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Research article

International monetary spillovers and macroeconomic stability in developing countries

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Abstract: This paper analyses the impact of international spillovers on macroeconomic stability in developing countries. Specifically, the study investigates the impact of United States (US) monetary policy spillovers in the form of US inflation and Federal funds interest rate on Uganda and Kenya's inflation rates, interest rates and the exchange rates, key macroeconomic indicators of importance to macroeconomic stability. The focus on international spillovers from the USA is due to the dominant role it plays in determining global economic conditions. The study applies the Generalized Vector Autoregressive (GVAR) approach to quantify spillovers across these economies. The results shows that despite recent efforts towards East African regional integration, international spillovers from global economies like the US are more significant in determining macroeconomic stability in developing countries, underscoring the importance of global policy coordination. Specifically, we find an amplification of return and volatility spillovers after the onset of the Global financial crisis.

Keywords: international spillovers; inflation; exchange rates; volatility spillovers

JEL Codes: F36, G01, G12, G14, G15

1. Introduction

One of the major consequences of globalization is that news, ideas and knowledge are quickly transmitted across national borders, generating international spillovers. In this increasingly integrated and globalized world, developing economies are often subject to huge external shocks emanating from volatility in world markets. Indeed the proliferation of financial and currency crises in such economies is often viewed as a natural consequence of financial globalization (Prasad et al., 2003). African countries are especially vulnerable to global imbalances and spillovers given their economic dependence on foreign markets and aid arising from fragile structural, institutional and policy frameworks as well as a high exposure to surges in capital flows and reversals and dependence on primary commodities and resultant vulnerability to the vagaries of global commodity prices (International Monetary Fund, 2003; Varangis et al., 2004). Of even more concern is the evidence that these external shocks are one of the major reasons for macroeconomic instability and poor economic performance of African countries (International Monetary Fund, 2003; Raddatz, 2007; Varangis et al., 2004). Thus it is important to understand the nature of global spillovers, given their adverse impact on macroeconomic stability, economic growth and poverty alleviation efforts especially in the context of developing countries.

We contribute to this effort by examining the impact of international spillovers on macroeconomic stability in developing countries. Although it is widely accepted that monetary policy plays a crucial role in promoting domestic macroeconomic stability, recent empirical evidence suggests that global financial conditions may generate large spillovers into local financial markets and disrupt domestic monetary policy efforts to manage financial conditions. For instance, a recent report by the United Nations suggests that the role of monetary policy in supporting growth in emerging economies will be constrained by the tightening cycle in the United States (see United Nations, 2017). According to this report, the current monetary tightening process in the United States could have large spillovers on the emerging economies, such that, a significant pick-up in inflationary pressures could force the Fed to raise interest rates at a faster-than-expected pace, heightening risk aversion and global financial volatility. Thus an understanding the impact of international spillovers is essential, particularly in the context of developing counties, in ensuring that the best possible decisions are reached by central banks. Nevertheless, very little work in this area has been done in the context of developing countries. This paper therefore seeks to bridge the gap in the extant literature by investigating the impact of interest rate and inflation spillovers from the United States (US) on Uganda and Kenya's inflation and the exchange rates, key macroeconomic indicators of importance to macroeconomic stability. We focus on Uganda and Kenya because they typify developing countries, being that they are named among the poorest nations in the world and are classified as developing countries by the World Bank (Zheng et al., 2019).The paper is organized as follows: Section 2 provides an overview of macroeconomic stability in Uganda and Kenya, followed by Section 3 with a brief review of the literature and Section 4 discussing the methodology applied for the analyses while Section 5 presents the results and Section 6 concludes with some policy recommendations.

2. Overview of macroeconomic stability in Uganda and Kenya

Global developments impact on Uganda and Kenya's macroeconomic performance. For instance the global financial crisis resulted in an economic slowdown in the Uganda and Kenya's economies, although this economic slowdown was more pronounced in Kenya, which suffered from external

shocks amplified by adverse domestic developments (Ramirez and Drummond, 2009). In the aftermath of the global financial crisis and the European sovereign debt crisis, the two east African countries have been greatly affected by reduced external demand for exports and deteriorating terms of trade prompted as a result of the subsequent global recession and declines in global commodity prices (Ramirez and Drummond, 2009; Tumusiime-Mutebile, 2012). In addition, these countries were also affected by tighter financial conditions abroad, particularly during the global financial crisis. In their pursuit of macroeconomic stability, policy makers relied on prudent macroeconomic policies during these crisis episodes.

Uganda and Kenya have fairly similar monetary policies, in part because they have a history of co-operation under successive regional integration arrangements. They are two of the three initial countries behind the reestablishment of the East African Community that came into force on 7 July 2000. At the core of Uganda and Kenya's central bank responsibilities is the explicitly stated mandate of maintaining price stability and a sound financial system (Bank of Uganda, n.d.; Central Bank of Kenya, n.d.). In recognition of the importance of a stable macroeconomic environment for growth, their central banks have focussed on maintaining low and stable inflation, optimal exchange and interest rates which are crucial to macroeconomic stability. Indeed, Uganda and Kenya's inflation and exchange rates in 2018 show success in attaining macroeconomic stability, reflecting the benefits of pursuing appropriate monetary policies (Bank of Uganda, 2011; Central Bank of Kenya, n.d.; International Monetary Fund, 2018). Headline inflation in Uganda and Kenya declined markedly when compared the respective rates of 9.2 percent and 5.9 percent registered in June 2017. In Kenya, the region's dominant and sophisticated economy, annual headline inflation remained relatively stable and was within target in June 2018, increasing marginally to 4.3 percent from 4.0 percent in May 2018. This is mainly attributed to declining food inflation in first half of 2018 due to sufficient food production and lower food prices in the market while fuel inflation has been on the rise due to increased fuel prices locally as well as internationally (Parliamentary Budget Office, 2018). Uganda's annual headline inflation also marginally increased to 2.2 percent in June 2018 from 1.7 percent May 2018 but remained within target. The low inflation environment was largely a result of the stable exchange rate, favourable weather conditions which contributed significantly towards ample food supplies, and the relatively subdued aggregate demand driven by the negative output gap (Bank of Uganda, 2018).

Since 1993, Kenya's exchange rate regime has been a free float determined in the market through demand and supply forces, where the central bank's participation in the forex market is limited to stemming volatility emanating from external shocks, building the stock of foreign reserves, effecting government payments and injecting or withdrawing liquidity in the market. In 1993, Uganda also adopted flexible exchange rate system which was introduced as a means of improving the country's trade performance and promoting macroeconomic stability and sustainable economic growth (Kasekende et al., 2004). The Uganda shilling's exchange rate is determined by market forces, with the Bank of Uganda's involvement in the foreign exchange market limited to regulatory interventions to dampen excessive volatility in the foreign exchange market (Bank of Uganda, 1999, 2011). These policy settings mean that the exchange rates of both Uganda and Kenya adjust, weakening or strengthening in line with macroeconomic fundamentals such as trade and investment.

