preventing greater labor and capital mobility still remain.[6] Weak capacity of implementing agencies, low level of awareness, inappropriate legal and regulatory frameworks, lingering nationalistic tendencies, a weak private sector, differences in education systems, cultural diversities, language barriers, differences in levels of economic development, inadequate safeguard measures and dispute settlement mechanisms, incomplete harmonization of examination and certifications, inappropriate labor policies and legislation, weak urban planning policies, and disparities in intra-regional trade are examples of impediments to job mobility in the EAC. Continuous efforts are needed to ensure labor, and capital mobility can continue to increase and play the important role of shock absorber once the common currency is adopted.

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[6] The report *EAC Development Strategy (2011/12 – 2015/16): Deepening and Accelerating Integration* (EAC, 2010) is a good source of understanding how EAC protagonists describe the challenges facing the community.

Managing shocks in the EAC

Creating mechanisms to manage economic shocks is an objective shared by all EAC partner states. The Monetary Union Protocol raises the key concern of building resilience and appropriately managing economic shocks in the context of a monetary union.[7] It establishes prerequisites including among others the full implementation of the EAC Customs Union and the EAC Common Market; harmonization and coordination of fiscal, monetary, and exchange rate policies; integration of financial systems; and adoption of common principles and rules for financial systems regulation and supervision. It also commands partner states to establish mechanisms for managing economic shocks that may arise from exogenous factors.

The Protocol also highlights the central role of building strong institutions to monitor and reduce risks[8]. This includes the creation of a well-capitalized East African central bank as a functionally integrated system of central banks to perform the duties of a central bank independent of political influence from partner states. Moreover, the protocol establishes the formation of various supra-national institutions to support the monetary union, including those responsible for financial services, statistics, surveillance, compliance, and enforcement.

While the Protocol establishes a set of convergence criteria toward the adoption of the single currency, including ceilings on fiscal deficits, debt and inflation, and a minimum international reserves buffer, partner states are yet to establish mechanisms to manage shocks. In particular, partner states must ensure strong fiscal governance early on to reduce potential for fiscal risks to emerge in the aftermath of the adoption of the single currency. The experiences of other currency areas can be helpful to frame ongoing discussions.

Experiences from Other Currency Unions

The African experience with monetary unions, the West African Economic and Monetary Union (WAEMU) and Central African Monetary and Economic Union (CEMAC), offers relevant lessons for the EAC. Gulde (2008) argued that their experience has been positive to maintain macroeconomic stability—particularly low and stable inflation—and stimulating institutional development. Nevertheless, according to the 2014 Staff Report for the WAEMU, the frequency and asymmetry of shocks in the region are still high, and observance of the key fiscal

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[7] See Article 10 of the Monetary Union Protocol (2013).

[8] See articles 20 and 21 of the Monetary Union Protocol (2013).

convergence criterion remains limited. In this context, preserving debt sustainability and the stability of the WAEMU in the medium term will require better coordination of fiscal policies. Additionally, both the design of the main convergence criteria and their enforcement could be reconsidered. For example, the criterion on nominal public debt could be lowered to reduce the risk of debt distress.

The European crisis has also exposed critical gaps that may be relevant for the EAC. Despite several years of integration and sharing of a single currency, country-specific shocks have remained more prevalent than initially expected.[9] In addition, prices and wages continued to display strong downward rigidities in several euro zone countries, preventing the real exchange rate adjustments necessary after a negative shock. Likewise, labor mobility continued to be sub-optimal because of language and cultural barriers and institutional constraints related, for example, to the inability to transfer pensions and unemployment benefits across borders, negatively affecting migration. The high degrees of trade and financial integration have created room for significant contagion, and problems were compounded by weak fiscal governance and the absence of effective market discipline. The crisis prompted European policymakers to discuss frameworks to better manage country-specific shocks and contain spillovers and exposed the need of a common backstop for the banking union. The crisis also highlighted the importance for individual countries to adhere to credible euro area fiscal rules and at the same time hold fiscal buffers to ensure the needed space to conduct countercyclical fiscal policies. In addition, given that nominal exchange rate devaluations are no longer available to individual countries in the euro area, one potential way to address internal union imbalances is through fiscal devaluations.[10]

Policy Options

This sub-section reviews policy options for the EAC taking into account the current status of discussions and applying the most important lessons from other monetary unions to the EAC context.

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[9] See Allard and others (2013) among others.

[10] An example of fiscal devaluation could be a revenue-neutral fiscal policy mix entailing a reduction in employers' social contributions and an increase in the value-added tax. See IMF (2011) pp. 37–42; de Mooij and Keen (2013).

Implementation of agreements contained in the EAC Customs Union and Common Market protocols will be key to ensure greater price and wage flexibility, and increased labor and capital mobility within the EAC. In the absence of bilateral exchange rates, these can be critical adjustment levers to restore real exchange rate equilibrium following large shocks.

The early discussion and eventual adoption of risk-sharing mechanisms is critical to help mitigate costs emanating from shocks. There is a wide range of potential risk-sharing mechanism options that could be established before the single currency is formally introduced in 2024. These include (i) setting up a system of government transfers; (ii) issuance of supra-national EAC bonds along the lines of the European Financial Stability Facility; (iii) creation of an EAC fiscal stabilization fund; and formation of a banking union. The viability of these risk-sharing options depends on the willingness of member countries entering the monetary union and resource availability. The former requires fiscal solidarity; the latter requires sufficient fiscal buffers of contributing EAC members beyond those envisaged to meeting the convergence criteria established in the EAC monetary union protocol. EAC members should discuss these various alternatives early on.

- Inter-governmental fiscal transfers can play a significant macroeconomic stabilization role. Such transfers could serve to counteract an adverse asymmetric shock on a member state. This stabilization role is key because it will discourage individual member states from undertaking fiscal measures that conflict with the price stability objectives of the EAC central bank.

- Supra-national EAC bonds can offer a partial risk-sharing alternative via a facility providing assistance to members through bond issuance backed by the guarantees based for instance on revenues of member sovereigns. If the EAC borrows collectively, market access could be secured at sustainable yields even when one or more member countries come under stress following an adverse shock.

A regional stabilization fund could provide temporary funding for members to finance any fiscal shortfalls in the event of a country-specific adverse shock. Such a stabilization fund or a "rainy-day fund" needs to be set up from initial contributions of the members and could be replenished at a time when output returns to long-run trend in the affected members. For the European Union, Allard and others (2013) estimate that such an ex-ante support could be setup through 1½ to 2½ percent of GNP annual contributions by member states, and these would

provide sufficient resources to guarantee overall income stabilization where 80 percent of regional income shocks are smoothed.[11] For the WAEMU, according to Hitaj and others (2013), stabilization mechanisms aimed at absorbing common and idiosyncratic shocks are absent or ineffective. The 2014 Staff Report for the WAEMU estimates that a contribution of about 1–1¼ percent of GDP would be needed to insure WAEMU countries against severe downturns.

- A banking union can significantly reduce financial risks. The union would complement the adoption of common financial rules and supervision already prescribed in the EAC Monetary Union protocol. But it would go a step further by creating a common bank-resolution framework relying on funding from the industry accumulated in a resolution fund and a common backstop, in exceptional cases, through a credit line from the EAC central bank and from pooled fiscal resources.

The introduction of risk-sharing mechanisms requires strong fiscal governance and safeguards to prevent the buildup of large risks. As with any insurance scheme, "free riding" and moral hazard are risks especially if the risk-sharing mechanisms end up allowing for transfers to a member state for longer than warranted. To prevent "free-riding," the EAC could choose among several options; one extreme is self-imposed budget constraints, reliance on strong market discipline, and no bailout rule (Canada and the United States). At the other extreme, coordination and centralization of fiscal governance along the lines of the Fiscal Compact in the European Union, aim to limit the fiscal risks taken by member states. Intermediary systems may involve intergovernmental coordination (Australia and Belgium) or direct democracy (Switzerland) to instill sound fiscal policies by the members of the monetary union. Such safeguards will reduce the temptation by member countries to implement riskier policies and free ride on the introduced safety net.

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[11] The establishment of an EAMU unemployment insurance fund could be yet another option for fiscal risk sharing. However, this option is currently infeasible as it requires in the EAC (i) significant share of formal employment in total employment; (ii) data availability and timeliness on unemployment; (iii) centralizing a minimum level of provision of unemployment benefits and social security contributions at the EAMU level; and finally (iv) a minimum amount of harmonization of labor taxation within the EAMU. Formal employment is indeed only 17 percent in Kenya (2013), about 14 percent in Uganda (2009) and less than 10 percent in Tanzania (2009).

4 Conclusions

This paper identifies the degree of susceptibility of the EAC economies to asymmetric shocks; assesses the value of the exchange rate as a shock absorber for these countries; and reviews adjustment mechanisms that would help ensure a successful experience under the monetary union.

Our findings reveal that despite some similarities in the structures of their economies, country-specific shocks have been prevalent in the last two decades, with EAC economies remaining susceptible to asymmetric shocks. Additionally, declining dispersion of growth rates across countries suggests only a gradual move toward economic convergence in the last decade. Cluster analysis would seem to indicate that from an optimal currency area perspective, dissimilarities remain large.

The exchange rates appear to absorb real asymmetric shocks in all cases save that of Burundi, highlighting the need for additional tools to stabilize the EAC economies once country-specific (nominal) exchange rates are no longer available as shock absorbers. Our results also indicate that, while exchange-rate shocks do not seem materially to affect output, they are a source of disturbances to inflation, suggesting that EAC countries should press ahead on their journey to modernize their monetary policy frameworks.

While the analysis draws on recent experience, backward-looking measures are imperfect for a forward-looking assessment. What appear to be long-term structural differences may rapidly disappear in the run up to the establishment of the monetary union. The adjustment of economic structures and performance could speed up, and deeper economic integration can lessen, the probability of occurrence of asymmetric shocks. Moreover, the asymmetric shocks could be policy-induced rather than exogenous and, as a result, loss of policy independence may not always be necessarily costly.

Nevertheless, EAC countries will still likely continue to be exposed to these shocks for quite some time, requiring policy responses. Going forward, as highlighted by the experience in other currency unions, it will be key for the EAC to continue to direct its efforts to design and put in place adequate mechanisms that can help member countries to adjust to future shocks once the Monetary Union is consolidated. This includes the usual levers to mitigate costs of common monetary policy such as labor and capital mobility, price, and wage flexibility, as well as various

risk-sharing mechanisms, including fiscal. These levers should be agreed among member countries before the introduction of the single currency to reduce risks and signal early commitment to macroeconomic stability.

Appendix I. Exchange Rate Classification Codes

Ilzetzki, Reinhart, and Rogoff (2010) [IRR] classification codes

1	No separate legal tender
2	Pre-announced peg or currency board arrangement
3	Pre-announced horizontal band that is narrower than or equal to +/–2%
4	De facto peg
5	Pre-announced crawling peg
6	Pre-announced crawling band that is narrower than or equal to +/–2%
7	De factor crawling peg
8	De facto crawling band that is narrower than or equal to +/–2%
9	Pre-announced crawling band that is wider than or equal to +/–2%
10	De facto crawling band that is narrower than or equal to +/–5%
11	Moving band that is narrower than or equal to +/–2% (that is, allows for both appreciation and depreciation over time)
12	Managed floating
13	Freely floating
14	Freely falling
15	Dual market in which parallel market data are missing.

IMF classification codes[1]

(1985 – April 2008)		**(April 2008 – Present)**	
1	Exchange arrangement with no separate legal tender	1	No separate legal tender
2	Currency board arrangement	2	Currency board
3	Conventional peg to a single currency	3	Conventional peg to a single currency
3.5	Conventional peg to a composite	3.5	Conventional peg to a composite
4	Pegged exchange rate within horizontal bands	4	Stabilized arrangement
5	Crawling peg	5	Crawling peg
6	Crawling band	6	Crawl-like arrangement
7	Managed floating, no predetermined path for the exchange rate	7	Pegged exchange rate within horizontal bands
8	Independently floating	8	Other managed arrangement
		9	Floating
		10	Free floating

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[1] The change in classification methodology implemented with retroactive effect to April 2008 is explained in Habermeier and others (2009). Note that changes in the classification of EAC countries at this time followed from the methodological change rather than a judgment that there has been a substantive alteration in the countries' de facto exchange-rate policies.

Appendix II. Country Specifications in the SVAR

Our data set includes observations for the following periods (data for the United States, Canada, and the oil price are available for as long as is necessary for our purposes).

Burundi	1988:Q2 – 2012:Q4
Kenya	1980:Q1 – 2013:Q3
Rwanda	2001:Q3 – 2012:Q4
Tanzania	1993:Q4 – 2013:Q4
Uganda	1980:Q1 – 2013:Q4

We chose lag lengths to using AIC and likelihood ratio tests. The lag lengths selected vary by country, possibly reflecting different sample lengths. The augmented Dickey-Fuller test suggests the presence of unit roots for some of the variables, notably those in levels (the interest rate variables). Therefore, following Artis and Ehrmann (2000), we test for unit roots within the VAR system, using Johansen's (Trace) test for cointegration rank. Including the number of lags selected by the lag length tests, the Johansen test indicates a cointegration rank of 6 in the VARs with six variables (including the exogenous oil price shock), suggesting that all variables can be considered stationary within the VAR system.

Lags included	Foreign Country: USA	Foreign Country: Kenya
Burundi	3	3
Kenya	4	-
Rwanda	2	1
Tanzania	7	4
Uganda	7	4

Estimates of ω

Our estimates of ω using the full samples available are shown in the table below, with standard errors in brackets.[1]

Estimates of ω	Foreign country: US	Foreign Country: Kenya
Burundi	0.10*** (0.02)	−0.04 (0.03)
Kenya	0.34 (0.84)	-
Rwanda	0.31 (0.71)	−0.17 (0.05)
Tanzania	0.05 (0.23)	0.05 (0.08)
Uganda	0.14 (0.09)	0.10 (0.26)

At first glance, these results are puzzling, since only Burundi has a statistically significant coefficient, and the estimates for Burundi and Rwanda with Kenya as the foreign country are negative when they should be between 0 and 1. The point estimates with the United States as the foreign country are generally of plausible magnitudes, given the classifications discussed previously. For comparison, Artis and Ehrmann estimate ω to be 0.14 for the United Kingdom during the period 1980 to 1998, increasing to 0.22 in the subsample from October 1990 to August 1992 when the United Kingdom was part of the Exchange Rate Mechanism (and the exchange rate became the official monetary policy target).