While most African currencies including Uganda weakened against the U.S. dollar in 2018, the Kenyan shilling strengthened slightly. Year on year, the Kenya shilling strengthened, appreciating by 2.5 percent and 2.4 percent on an annual basis in May 2018 and June 2018 respectively, closing at an average of Shs. 101.00 per US Dollar in June 2018 (International Monetary Fund, 2018). The Kenya

shilling appreciation in the first half of 2018 is due to increased foreign remittances as well as increased export and tourist earnings which boosted foreign exchange reserves (Parliamentary Budget Office, 2018). In contrast, the Uganda Shilling depreciated by 6.9 percent as at June 2018 to an average of Shs. 3840.48 per US Dollar, compared to a depreciation of 2.8 percent recorded in May 2018 (Bank of Uganda, 2018; International Monetary Fund, 2018). During this period, the Uganda Shilling came under pressure largely on account of global strengthening of the US Dollar and elevated US Dollar demand mainly from oil, manufacturing and telecommunications sectors, as well as offshore investors, in the midst of subdued export receipts (Bank of Uganda, 2018). Speculative activity could have also heightened the pace of depreciation as economic agents positioned themselves in anticipation for further depreciation.

Existing evidence suggests that high frequency of crisis is closely associated with higher macroeconomic volatility which is associated with lower growth (Perry, 2009). Large volatilities in nominal exchange rates have characterized Uganda and Kenya's financial markets since they were liberalised suggesting that their integration into global markets is linked to the increased exposure to international volatility spillovers. This is consistent with recent evidence that shows developing countries remain predominantly a destination, rather than a source, of global financial spillovers as a result of their increasing integration into international financial markets (Agénor and Pereira da Silva, 2018). However the very magnitude of spillovers may vary across countries due to domestic financial market imperfections. Indeed despite sharing some similarities in economic structure, Uganda and Kenya remain susceptible to asymmetric shocks and have country-specific shocks which have been prevalent in the last two decades (Drummond et al., 2015). This paper thus examines the impact international spillover effects of US macroeconomic shocks on developing countries such as Kenya and Uganda. Specifically, using the Generalized Vector Autoregressive (GVAR) approach to quantify spillovers across these economies, the study investigates the impact of interest rate and inflation spillovers from the US on Uganda and Kenya's inflation and the exchange rate, key macroeconomic indicators of importance to Macroeconomic stability.

3. Literature review

Spillovers typify occurrences where shocks to macroeconomic variables such as asset prices in one country trigger changes in the same or other macroeconomic variables in another country. Over the last decades the global economy has witnessed a substantive deepening of linkages in the global economy which resulted in increased cross-border transmission of shocks, volatility and crises across countries. The spillover of shocks across economies and associated the volatility and crises has given impetus towards the study and understanding of international spillovers by academics and practitioners alike. At the core of this discussion is the magnitude and impact of spillovers on the economic welfare and independence of recipient countries. The complexity of the subject of international monetary policy spillovers is further highlighted by existing evidence which indicates these spillovers are time varying. A number of studies highlight the role of US monetary policy in driving global financial conditions and capital flows (Bruno and Shin, 2015; Miranda-Agrippino and Rey, 2015; Rey, 2015) while others show that the spillover effects of US policy appear to be much stronger than those of other advanced economies, such as the euro area, Japan, and United Kingdom (Gupta et al., 2017). This may be due to the fact that the US is the world's largest economy and issuer of the world's most widely used reserve currency. Although US policy may easily spillover to small developing countries with

liberalized markets like Uganda and Kenya, much of the discussion of the spillovers of U.S monetary policy focuses on their effects on financial conditions in advanced and emerging market economies (see for instance (Canova, 2005; Dedola et al., 2017; Gupta et al., 2017; Hofmann and Takats, 2015; Iacoviello and Navarro, 2018; Miranda-Agrippino and Rey, 2015). This research documents the presence of significant USA monetary policy spillovers in advanced and emerging market economies and confirms heterogeneity in magnitude, effects and policy response across countries, a reflection of country specific characteristics. Nevertheless, the impact of USA monetary policy spillovers is larger for emerging economies than advanced economies.

Among the few studies which investigate the context of developing countries is Canova (2005), whose study investigating both emerging and developing Latin American economies finds that US monetary shocks explain important portions of the variability of Latin American macroeconomic variables but real demand and supply shocks including inflation do not. In addition, US monetary policy shocks have strong spillover effects that mainly operate via the financial channel and on occasion destabilize the nominal exchange rate. A monetary policy contraction in the US leads to increases in domestic interest rates of Latin American countries, which in turn are accompanied by capital inflows, price increases and real exchange rate depreciation. Moreover for some Latin American countries US monetary shocks not only play a destabilizing role on nominal exchange rates, they also induce significant co-movements in US and Latin American output and inflation. Georgiadis (2016) estimates spillover effects from US monetary policy to a large set of countries using a GVAR approach. He finds that the role of country characteristics often differs across advanced and non-advanced economies such that the magnitude of spillover effects depends on the receiving country's trade and financial integration, de jure financial openness, exchange rate regime, financial market development, labour market rigidities, industry structure, and participation in global value chains. Further, spillover effects on output are stronger in countries which are less financially developed, less open to trade and which have less flexible exchange rates and labour markets.

To the extent that domestic economic conditions are influenced by foreign developments, such international spillovers may complicate the conduct of monetary policy where they conflict with the goals of monetary policy. This especially concerning when spillovers undermine the ability of recipient central banks to set appropriate monetary conditions (Miranda-Agrippino and Rey, 2015; Rey, 2015). As long as capital flows across borders are free and macro prudential tools are not used to control credit growth, monetary conditions in any country, even one with a flexible exchange rate, are partly dictated by US monetary policy and as such exchange rate movements cannot insulate a country from US monetary policy shocks, implying that flexible exchange rate economies cannot run fully independent monetary policy (Miranda-Agrippino and Rey, 2015; Rey, 2015). Monetary policy spillovers may also create excessive volatility which is of concern to policymakers, as it may adversely impact financial market stability and economic performance (see Becketti and Sellon 1989). Milunovich and Thorp (2006) suggested that volatility spillovers appear widely in financial markets. Using high-frequency data of the most actively traded currencies, Baruník et al., (2017) provided evidence for asymmetric volatility connectedness on the foreign exchange market. They also showed that negative spillovers are chiefly tied to the dragging sovereign debt crisis in Europe, while positive spillovers are correlated with the subprime crisis, different monetary policies among key world central banks, and developments in commodities markets. They concluded that a combination of monetary and real-economy events is behind the positive asymmetries in volatility spillovers, while fiscal factors are linked with negative spillovers. Diebold and Yilmaz (2009) showed that the behaviour of return

and volatility spillovers may differ. In addition, their study shows that spillover intensity is time varying, and the nature of the time variation is also strikingly different for returns and volatilities.

Nevertheless, the research on volatility spillover effects has also focused on advanced and emerging market economies, and less on developing counties. In addition, few empirical studies have investigated the spillover effects of US monetary policy on developing countries' inflation, interest rates and exchange rates. It is against this backdrop that we revisit the debate on US monetary policy return and volatility spillover effects in developing economies. This paper advances our understanding of international monetary policy spillovers by quantifying the impact of US monetary policy spillovers in interest rate and inflation on Uganda and Kenya's inflation, interest rates and the exchange rates, key indicators of importance to macroeconomic stability.

4. Methods

This section briefly summarizes the approaches used in the literature to measure spillovers and presents the specific hypothesis and methodology used to estimate the effects of return and volatility spillovers. The vast majority of research has used multivariate Generalized AutoRegressive Conditional Heteroskedasticity (GARCH) models, cointegration, structural vector autoregressions (VAR) models or AutoRegressive Conditional Heteroskedasticity (ARCH) type models to study spillovers (Palanska, 2020). However, these models have very limited ability to quantify spillovers due to their lack of spillover dynamics. (Baruník et al., 2015). Diebold and Yilmaz (2012, 2009) introduced a novel approach to capture spillovers more effectively. In their seminal work, Diebold and Yilmaz (2009) developed a volatility spillover index based on forecast error variance decompositions from VARs to measure the extent of volatility transfer among markets. They concentrate on variance decompositions and demonstrate how to aggregate spillover effects across markets, capturing a great deal of information into a single spillover measure. The methodology was further improved upon in Diebold and Yilmaz (2012) who used a Generalized VAR (GVAR) framework in which forecast-error variance decompositions are invariant to variable ordering to measure both the total and directional volatility spillovers and reveal the level of intra-market spillovers. Thus the Diebold and Yilmaz (2012) methodology provides a useful toolkit to measure the proportion of a crisis from one country that spills over another country or group of countries. As outlined in Diebold and Yilmaz (2012), the dynamic spillover index may act as an early-warning system for predicting crises which makes it useful when policy makers want to know what country (or group of countries) is more vulnerable when another country is hit by a crisis.

In order to test the null hypothesis of no connectedness or spillovers, the study applies the forecast-error variance decomposition framework of a GVAR model proposed by Diebold and Yilmaz (2012) to measure total and directional US inflation and interest rate return and volatility spillovers on inflation and foreign exchange rates in Uganda and Kenya. We test the null against the alternative hypothesis of the presence of total and/or directional return and volatility spillovers. In contrast with Diebold and Yilmaz (2009), which relies on Cholesky factorization, the approach by Diebold and Yilmaz (2012) yields results that are unique and invariant to the ordering of variables. The procedure is based on the generalized VAR framework of Koop et al. (1996) and Pesaran and Shin (1998), and calculates the forecast error variance decomposition without the orthogonalization of shocks. Nevertheless, the Generalized forecast error Variance Decomposition (GVD) requires normality of the shock distribution, and as such, we take logarithms to make the data more normal-like. In general, for variance decompositions, own variance shares are defined to be the fractions of the H-step-ahead error variances

in forecasting Y_{it} due to shocks to i, for $i = 1, \dots, N$, and spillovers to be the fractions of the H-step-ahead error in forecasting Y_{it} due to shocks to j, for $j = 1,2, \dots, N$, such that $i \neq j$. The H-step-ahead generalized variance decomposition matrix $D^{gH} = \left[d_{ij}^{gH}\right]$, $i, j = 1, \dots, N$ is defined to have entries:

$$d_{ij}^{gH} = \frac{\sigma_{ij} \sum_{h=0}^{H-1} \left(e_i^T \Phi_h \sum_u e_j\right)^2}{\sum_{h=0}^{H-1} \left(e_i^T \Phi_h \sum_u \Phi_h^T e_i\right)} \times 100 \quad (1)$$

where e_j is a selection vector with j-th element unity and zeros elsewhere, Φ_h is the h-th moving average coefficient matrix, $\sum_u$ is the covariance matrix off the error terms, and σ_{ij} is the j-th diagonal element of $\sum_u$. The denominator is the forecast error variance of variable i, and the numerator is the contribution of shocks in variable j to the H-step-ahead forecast error variance of variable i. Given that the shocks do not need to be orthogonal, forecast error variation contributions do not necessarily sum up to 100, i.e., row sums of D^{gH} are not necessarily equal to 100. Hence, in order to be able to interpret the entries of a variance decomposition matrix as shares, they have to be scaled. Hence, we use $\tilde{D}^{gH} = \left[\tilde{d}_{ij}^{gH}\right]$ with $\left[\tilde{d}_{ij}^{gH}\right] = \frac{\left[d_{ij}^{gH}\right]}{\sum_{j=1}^{N} d_{ij}^{gH}}$ instead of D^{gH}. The entries of $\tilde{D}^{gH}$ can be used to analyse the connectedness between assets i and j. More precisely, as described in Diebold and Yılmaz (2014), the matrix $\tilde{D}^{gH}$ leads to a spillover table, which displays pairwise as well as system-wide spillovers. For a system with N variables $(Y_{1t}, \dots, Y_{Nt})$, its upper-left $N \times N$-block matrix contains the scaled generalized variance decomposition matrix of the H-step-ahead forecast error, i.e., $\tilde{D}^{gH}$. Its rightmost column contains row sums "From Others", and the next to last bottom row contains column sums "To Others", and the lower-right element contains the average of the column sums, where, in all of the cases, $i \neq j$, i.e., the diagonal elements are excluded. The off-diagonal entries of $\tilde{D}^{gH}$ measure pairwise directional spillovers from j to i. Hence the off-diagonal column sums (i to ALL) or row sums (All to i), when totalled across countries, give the numerator of the spillover index. Similarly, the column sums or row sums (including diagonals), when totalled across countries, give the denominator of the spillover index. Moreover, total spillover variation over time is also assessed using a rolling window methodology that captures the evolution of the total spillover index, which is a measure of the contribution of spillovers of shocks across all variables to the total forecast error variance over time.

5. Results and discussion

5.1. Data and Descriptive Statistics

We use monthly data from the International Monetary Fund's (2018) International Financial Statistics (IFS) for Uganda, Kenya and the US. Our sample begins on July 1993 and ends on September 2018 and spans several important financial market episodes including the World food price crisis, global financial crisis and the euro area sovereign debt crisis. The study uses logarithmic transformations of variables of interest, namely, Consumer Price index for Uganda, Kenya and US, and Nominal exchange rate (quoted as average Domestic Currency per U.S. Dollar) for Uganda and Kenya with the exception of the 91 day Treasury bill rates for Uganda and Kenya and the US Federal funds interest rate[1]. The Federal funds rate was chosen because it is the rate which the Federal Reserve

[1]The Federal Funds Rate is the interest rate at which depository institutions like banks lend reserve balances to other banks on an overnight basis. It is a good indicator of USA monetary policy and is also an indicator of the health of the USA economy.

affects most directly through open market operations to control the supply of available funds and hence, inflation and other interest rates. Returns series analysed in the study are defined as $y_t = (p_t - p_{t-1})$, where P_t is the Consumer Price index series, Treasury Bill interest rate, exchange rate or Federal Funds Rate at time t for the respective country. Preliminary evidence on the movement of prices as presented in Figure 1 below shows that the returns for all series tend to fluctuate around zero and are characterized by a high degree of variability and volatility clustering with large changes being likely to be followed by further large changes which indicates the volatile nature of these markets. The level of variability in all return series appears to be higher in Uganda and Kenya than the US.