The EAC versus US estimates may be insignificant because of lower-than-ideal data frequency, which reduces our sample size. Also it could be due to the variation in the exchange rate regimes of EAC countries in the sample based on the classifications in Appendix I. For example, according to Ilzetzki, Reinhart, and Rogoff (2010) classification, Kenya's exchange rate became more flexible at the beginning of 2008. When, we excluded post-2007 the observations in our sample, we obtained a significant estimate of 0.7 for ω. Our baseline analysis will set ω to zero for all countries except Burundi (in the case with the United States as the foreign country). Sensitivity analyses on the value of ω used reveals that our results are robust to using much higher values of ω. In the SVAR analysis, ω only matters for the identification of the domestic monetary policy shock and the exchange rate shock—it does not affect other shocks or responses of the endogenous variables to them.

As a robustness check, we repeated the SVAR analysis with ω set to 0.5 and to 0.75, implying much stronger responses of monetary policy to exchange rate innovations than in our baseline analysis. The results were qualitatively very similar to the baseline results, and our overall conclusions remained unchanged.

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[1] As per convention, we use */**/*** to denote significance at the 10%/5%/1% levels, respectively.

Appendix III. Impulse Response Functions

Impulse responses functions are plotted below for the five endogenous variables and the five structural shocks. The dotted lines represent bootstrapped 90 percent confidence bands. United States* and Kenya*, respectively, indicate that the United States and Kenya are treated as the foreign country.

Impulse Responses with the United States*
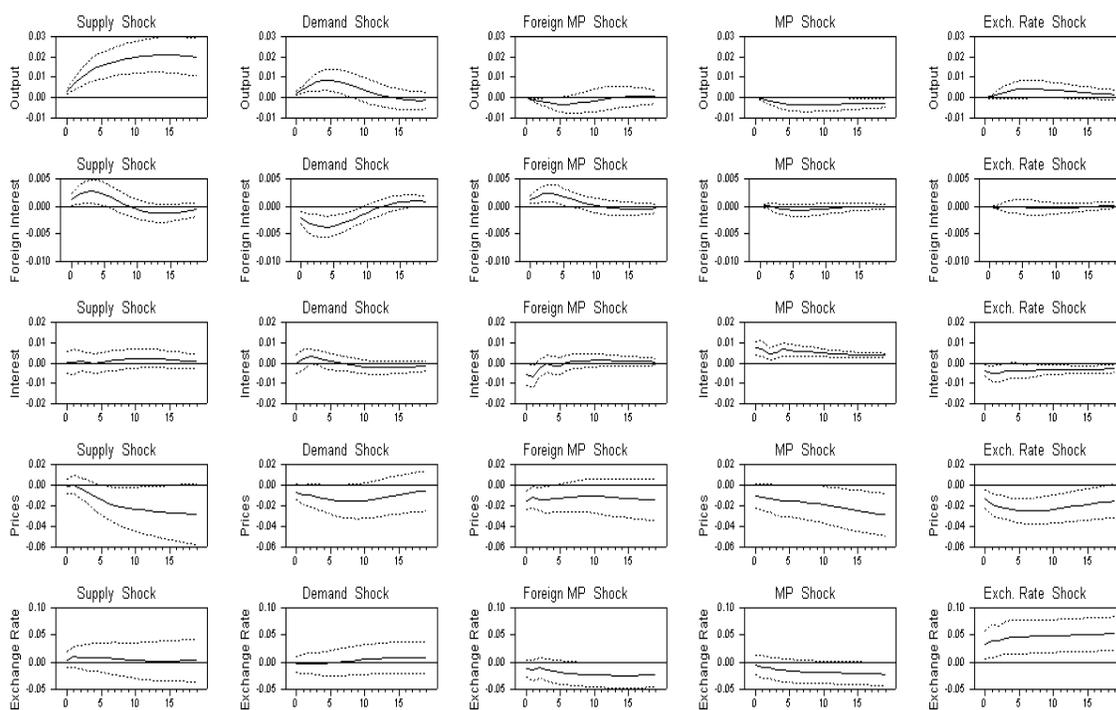
Burundi