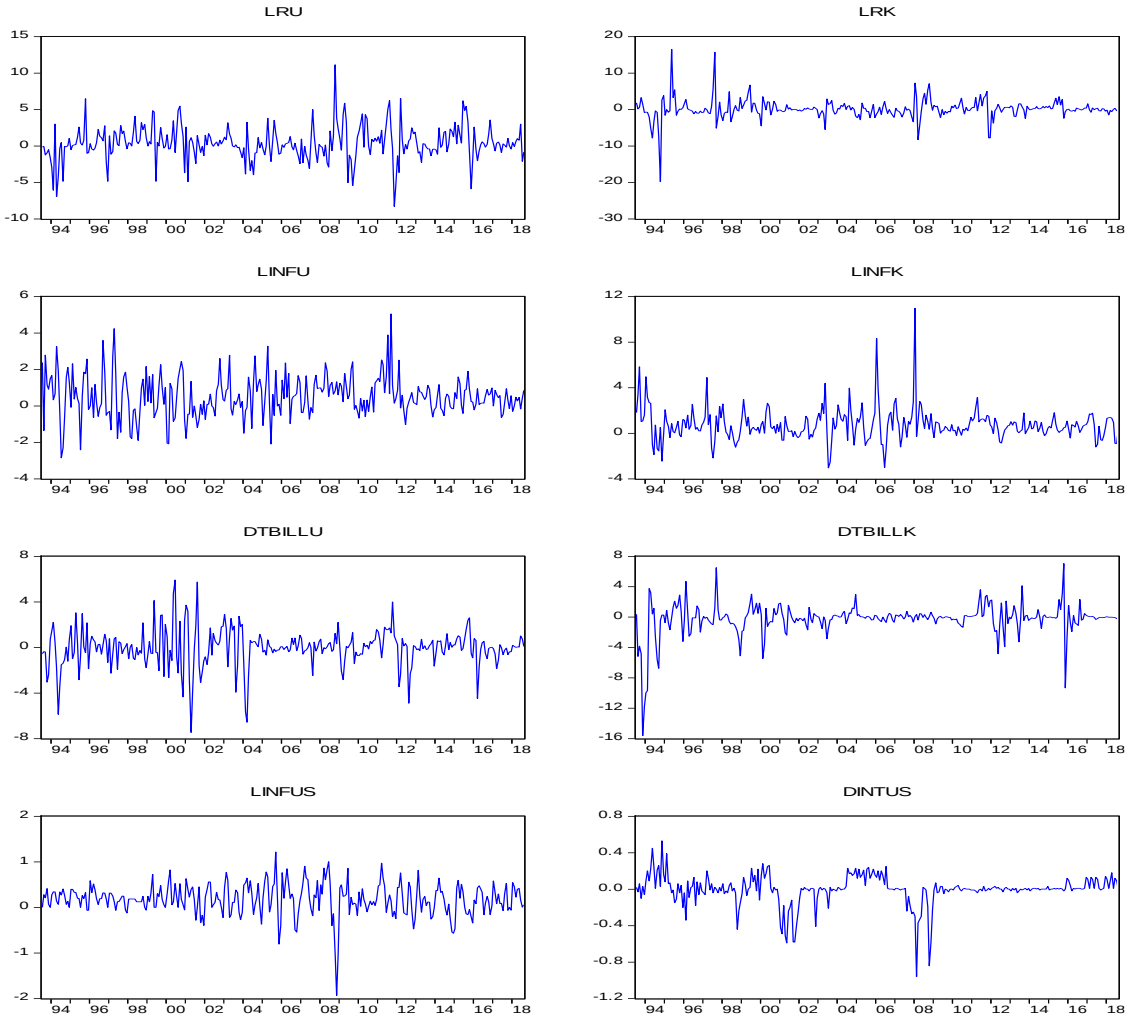

Figure 1. Returns of exchange rates, consumer price indices and federal funds interest rate. Notes: LRU, LRK, LINFU, LINFK, DTBILLU, DTBILLK, LINFUS and DINTUS denote Log returns for the Uganda Shilling per US Dollar nominal foreign exchange rate, Log returns for the Kenya Shilling per US Dollar nominal foreign exchange rate, Log of the Ugandan Inflation rate, Log of the Kenyan Inflation rate, differenced Ugandan 91-day Treasury Bill rate, differenced Kenyan 91-day Treasury Bill rate, Log of the US Inflation Rate and the differenced US Federal Funds Rate, respectively.

Table 1 below provides a summary of descriptive statistics for the differenced series of the variables of interest over the period under study. The sample period considered runs from July 1993

to August 2018, resulting in 302 observations. The choice of the sample period and data frequency is guided by data availability. A look at the distributional properties of data suggests that all series strongly differ from the standard normal. This is confirmed by the Jarque-Bera test, which rejects the normality assumption for all return series. Table 1 also reports the result of Box-Pierce Q-Statistics which tests the joint hypothesis that all the individual autocorrelation coefficients are simultaneously equal to zero for various lags. The test results reject the null hypothesis of no serial autocorrelation at examined lags for all the return series in view of the reported zero Q-statistic probabilities. The results of unit root tests carried out to inform the specification of the models applied in analyses are also presented in Table 1. The Augmented Dickey Fuller (ADF) test (Dickey and Fuller, 1979), Phillip-Perron (PP) (Phillips and Perron, 1988) and Kwiatkowski, Phillips, Schmidt, and Shin (KPSS) (Kwiatkowski et al., 1992) tests indicate that all returns series were found to be stationary.

Table 1. Summary statistics.

	LRU	LRK	LINFU	LINFK	DTBILLU	DTBILLK	LINFUS	DINTUS
Mean	0.376	0.149	0.525	0.736	−0.044	−0.254	0.185	−0.004
Maximum	11.129	16.520	5.043	10.978	5.930	7.041	1.215	0.530
Minimum	−8.290	−19.797	−2.849	−3.041	−7.450	−15.620	−1.934	−0.960
Std. Dev.	2.285	2.690	1.111	1.375	1.645	2.117	0.338	0.164
Skewness	0.103	−0.153	0.335	2.185	−0.550	−2.616	−0.991	−1.820
Kurtosis	5.745	20.800	4.351	16.234	6.627	18.350	8.415	10.716
Jarque-Bera	95	3988	29	2444	181	3309	418	916
Probability	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Observations	302	302	302	302	302	302	302	302
Returns correlations								
Ljung-Box (2)	32.993 [0.000]	18.861 [0.000]	26.968 [0.000]	53.873 [0.000]	39.664 [0.000]	84.882 [0.000]	67.519 [0.000]	62.938 [0.000]
Ljung-Box (7)	34.597 [0.000]	33.148 [0.000]	53.375 [0.000]	70.132 [0.000]	72.035 [0.000]	99.399 [0.000]	101.63 [0.000]	77.354 [0.000]
ADF test	−12.494	−13.436	−12.805	−11.324	−13.236	−6.926	−11.359	−10.913
	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
PP Test	−12.517	−13.463	−12.539	−10.656	−11.769	−10.136	−9.152	−10.963
P-values	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
KPSS Test	0.116	0.046	0.137	0.099	0.079801	0.447844	0.279	0.21
Test critical values:	ADF			PP			KPSS	
1% level	−3.451			−3.451			0.739	
5% level	−2.871			−2.871			0.463	
10% level	−2.572			−2.572			0.347	

Notes: N denotes the number of observations. P-values are in square brackets. Jarque-Bera tests normality distribution of return series. Ljung-Box (P) is the statistic of the Ljung-Box Q-test which tests the joint hypothesis that all the autocorrelations are significantly different from zero. LRU, LRK, LINFU, LINFK, DTBILLU, DTBILLK, LINFUS and DINTUS are as previously defined in Figure 1.