Kenya
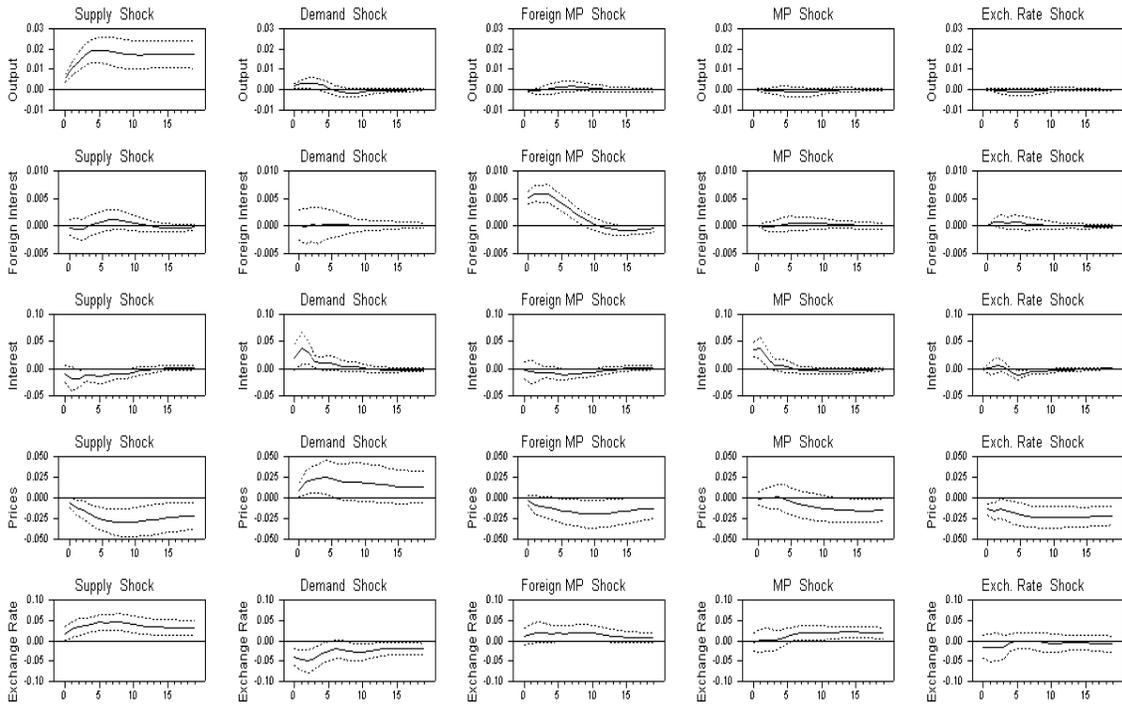
Rwanda
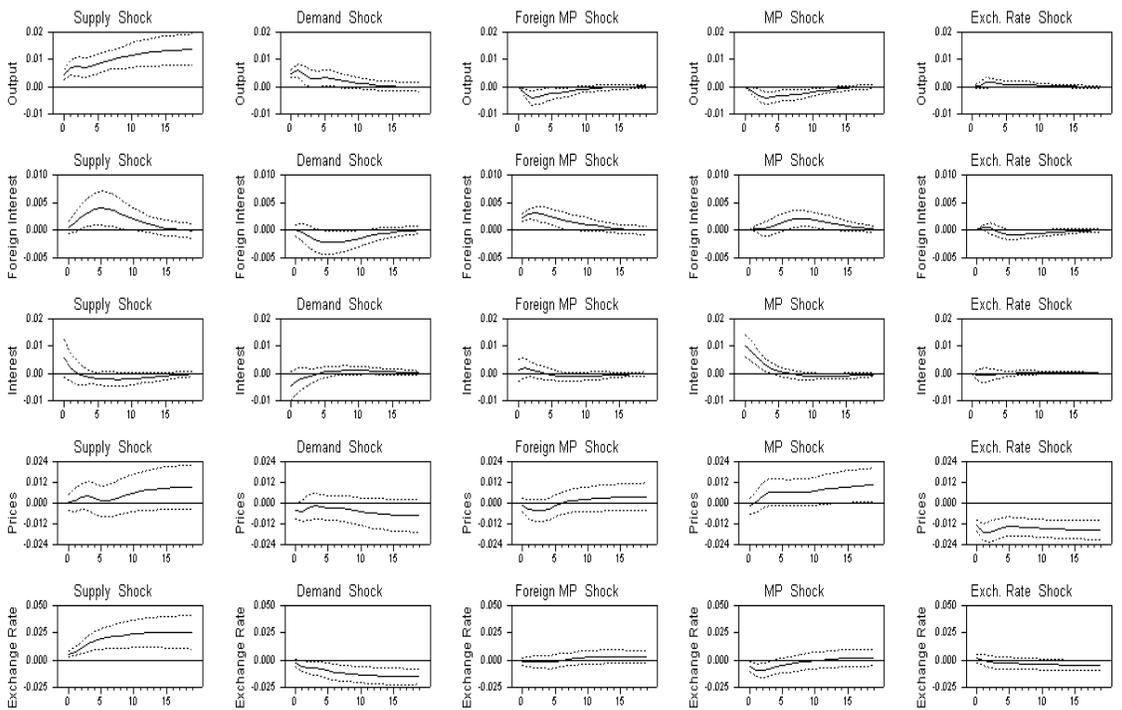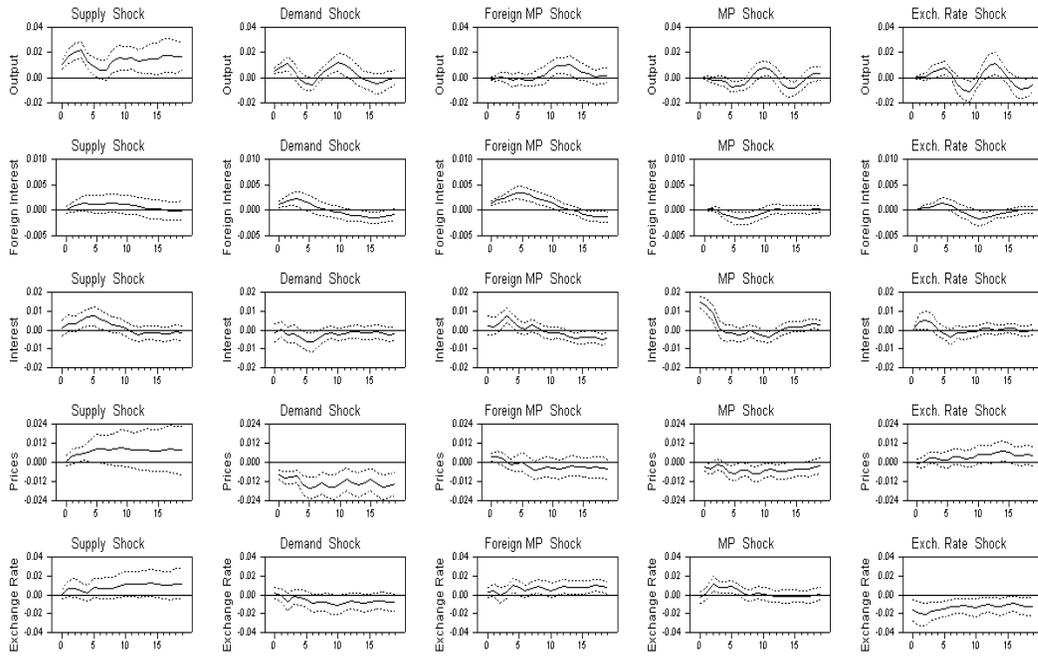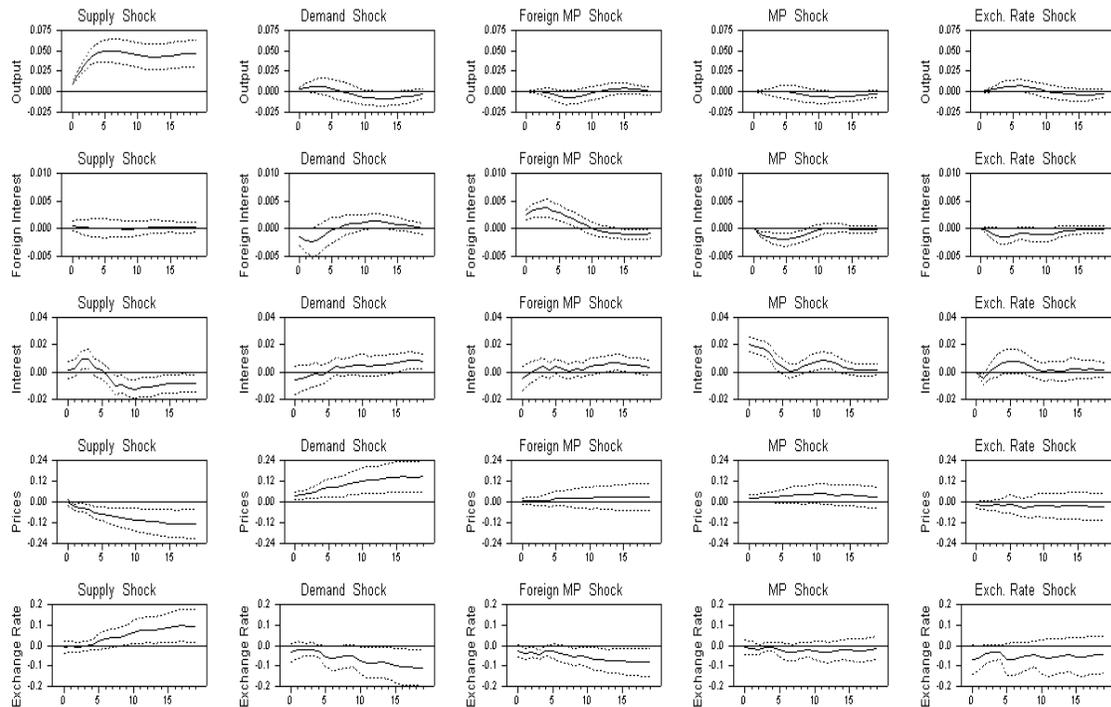
Tanzania

Uganda

Impulse Responses with Kenya*

Burundi
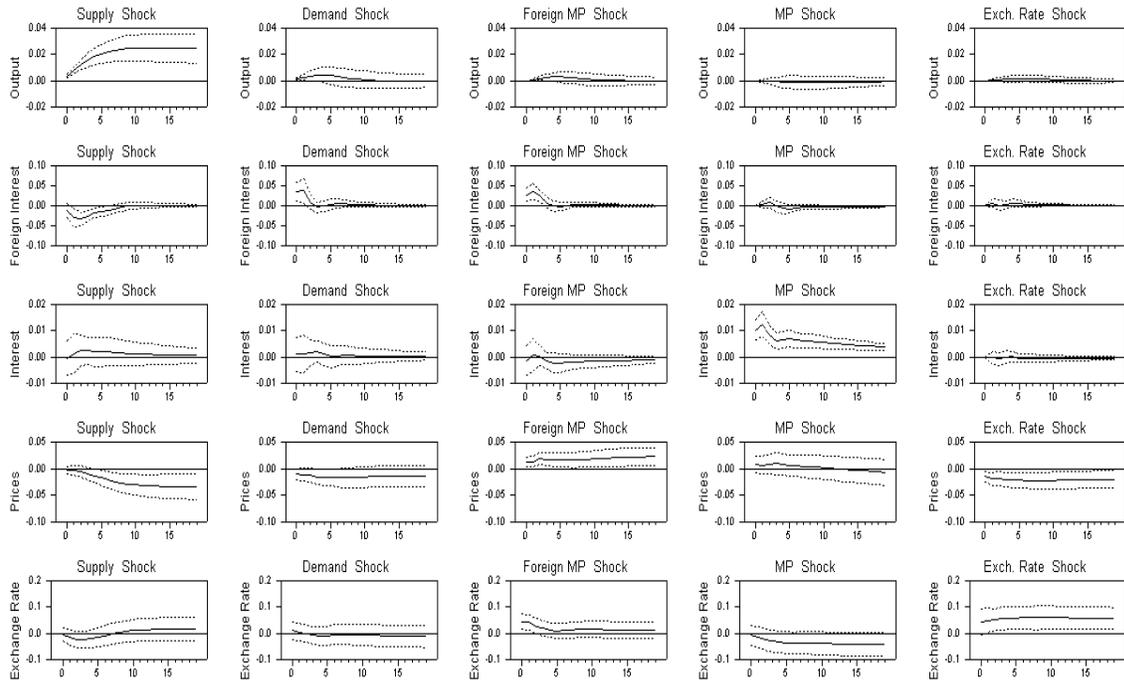
Rwanda
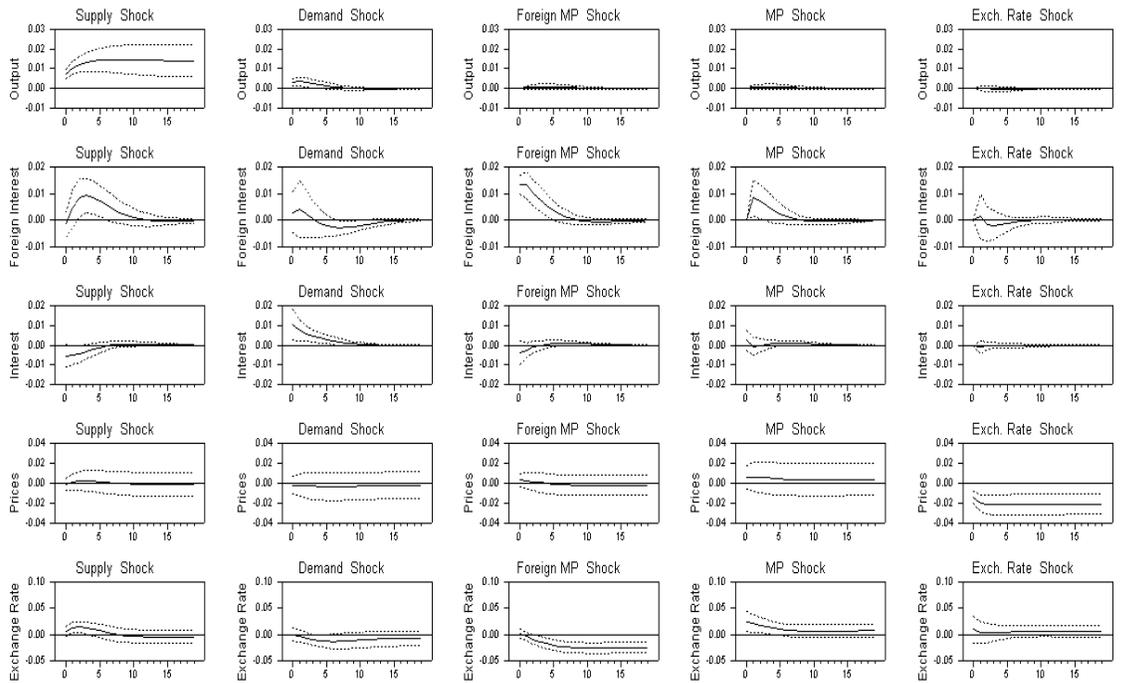
Tanzania
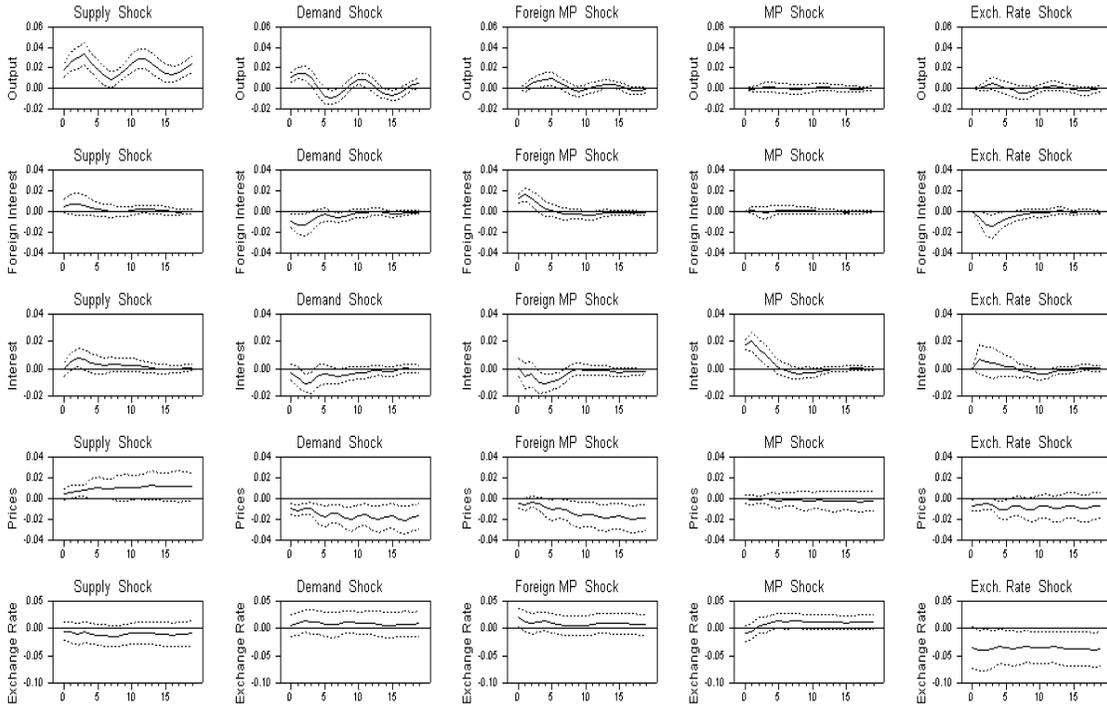
Uganda
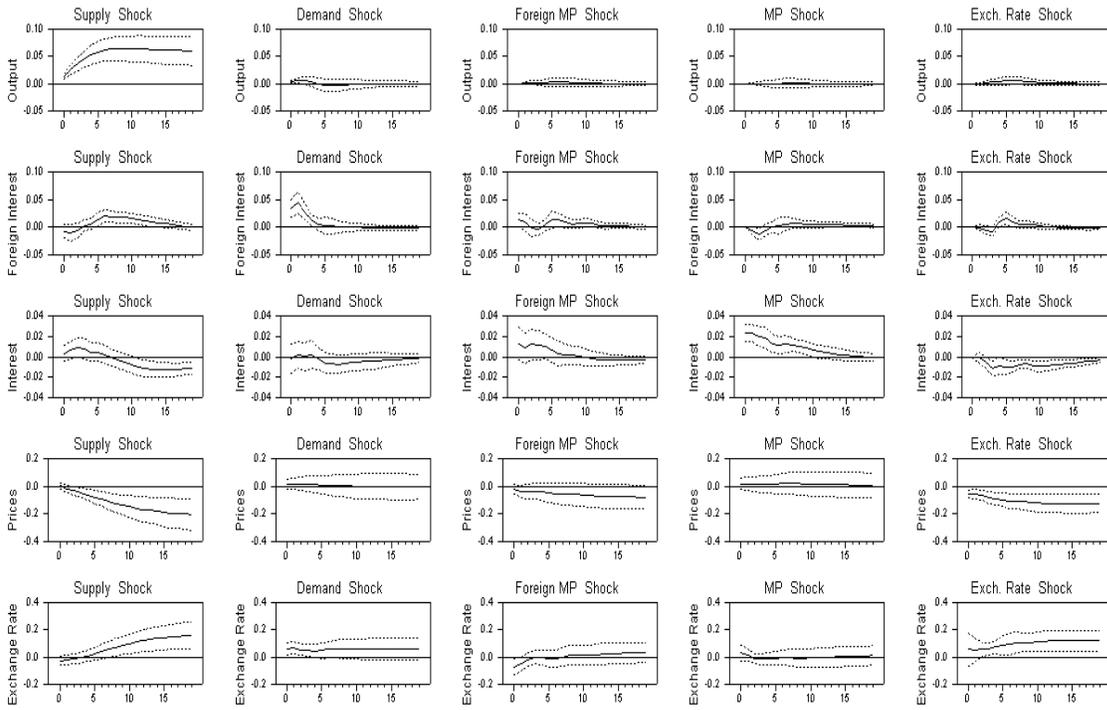
Appendix IV. Variance Decompositions