5.2. Discussion of results

5.2.1. Average spillovers throughout the sample

Tables 2 to 5 present a summary of the average return and volatility spillover behaviour for Uganda and Kenya based on two different and distinguished measures of the US economy as proxies of global return and volatility spillover influence. Table 2 contains the total and directional indices for return and volatility spillovers in which a measure of US monetary policy, the Federal Funds rate, is used while Table 3 presents results of total and directional return and volatility spillover indices using US inflation as a proxy for global influence. In addition, we carry out a sensitivity analysis in Tables 4 and 5, where the Uganda Shilling per US Dollar and the Kenya Shilling per US Dollar exchange rates are replaced with the Uganda Shilling per Kenya Shilling foreign exchange rate. In Table 4, the results for total and directional returns and volatility spillover indices where the US Federal Funds interest rate is used to proxy global effects are presented while Table 5 contains the results for total and directional returns and volatility spillover indices where the US inflation rate is used as a proxy for global influence. In each Table, the directional spillover indices, ALL to i, i to ALL, and Net i to ALL, describe the spillovers received by market i from all of the other markets, spillovers transmitted by market i to all of the other markets, and the difference between these two measures, respectively. In addition, the total volatility spillover index appears in the lower right corner of the return and volatility spillover table. The main diagonal elements measure own spillovers while the remaining rows of each table comprise the gross pairwise spillovers captured in the off-diagonal entries that show the contribution of a market to another particular market, based on "non-own" or "cross" variance decompositions.

The results in all tables show large values of the diagonal entries ("own spillovers") for both returns and volatility, an indication that a large percentage of the forecast error variance of the variables considered in the study comes from own idiosyncratic shocks. In Table 2, own return spillovers range from 62.5% to 83.4% and the highest levels of own return connectedness are recorded for the Kenyan Treasury bill rate (83.4%) and Kenyan inflation rate (79.9%), which suggests a relatively low level of connectedness of the Treasury bill and goods, and services markets in Kenya to other markets. In contrast, the lowest measures of own return spillovers are recorded for the Ugandan and Kenyan exchange rates of 62.5% and 63.9% respectively, indication a high connectedness of these foreign exchange markets to other markets. In table 2, own volatility spillovers range from 54.8% to 97.5%, the measure is highest for the Ugandan Inflation rate (97.5%) and lowest for the Ugandan foreign exchange market (54.8%), indicating that Ugandan exchange rate fluctuations are highly influenced by volatility shocks origination from other markets while the contribution of volatility shocks originating from other markets to the forecast error variance of inflation volatility in Uganda is relatively low. In table 3, the own return and volatility spillovers range from 67.4% to 83.5% and 65.2% to 97.6% respectively. The highest levels of own return and volatility connectedness are recorded for the Kenyan Treasury bill rate (83.5%) and US inflation rate (81.5%) for return spillovers and Ugandan inflation rate (97.6%) and Kenyan Treasury bill rate (94.2%) for volatility spillovers, reflecting these markets relatively low level of return and volatility connectedness to other markets. On the other hand, lowest levels of own return and volatility connectedness are recorded for the Ugandan foreign exchange market of 67.4% and 65.2% respectively, reflecting Ugandan foreign exchange market's relatively high level of return and volatility connectedness to other markets. Overall, the high interconnectedness of the foreign exchange markets of Uganda and Kenya to other markets

suggests that these markets are important sources of shocks that drive exchange rate fluctuations, highlighting key advantage of floating exchange rates in providing an appropriate adjustment mechanism to various shocks in these countries.

The results of relatively high own spillovers are also consistent with the moderate values of the system wide aggregate return and volatility spillover indices. The total return spillovers among the three countries under study are 25.7% and 24.1% in Tables 2 and 3 respectively, which are higher than the system wide total volatility spillovers among the three countries under study of 17.7% and 15.6% in Tables 2 and 3 respectively. Given that the total return and volatility spillover indices describe the portion of the forecast error variance that comes from spillovers, this suggests that for our sample of selected countries and markets the proportion of each variable's forecast error variance that is on average due to return and volatility shocks originating from other markets is approximately 24.9% and 16.6% respectively. In addition, the results of the total return and volatility spillover indices based on the US federal funds rate and US inflation rate as proxies for global spillovers in Tables 2 and 3 respectively are fairly comparable and bear similar regularities, although the results of total return and volatility spillover indices based on the US federal funds rate are marginally higher than those based on US inflation rate. Thus our results point to moderate level of interconnectedness in returns and volatility for the selected economies' markets within the sample period.

Interestingly, the total directional return and volatility spillovers ("ALL to i" or "i to ALL") are also less than own spillovers for all considered countries and variables, suggesting that cross-market return and volatility spillovers are quite limited in the considered countries' markets. This is surprising especially in the case of Uganda and Kenya which are core members of the East African Community under which progressive steps have been made towards realisation of an economic and monetary union. The results for total directional spillovers received from others ("ALL to i") presented in Tables 2 and 3 identify the Ugandan exchange rate returns as the dominant recipients of return spillovers from other markets averaging at 37.5% and 32.6% respectively followed by the Kenyan exchange rate returns at 36.1% and 31.4% respectively. Likewise, the level of total directional volatility spillovers received from other countries in tables 2 and 3 ranges from 2.5% to 45.2% and 2.4% to 34.8% respectively with the Ugandan exchange rate as the highest recipient of volatility from other markets as shown by the respective values of 45.2% and 34.89%. In terms of the total directional return spillovers to others ("i to ALL"), the results presented in Tables 2 and 3 show that the foreign exchange markets of Kenya (46.9%) and Uganda (41.7%) respectively contributed the most to other markets' forecast error variance. In addition, Tables 2 and 3 also present very similar results for the total directional volatility spillovers, in that it also shows the foreign exchange markets of Uganda (45.4%) and Kenya (38.8%) as the largest contributor of volatility shocks to other markets' forecast error variance.

In Tables 2 and 3, the highest pairwise directional spillover measures are observed between Uganda and Kenya's markets, suggesting that Uganda and Kenya are large transmitters of cross market return and volatility spillovers especially amongst themselves. A look at the pairwise directional spillovers captured in the off-diagonal elements of the return and volatility matrices suggests that the interconnectedness between the foreign exchange, Treasury bill and goods and services markets of Uganda and Kenya markets is slightly higher than the link between these markets and the US which is consistent with the relations between these two countries. For instance, in tables 2 and 3 Uganda's markets, especially the foreign exchange market, are seen as quite big transmitters of return innovations, with the majority of these shocks received by Kenya's markets especially the foreign exchange market. The highest observed pairwise return spillovers are from the Ugandan exchange rate

to the Kenyan exchange rate of 24.8% and 27.2% in Tables 2 and 3 respectively. In terms of volatility spillovers, tables 2 and 3 show that Uganda and Kenya's markets remain large transmitters of cross market volatility, especially their exchange rate markets. In Table 2, the highest volatility spillovers of 22.8% and 22.2% are observed from the Ugandan and Kenyan exchange rates to the US federal funds rate and Ugandan foreign exchange rate respectively while in Table 3, the highest volatility spillover of 28.0% is observed from the Kenyan exchange rate to Ugandan exchange rate.

In Table 2, the highest net recipients of shocks from other markets in the selected network of countries' markets are the Kenyan inflation rate (−8.4%) and US federal Funds rate (−7.7%) as indicated by negative sum of net directional return spillovers (Net i to ALL) measures. In contrast, Kenyan exchange rate (10.7%) and Ugandan exchange rate (7.5%) are identified as the biggest net transmitters of return shocks to other markets. The highest net recipient of volatility spillovers is the US federal Funds rate (−8.8%) while the highest net transmitter of volatility spillovers to other markets is the Kenyan exchange rate (10.3%). Table 3 shows fairly similar results for net directional return and volatility spillovers. The highest observed net recipients of return spillovers from other markets are the Kenyan inflation rate (−9.5%) and US inflation rate (−7.2%) while the highest net transmitters of return spillovers to other markets are the Ugandan exchange rate (9.1%) and Kenyan exchange rate (6.8%). In addition, the highest net recipients of volatility spillovers on a net basis is the US inflation rate (−15.9%) while the highest observed net transmitter of volatility spillovers across markets is the Kenyan Exchange rate (15.1%).

Table 2. Return and Volatility Spillovers using a generalized vector autoregressive framework.

RETURN SPILLOVERS								
	LRU	LRK	LINFU	LINFK	DTBILLU	DTBILLK	DINTUS	ALL to i
LRU	62.48	23.05	0.15	0.66	4.12	1.87	7.67	37.52
LRK	24.77	63.85	1.20	0.09	0.68	1.97	7.43	36.15
LINFU	3.51	1.48	79.22	6.80	1.50	6.15	1.34	20.78
LINFK	0.61	0.53	15.47	79.93	2.77	0.64	0.05	20.07
DTBILLU	6.24	2.89	2.54	3.38	76.96	6.65	1.33	23.04
DTBILLK	2.04	2.23	3.45	0.75	8.10	83.40	0.03	16.60
DINTUS	7.83	16.67	0.35	0.03	0.48	0.19	74.45	25.55
i to ALL	45.00	46.86	23.16	11.71	17.65	17.47	17.85	25.67
Net i to ALL	7.48	10.71	2.38	−8.36	−5.39	0.87	−7.69	0.00
VOLATILITY SPILLOVERS								
LRU	54.77	22.21	0.32	1.71	0.04	1.28	19.66	45.23
LRK	17.91	74.78	2.05	0.21	1.83	0.08	3.13	25.22
LINFU	1.74	0.01	97.54	0.36	0.09	0.04	0.21	2.46
LINFK	1.46	0.35	0.59	95.54	1.46	0.57	0.05	4.46
DTBILLU	0.18	4.18	2.49	0.34	91.33	1.42	0.06	8.67
DTBILLK	1.29	0.34	0.14	0.88	2.96	94.38	0.02	5.62
DINTUS	22.80	8.39	0.14	0.23	0.36	0.02	68.06	31.94
i to ALL	45.38	35.48	5.72	3.74	6.75	3.42	23.12	17.66
Net i to ALL	0.15	10.27	3.26	−0.72	−1.92	−2.21	−8.82	0.00

Notes: LRU, LRK, LINFU, LINFK, DTBILLU, DTBILLK, LINFUS and DINTUS are as previously defined in Figure 1.

Table 3. Return and Volatility Spillovers using a generalized vector autoregressive framework.

RETURN SPILLOVERS								
	LRU	LRK	LINFU	LINFK	DTBILLU	DTBILLK	DLINFUS	ALL to i
LRU	67.40	24.88	0.22	0.69	4.56	2.02	0.24	32.60
LRK	27.15	68.64	1.13	0.17	0.80	2.02	0.09	31.36
LINFU	4.26	1.74	78.21	5.72	1.72	6.63	1.72	21.79
LINFK	0.54	0.62	14.01	79.05	2.35	0.77	2.67	20.95
DTBILLU	5.60	2.68	2.48	3.32	73.23	6.34	6.35	26.77
DTBILLK	1.88	2.02	3.54	0.71	8.16	83.52	0.18	16.48
DLINFUS	2.25	6.18	1.72	0.85	7.29	0.20	81.51	18.49
i to ALL	41.67	38.12	23.10	11.46	24.87	17.98	11.25	24.06
Net i to ALL	9.07	6.75	1.30	−9.49	−1.90	1.50	−7.24	0.00
VOLATILITY SPILLOVERS								
LRU	65.23	27.99	0.14	1.11	0.02	1.02	4.48	34.77
LRK	19.55	76.24	1.48	0.25	1.57	0.01	0.90	23.76
LINFU	1.32	0.06	97.60	0.19	0.09	0.02	0.72	2.40
LINFK	0.70	0.13	0.33	92.38	1.23	0.64	4.60	7.62
DTBILLU	0.14	3.63	2.19	0.39	92.06	1.34	0.25	7.94
DTBILLK	1.03	0.22	0.08	1.11	2.97	94.22	0.38	5.78
DLINFUS	15.69	6.81	1.36	2.82	0.09	0.45	72.78	27.22
i to ALL	38.42	38.84	5.58	5.87	5.97	3.48	11.33	15.64
Net i to ALL	3.65	15.08	3.18	-1.75	-1.97	-2.30	-15.89	0.00

Notes: LRU, LRK, LINFU, LINFK, DTBILLU, DTBILLK, LINFUS and DINTUS are as previously defined in Figure 1.

Even though the magnitudes are relatively modest, these results identify the Kenyan Exchange rate market as one of the major sources of return and volatility spillovers to other markets implying the Kenyan exchange rate acted as a shock transmitter of both return and volatility shocks while the Ugandan exchange rate market, which is also identified as one of the main sources of return spillovers, was largely a transmitter of returns innovations over the sample period. In contrast, the US federal Funds rate is identified as one of the major recipient of return and volatility spillovers in this network of countries' markets over the sample period.

The finding that US markets are net recipients of return and volatility spillovers in developing country markets such as Uganda and Kenya is rather surprising and contradicts comparable findings in the literature which show emerging markets are often the recipients of return and volatility shocks from advanced economies (Gupta et al., 2017; Hofmann and Takats, 2015; Iacoviello and Navarro, 2018). This result, albeit small in magnitude, may be a reflection of the global role the US dollar holds as a reserve currency and store of liquidity, highlighting the role of investor risk aversion and flight to safety when global markets get shaky, especially during severe episodes of financial market crises such as the global financial crisis, included in the sample under study. Kose et al. (2017) examining the extent of global spillovers from changes in US growth, monetary and fiscal policies, and uncertainty in US financial markets and economic policies find that developments in the US economy affect the global economy with tightening US financial conditions adversely affecting emerging market and developing economies that rely heavily on external financing. Interestingly, their study also finds that while the United States plays a critical role in the world economy, activity in the rest of the world is also important for the United States. Thus our results suggest

that on average, over the sample period under study, return and volatility exchange rate shocks in Uganda and Kenya triggered investor flight safety, reflected in US markets as net recipients of return and volatility spillovers. Small, open and developing country markets like the Uganda and Kenya are vulnerable to capital flows and valuation changes linked to the important international use of the dollar which also have substantial and complex effects on the domestic financial system of recipient countries, quite apart from their effect on the exchange rate.