Variance Decompositions with the United States[*]

Burundi

Variance decomposition for output					
Step	Supply	Demand	Foreign MP	MP	Exch. rate
1	68.46	31.54	0.00	0.00	0.00
4	66.24	27.34	1.90	1.90	2.63
8	70.41	20.61	2.37	2.53	4.07
12	78.88	13.28	1.58	2.47	3.78
16	84.62	8.90	1.06	2.32	3.10
20	87.60	6.84	0.82	2.20	2.54
Variance decomposition for foreign interest rates					
Step	Supply	Demand	Foreign MP	MP	Exch. rate
1	22.56	55.41	22.03	0.00	0.00
4	27.65	51.10	20.84	0.36	0.05
8	24.96	55.49	18.09	1.36	0.10
12	23.88	56.80	17.12	1.82	0.38
16	26.28	54.80	16.68	1.79	0.46
20	26.82	54.56	16.41	1.72	0.49
Variance decomposition for domestic interest rates					
Step	Supply	Demand	Foreign MP	MP	Exch. rate
1	0.12	0.32	31.35	54.41	13.80
4	0.48	5.70	25.13	43.99	24.70
8	0.68	3.99	15.95	53.82	25.57
12	2.89	4.52	12.60	54.67	25.32
16	4.26	5.97	10.98	53.37	25.43
20	4.28	6.61	9.96	53.04	26.11
Variance decomposition for prices					
Step	Supply	Demand	Foreign MP	MP	Exch. rate
1	0.20	7.66	39.61	20.19	32.35
4	1.65	10.70	22.63	19.34	45.68
8	11.47	13.12	14.56	17.50	43.35
12	19.34	12.94	10.92	18.44	38.36
16	24.49	10.85	9.92	21.71	33.03
20	27.85	8.67	9.83	25.66	28.00

Variance decomposition for the exchange rate					
Step	Supply	Demand	Foreign MP	MP	Exch. rate
1	1.90	0.80	10.17	2.21	84.93
4	3.71	0.37	8.48	5.02	82.42
8	2.94	0.21	10.83	7.23	78.79
12	1.99	0.43	12.90	8.43	76.26
16	1.43	0.84	13.86	9.14	74.72
20	1.16	1.11	14.08	9.80	73.85

Kenya

Variance decomposition for output
Step	Supply	Demand	Foreign MP	MP	Exch. rate
1	88.40	11.60	0.00	0.00	0.00
4	94.55	5.28	0.09	0.04	0.05
8	97.26	2.01	0.36	0.17	0.21
12	97.82	1.44	0.40	0.20	0.15
16	98.37	1.06	0.30	0.15	0.13
20	98.71	0.84	0.23	0.12	0.10
Variance decomposition for foreign interest rates
Step	Supply	Demand	Foreign MP	MP	Exch. rate
1	0.37	0.08	99.56	0.00	0.00
4	0.68	0.09	98.21	0.03	1.00
8	2.08	0.27	95.99	0.41	1.25
12	2.94	0.29	94.78	0.73	1.25
16	3.02	0.32	94.60	0.82	1.24
20	3.19	0.34	94.40	0.81	1.25
Variance decomposition for domestic interest rates
Step	Supply	Demand	Foreign MP	MP	Exch. rate
1	4.51	24.48	0.56	70.46	0.00
4	13.22	41.37	1.96	42.63	0.83
8	17.70	37.42	5.78	35.40	3.69
12	18.98	35.36	7.74	33.80	4.12
16	18.84	35.16	7.80	34.01	4.20
20	18.88	35.08	7.95	33.90	4.19
Variance decomposition for prices
Step	Supply	Demand	Foreign MP	MP	Exch. rate
1	10.95	29.19	2.72	0.18	56.96
4	21.59	43.61	9.69	0.06	25.05
8	32.53	30.74	12.12	1.33	23.28
12	34.79	23.68	14.03	3.73	23.78
16	34.39	20.50	14.32	5.94	24.85
20	33.96	18.79	13.80	7.58	25.87
Variance decomposition for the exchange rate
Step	Supply	Demand	Foreign MP	MP	Exch. rate
1	13.55	69.73	5.61	0.55	10.56
4	26.40	57.96	8.58	0.16	6.90
8	43.59	39.83	9.50	3.40	3.68
12	47.41	33.99	9.90	6.02	2.69
16	48.49	31.31	9.20	8.64	2.36
20	49.19	29.84	8.34	10.27	2.36