This is confirmed in the sensitivity analysis in Tables 4 and 5, where the Uganda Shilling per US Dollar and the Kenya Shilling per US Dollar exchange rates are replaced with the Uganda Shilling per Kenya Shilling foreign exchange rate. Overall, the results of the sensitivity analysis indicate that return and volatility spillovers are not driven by the increased exposure of any specific market to US policy but instead they are driven by the portfolio decisions of foreign institutional investors and the exchange rates of Uganda and Kenya becoming more sensitive to US monetary policy due to the international use of the dollar. For instance, replacing the Uganda Shilling per US Dollar and the Kenya Shilling per US Dollar exchange rates with the Uganda Shilling per Kenya Shilling foreign exchange rate, own return and volatility spillovers increase markedly when compared to the total or directional return and volatility spillovers FROM and TO other markets, especially for the Uganda Shilling per Kenya Shilling foreign exchange rate and US market variables; namely inflation and the federal funds rate. Thus the considered markets are independent of each other and are most exposed to global spillovers through their dollar denominated trade and financial transactions. This implies that the exchange rate market and its link to foreign trade and financial markets is a major channel through which global spillovers from US policy are transmitted to the domestic markets. Uganda and Kenya are net importers with a major segment of their trade denominated in dollars as well as a colossal external debt stock also largely denominated in US dollars. In addition, Uganda and Kenya's financial markets are small, illiquid and far more volatile than US markets with the consequence that foreign shocks may not be easily absorbed and thus are more likely to have systemic effects in these markets when compared to the US markets. Nevertheless the results remain consistent with previous finding in Tables 2 and 3, where the own return and volatility spillovers are also larger than any total or directional return and volatility spillovers FROM and TO other markets.

The results for total and directional volatility spillovers sharply contrast our previous findings further confirming the fact that the US dollar exchange rate is a major source of global volatility spillovers in these markets, independent of US policy stance. Once the exposure to the US dollar exchange rate is controlled for, total return spillovers decline to an average of 17.8% in Tables 4 and 5 which is lower than the average of 24.9% in Tables 2 and 3. In addition, net return spillovers fall to less than 2% in most markets and the good and services markets hold both highest net recipient (Kenyan inflation, −6.5%) and net transmitters (Ugandan inflation, 3.9%) on average in Tables 4 and 5, contrary to our previous results. Further, in contrast with previous findings, the US markets are net transmitters of return spillovers, albeit small magnitude. Also in Tables 4 and 5, the total volatility spillover indices decline to 5.1% and 4.1% respectively a sharp fall when compared to the average level of 16.6% in Tables 2 and 3. In stark contrast to our previous results in Tables 2 and 3, net volatility spillovers fall to less than 3% in all markets in Tables 4 and 5, further confirming the independence of these markets. Again we find that US market rates have little or no impact on volatility in Uganda and Kenya's markets once the US dollar exchange rate is controlled for.

Table 4. Return and Volatility Spillovers using a generalized vector autoregressive framework.

RETURN SPILLOVERS							
EAC int	LREAC	LINFU	LINFK	DTBILLU	DTBILLK	DINTUS	ALL to i
LREAC	84.98	0.19	1.32	6.01	5.05	2.45	15.02
LINFU	2.16	78.95	7.57	1.84	7.31	2.17	21.05
LINFK	0.62	16.35	80.18	1.91	0.76	0.18	19.82
DTBILLU	3.60	3.10	3.49	79.13	8.19	2.49	20.87
DTBILLK	4.87	4.12	0.74	9.13	80.89	0.26	19.11
DINTUS	2.18	1.03	0.20	1.52	0.67	94.39	5.61
i to ALL	13.42	24.80	13.32	20.40	21.98	7.55	16.91
Net i to ALL	−1.60	3.75	−6.50	−0.46	2.87	1.95	0.00
VOLATILITY SPILLOVERS							
LREAC	93.12	0.94	0.33	1.29	3.81	0.51	6.88
LINFU	0.55	99.17	0.10	0.09	0.01	0.09	0.83
LINFK	0.97	0.42	95.23	1.77	0.66	0.95	4.77
DTBILLU	0.57	1.47	0.34	96.42	1.09	0.11	3.58
DTBILLK	2.93	0.01	1.00	2.55	93.48	0.03	6.52
LINFUS	0.69	0.05	0.30	0.70	0.01	98.26	1.74
i to ALL	5.71	2.89	2.06	6.40	5.58	1.69	4.05
Net i to ALL	−1.17	2.05	−2.70	2.82	−0.94	−0.06	0.00

Notes: LREAC denotes Log returns for the Uganda Shilling per Kenya Shilling foreign exchange rate, LINFU, LINFK, DTBILLU, DTBILLK, LINFUS and DINTUS are as previously defined in Figure 1.

Table 5. Return and Volatility Spillovers using a generalized vector autoregressive framework.

RETURN SPILLOVERS							
EAC inf	LREAC	LINFU	LINFK	DTBILLU	DTBILLK	LINFUS	ALL to i
LREAC	85.64	0.13	1.59	6.15	4.72	1.77	14.36
LINFU	2.52	80.56	6.82	1.99	7.76	0.35	19.44
LINFK	0.34	15.21	80.45	1.66	0.85	1.49	19.55
DTBILLU	3.50	3.38	3.61	72.70	7.36	9.45	27.30
DTBILLK	4.51	4.36	0.81	9.02	80.85	0.46	19.15
LINFUS	1.24	0.42	0.22	10.10	0.07	87.94	12.06
i to ALL	12.10	23.50	13.05	28.93	20.76	13.52	18.64
Net i to ALL	−2.26	4.06	−6.50	1.63	1.61	1.46	0.00
VOLATILITY SPILLOVERS							
LREAC	94.11	0.83	0.10	1.28	3.57	0.10	5.89
LINFU	0.48	99.16	0.08	0.10	0.01	0.16	0.84
LINFK	0.45	0.31	91.62	1.49	0.66	5.48	8.38
DTBILLU	0.60	1.40	0.30	96.28	1.10	0.32	3.72
DTBILLK	2.84	0.01	1.10	2.60	93.37	0.09	6.63
LINFUS	0.54	0.12	4.33	0.26	0.01	94.73	5.27
i to ALL	4.91	2.67	5.92	5.72	5.35	6.15	5.12
Net i to ALL	−0.98	1.83	−2.46	2.00	−1.28	0.88	0.00

Notes: LREAC denotes Log returns for the Uganda Shilling per Kenya Shilling foreign exchange rate, LINFU, LINFK, DTBILLU, DTBILLK, LINFUS and DINTUS are as previously defined in Figure 1.