Rwanda

		Variance decomposition for output			
Step	Supply	Demand	Foreign MP	MP	Exch. rate
1	44.47	55.54	0.00	0.00	0.00
4	52.83	25.64	11.49	8.66	1.38
8	64.67	16.09	8.29	9.86	1.09
12	76.71	10.03	5.20	7.30	0.76
16	84.39	6.65	3.44	5.00	0.51
20	88.61	4.85	2.51	3.66	0.37
		Variance decomposition for foreign interest rates			
Step	Supply	Demand	Foreign MP	MP	Exch. rate
1	4.86	0.00	95.14	0.00	0.00
4	33.38	8.17	57.23	0.48	0.74
8	47.00	14.67	30.27	6.52	1.53
12	45.55	15.67	25.27	11.73	1.78
16	44.64	15.74	24.52	13.26	1.84
20	44.51	15.73	24.45	13.47	1.85
		Variance decomposition for domestic interest rates			
Step	Supply	Demand	Foreign MP	MP	Exch. rate
1	19.17	13.49	0.94	66.39	0.00
4	12.95	10.51	2.85	73.36	0.33
8	16.30	10.46	3.46	69.42	0.36
12	19.55	11.08	4.46	64.46	0.46
16	20.43	11.38	4.73	62.91	0.55
20	20.49	11.44	4.77	62.74	0.57
		Variance decomposition for prices			
Step	Supply	Demand	Foreign MP	MP	Exch. rate
1	0.09	10.53	0.68	1.45	87.26
4	2.88	4.40	4.27	5.67	82.78
8	2.32	3.82	3.03	10.67	80.17
12	4.96	4.87	2.43	12.43	75.31
16	8.59	6.41	2.41	14.54	68.05
20	10.97	7.52	2.54	16.39	62.58
		Variance decomposition for the exchange rate			
Step	Supply	Demand	Foreign MP	MP	Exch. rate
1	44.85	6.64	1.88	41.23	5.40
4	53.29	15.35	1.04	29.08	1.24
8	68.95	18.16	0.42	11.10	1.37
12	71.98	20.25	0.62	5.60	1.55
16	72.47	21.34	0.88	3.61	1.70
20	72.46	21.95	1.02	2.76	1.81

Tanzania

Variance decomposition for output
Step	Supply	Demand	Foreign MP	MP	Exch. rate
1	79.89	20.11	0.00	0.00	0.00
4	81.80	16.21	0.16	0.50	1.33
8	72.46	14.00	0.80	6.20	6.54
12	62.56	16.73	3.95	6.88	9.88
16	59.51	13.10	7.44	8.19	11.77
20	63.64	10.96	6.10	7.05	12.25
Variance decomposition for foreign interest rates
Step	Supply	Demand	Foreign MP	MP	Exch. rate
1	0.17	43.83	56.00	0.00	0.00
4	8.53	35.09	51.49	1.71	3.18
8	9.49	18.79	57.52	9.41	4.80
12	11.77	15.89	53.71	9.41	9.22
16	11.38	19.28	50.19	8.76	10.38
20	10.47	21.84	50.05	8.11	9.53
Variance decomposition for domestic interest rates
Step	Supply	Demand	Foreign MP	MP	Exch. rate
1	0.44	0.88	2.31	96.38	0.00
4	7.62	1.99	12.77	68.16	9.46
8	19.93	12.93	11.50	47.32	8.32
12	19.98	13.51	11.29	46.92	8.30
16	19.73	13.19	15.08	44.18	7.82
20	18.71	13.02	19.34	41.80	7.13
Variance decomposition for prices
Step	Supply	Demand	Foreign MP	MP	Exch. rate
1	1.23	75.86	13.86	8.69	0.37
4	16.28	67.59	5.75	6.75	3.63
8	18.63	66.59	3.19	8.95	2.65
12	19.94	63.05	3.61	9.74	3.67
16	19.92	60.86	3.36	9.66	6.20
20	20.21	61.78	3.54	8.35	6.12
Variance decomposition for the exchange rate
Step	Supply	Demand	Foreign MP	MP	Exch. rate
1	0.23	1.05	2.79	2.75	93.17
4	6.16	3.32	2.01	11.39	77.12
8	7.92	7.12	7.81	11.20	65.95
12	13.40	12.11	9.46	7.76	57.27
16	18.65	12.69	11.08	6.05	51.54
20	21.04	12.79	12.95	5.00	48.23

Uganda

		Variance decomposition for output			
Step	Supply	Demand	Foreign MP	MP	Exch. rate
1	94.01	5.99	0.00	0.00	0.00
4	95.79	3.14	0.04	0.00	1.03
8	96.14	1.27	0.88	0.04	1.67
12	96.24	1.36	0.74	0.49	1.18
16	95.71	1.79	0.70	0.82	0.98
20	96.15	1.61	0.62	0.77	0.85
		Variance decomposition for foreign interest rates			
Step	Supply	Demand	Foreign MP	MP	Exch. rate
1	1.90	25.31	72.80	0.00	0.00
4	0.54	23.57	62.54	8.75	4.60
8	0.35	15.55	60.58	16.39	7.14
12	0.34	17.64	55.93	16.05	10.05
16	0.64	20.29	54.20	15.03	9.85
20	0.72	20.01	55.16	14.55	9.57
		Variance decomposition for domestic interest rates			
Step	Supply	Demand	Foreign MP	MP	Exch. rate
1	0.62	7.54	4.92	86.92	0.00
4	11.16	4.12	2.62	79.41	2.69
8	14.44	4.79	3.22	64.85	12.70
12	27.05	6.55	3.98	52.65	9.78
16	31.17	8.84	7.62	44.33	8.05
20	32.82	13.50	8.29	38.16	7.22
		Variance decomposition for prices			
Step	Supply	Demand	Foreign MP	MP	Exch. rate
1	0.20	61.73	1.19	24.85	12.04
4	23.68	54.56	0.69	13.44	7.63
8	35.28	48.65	2.12	9.60	4.36
12	35.89	50.30	2.20	8.70	2.91
16	37.24	51.44	2.12	6.94	2.26
20	38.40	51.82	2.17	5.50	2.12
		Variance decomposition for the exchange rate			
Step	Supply	Demand	Foreign MP	MP	Exch. rate
1	0.73	17.70	8.69	0.96	71.92
4	0.75	12.71	25.81	3.33	57.41
8	5.44	24.34	18.66	6.01	45.54
12	14.94	27.44	20.51	5.17	31.95
16	21.15	30.09	21.87	4.19	22.69
20	24.63	33.06	21.87	3.21	17.24

Variance Decompositions with Kenya*

Burundi

Variance decomposition for output					
Step	Supply	Demand	Foreign MP	MP	Exch. rate
1	83.69	16.31	0.00	0.00	0.00
4	89.27	8.02	1.96	0.10	0.66
8	93.73	3.72	1.57	0.27	0.72
12	96.39	1.95	0.87	0.31	0.48
16	97.54	1.29	0.58	0.27	0.32
20	98.12	0.97	0.44	0.23	0.24
Variance decomposition for foreign interest rates					
Step	Supply	Demand	Foreign MP	MP	Exch. rate
1	7.73	58.87	33.41	0.00	0.00
4	33.98	32.91	31.76	0.85	0.51
8	38.03	30.02	28.30	2.26	1.41
12	37.52	29.87	28.23	2.77	1.61
16	37.32	29.68	28.12	3.22	1.67
20	37.22	29.60	28.03	3.48	1.67
Variance decomposition for domestic interest rates					
Step	Supply	Demand	Foreign MP	MP	Exch. rate
1	0.16	1.00	1.42	97.42	0.00
4	3.47	2.70	1.07	92.65	0.10
8	4.77	2.13	3.50	89.46	0.15
12	4.86	1.85	4.21	88.82	0.27
16	4.66	1.71	4.56	88.73	0.34
20	4.48	1.65	4.74	88.75	0.37
Variance decomposition for prices					
Step	Supply	Demand	Foreign MP	MP	Exch. rate
1	0.68	18.17	32.79	11.69	36.68
4	3.37	17.20	31.83	8.70	38.91
8	17.17	18.30	24.70	5.01	34.82
12	29.10	15.79	21.88	2.93	30.30
16	35.83	13.58	21.77	1.99	26.83
20	39.37	12.20	22.27	1.78	24.38
Variance decomposition for the exchange rate					
Step	Supply	Demand	Foreign MP	MP	Exch. rate
1	0.21	2.94	50.50	0.76	45.59
4	6.97	1.02	26.80	9.09	56.12
8	5.03	0.99	14.40	16.54	63.05
12	3.90	0.79	10.92	19.77	64.61
16	4.06	0.96	8.89	21.91	64.18
20	4.24	1.22	7.63	23.44	63.48

Rwanda

Variance decomposition for output					
Step	Supply	Demand	Foreign MP	MP	Exch. rate
1	84.37	15.63	0.00	0.00	0.00
4	91.86	7.32	0.41	0.40	0.01
8	95.98	3.26	0.41	0.33	0.03
12	97.47	2.02	0.28	0.22	0.02
16	98.15	1.48	0.20	0.16	0.01
20	98.53	1.17	0.16	0.13	0.01
Variance decomposition for foreign interest rates					
Step	Supply	Demand	Foreign MP	MP	Exch. rate
1	1.80	4.55	93.65	0.00	0.00
4	20.18	3.30	58.86	16.80	0.87
8	30.63	4.44	49.10	14.67	1.17
12	30.91	5.89	47.76	14.30	1.14
16	30.81	6.06	47.67	14.31	1.15
20	30.83	6.06	47.65	14.31	1.15
Variance decomposition for domestic interest rates					
Step	Supply	Demand	Foreign MP	MP	Exch. rate
1	17.98	69.17	9.01	3.84	0.00
4	25.57	65.33	6.76	1.98	0.36
8	24.40	65.97	6.74	2.51	0.37
12	24.29	65.37	7.13	2.80	0.41
16	24.39	65.21	7.16	2.82	0.42
20	24.40	65.21	7.16	2.82	0.42
Variance decomposition for prices					
Step	Supply	Demand	Foreign MP	MP	Exch. rate
1	0.64	1.51	3.72	13.05	81.07
4	0.81	1.18	1.17	8.18	88.67
8	0.60	1.66	0.68	5.86	91.19
12	0.42	1.69	0.75	4.81	92.32
16	0.38	1.55	0.80	4.31	92.96
20	0.35	1.42	0.81	4.05	93.37
Variance decomposition for the exchange rate					
Step	Supply	Demand	Foreign MP	MP	Exch. rate
1	5.12	0.05	0.50	80.16	14.17
4	22.15	5.30	9.54	57.91	5.11
8	13.99	13.08	33.88	34.57	4.48
12	9.17	13.16	48.65	24.05	4.98
16	7.40	11.77	56.08	19.43	5.32
20	6.41	10.70	60.29	17.08	5.53

Tanzania

Variance decomposition for output					
Step	Supply	Demand	Foreign MP	MP	Exch. rate
1	72.59	27.41	0.00	0.00	0.00
4	78.99	18.32	1.93	0.06	0.70
8	77.25	16.32	5.37	0.07	0.98
12	80.71	14.16	4.00	0.08	1.05
16	83.42	11.94	3.62	0.10	0.93
20	84.86	10.90	3.23	0.09	0.92
Variance decomposition for foreign interest rates					
Step	Supply	Demand	Foreign MP	MP	Exch. rate
1	10.29	31.84	57.88	0.00	0.00
4	9.95	29.08	36.64	0.23	24.10
8	9.31	29.02	31.61	0.54	29.52
12	9.12	29.20	32.27	0.67	28.73
16	9.54	29.13	32.35	0.68	28.31
20	9.51	29.18	32.44	0.71	28.17
Variance decomposition for domestic interest rates					
Step	Supply	Demand	Foreign MP	MP	Exch. rate
1	0.07	2.23	0.32	97.39	0.00
4	8.05	15.66	8.87	61.61	5.82
8	8.15	16.35	20.43	49.73	5.34
12	8.89	17.45	19.16	47.57	6.93
16	8.86	17.69	19.45	46.91	7.09
20	8.82	17.54	20.10	46.46	7.08
Variance decomposition for prices					
Step	Supply	Demand	Foreign MP	MP	Exch. rate
1	11.47	51.91	13.04	0.07	23.51
4	22.85	49.16	10.90	0.47	16.62
8	19.88	46.86	17.06	0.43	15.77
12	17.59	44.26	24.33	0.43	13.39
16	17.41	41.97	28.80	0.49	11.32
20	16.67	40.82	31.84	0.59	10.08
Variance decomposition for the exchange rate					
Step	Supply	Demand	Foreign MP	MP	Exch. rate
1	1.62	1.27	22.99	4.33	69.79
4	3.01	5.86	10.35	2.42	78.36
8	5.59	5.00	8.05	5.92	75.44
12	6.13	5.78	6.16	7.28	74.65
16	5.88	5.31	5.88	7.34	75.59
20	5.94	4.94	5.42	7.32	76.38

Uganda

		Variance decomposition for output			
Step	Supply	Demand	Foreign MP	MP	Exch. rate
1	91.43	8.57	0.00	0.00	0.00
4	97.08	2.50	0.18	0.01	0.24
8	98.48	0.70	0.22	0.01	0.59
12	99.06	0.39	0.14	0.01	0.40
16	99.34	0.27	0.10	0.01	0.28
20	99.49	0.21	0.08	0.01	0.22
		Variance decomposition for foreign interest rates			
Step	Supply	Demand	Foreign MP	MP	Exch. rate
1	4.52	83.02	12.46	0.00	0.00
4	4.35	82.75	5.69	5.07	2.15
8	17.72	58.57	10.54	4.87	8.30
12	27.33	48.74	10.94	5.42	7.58
16	29.82	46.19	10.75	6.03	7.21
20	29.80	45.73	10.69	6.36	7.41
		Variance decomposition for domestic interest rates			
Step	Supply	Demand	Foreign MP	MP	Exch. rate
1	1.45	0.35	23.19	75.02	0.00
4	7.52	0.44	18.35	67.47	6.22
8	6.26	3.76	16.69	61.09	12.19
12	9.31	5.54	13.86	55.23	16.05
16	18.21	5.48	12.27	46.97	17.08
20	25.13	5.14	11.57	41.79	16.38
		Variance decomposition for prices			
Step	Supply	Demand	Foreign MP	MP	Exch. rate
1	0.99	5.03	9.92	8.63	75.44
4	12.24	4.59	15.78	4.57	62.83
8	30.53	1.50	12.34	2.57	53.06
12	43.25	0.65	10.77	1.68	43.65
16	50.83	0.36	10.25	1.13	37.43
20	55.45	0.24	10.11	0.78	33.42
		Variance decomposition for the exchange rate			
Step	Supply	Demand	Foreign MP	MP	Exch. rate
1	4.15	27.38	37.06	7.69	23.72
4	3.04	38.27	20.51	4.23	33.96
8	8.07	28.56	8.83	2.06	52.48
12	22.25	20.93	4.79	1.03	51.01
16	33.54	16.51	3.51	0.59	45.86
20	40.74	14.11	3.12	0.47	41.56

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