5.2.2. Rolling-window spillovers estimates

Finally, to gain further insights into the dynamics of the total return and volatility spillovers, the study estimates total return and volatility spillover indices using 120-day rolling-sample windows to assess the nature and extent of spillover variation over time. The total return and volatility spillover indices reported in Figure 4 represent the fraction of total forecast error variance attributable to non-domestic sources of shocks for the three countries as a whole over time and therefore track the sensitivity of return and volatility spillovers to significant domestic and global economic events. As may be seen in Figure 4, return and volatility spillovers vary over time, albeit follow a similar pattern for all series. In addition, return spillovers are found to be on average larger than volatility spillovers for all series.

The analyses of time-varying return and volatility spillovers reveal limited spillovers until the onset of the global financial crisis of 2007–2008. Total return spillovers increased markedly from averages of 13.4%, 11.0%, 11.9% and 9.8% for the Spillover Index with US inflation, Spillover Index with US interest rate, Spillover Index with US inflation and EAC exchange rate and the Spillover Index with US interest rate and EAC Exchange rate respectively to averages of 17.5%, 18.8%, 13.3% and 12.7% after the global financial crisis. Similarly, total volatility spillover indices based on US inflation, US interest rate, US inflation and EAC exchange rate and US interest rate and EAC Exchange rate fluctuated around the respective averages of 7.0%, 8.0%, 5.6% and 7.0% before the global financial crisis but rose to corresponding averages of 13.2%, 18.2%, 6.2% and 10.8% after this period. In addition, total volatility spillover indices also reveal sharp increases volatility spillovers during periods of high uncertainty and market crises, particularly during the global financial crises of 2007–2008 and sovereign debt crisis periods which peaked between 2010 and 2012, suggesting an intensification of market connectedness during crisis periods. These findings are similar to Diebold and Yilmaz (2012) who investigate daily volatility spillovers across US stock, bond, foreign exchange and commodities markets, from January 1999 to January 2010 and find that cross-market volatility spillovers were quite limited until the global financial crisis, which began in 2007. Katusiime (2019) also finds low but time-varying volatility spillovers that intensified during periods of high uncertainty and market crises, particularly during the global financial crisis and sovereign debt crisis periods while investigating spillover effects between oil and food price volatility and the nominal Uganda shilling per United States dollar exchange rate.

Overall, the time-varying behaviour of the total return and volatility spillover indices reveal an intensification of return and volatility spillovers during periods of high uncertainty, especially during the global financial crisis period and sovereign debt crisis in Europe. In line with Diebold and Yilmaz (2009), return spillovers seem to move around a positively sloped trend, which is in line with the general process of increased economic integration and globalization. We also find that the aggregated return and volatility spillovers for US dollar exchange rate based indices are larger than across EAC exchange rate based indices and conclude that the US dollar exchange rate provides a more efficient channel of information transmission among the countries considered. Our findings suggest a system in which the US dollar exchange rate plays a dominant role in the information transmission mechanism among the countries in the sample, which is consistent with the prevalence of the U.S. dollar in international transactions within the EAC regional block when compared to the EAC currencies. This US dollar exchange rate based strong information interdependence is also another indication that return and volatility spillovers within the region continue to be driven largely by global factors.

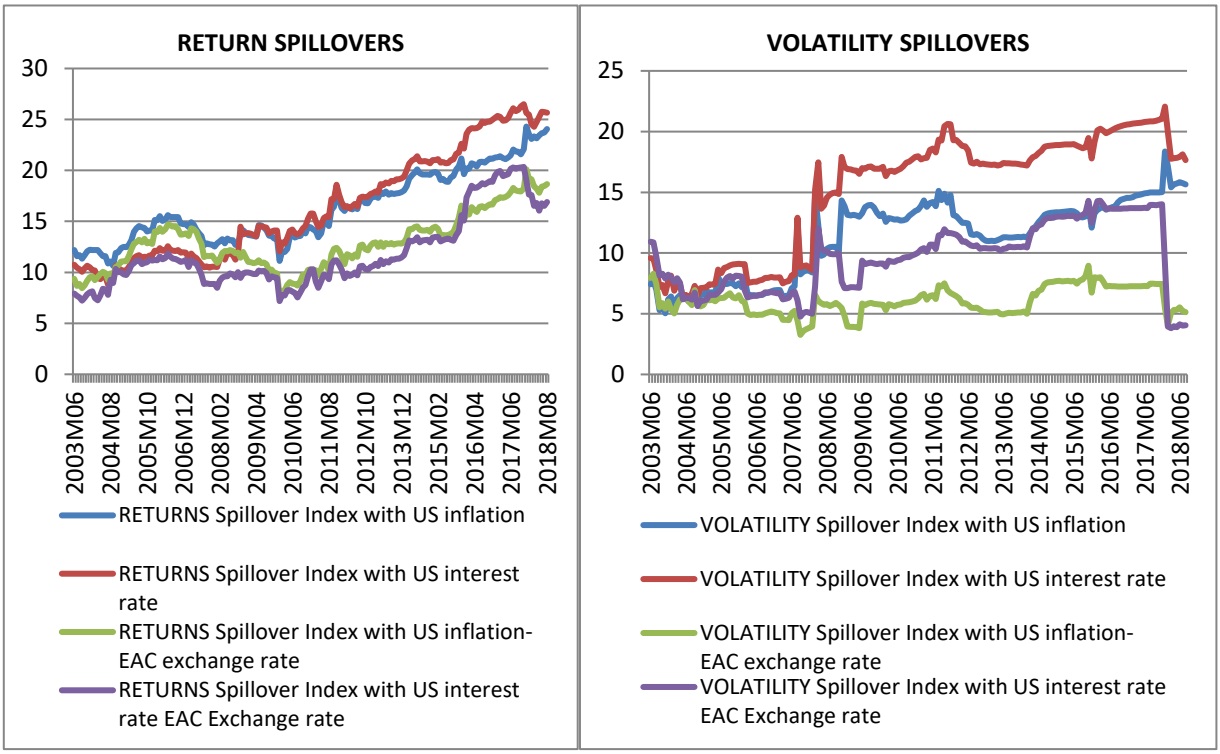

Figure 2. Evolution of total return and volatility spillover indices.

5.3. Sensitivity and robustness analysis

In order to enrich the analysis, we checked for model sensitivity by analysing monetary policy and macroeconomic spillovers from the US based on the Federal funds rate and USA inflation rate respectively. The summary of results based on these two different models are presented in Tables 2 and 3 and show that the findings from both models are qualitatively similar, with comparable magnitudes and signs of the coefficients. We also carry out additional analysis in Tables 4 and 5, where the Uganda Shilling per US Dollar exchange rate as well as the Kenya Shilling per US Dollar exchange rates are replaced with the Uganda Shilling per Kenya Shilling foreign exchange rate and find that the results of this analysis are also consistent with the previous analysis. In addition, we also checked the robustness of the volatility spillover analysis by comparing the results of the generalized variance decomposition proposed by Diebold and Yilmaz (2012) with the Cholesky factorization approach of Diebold and Yilmaz (2009)[2]. Since the results of the Cholesky factorization approach crucially depend on the ordering of the variables, it is not suitable for assessing pairwise and total directional connectedness, but it should be robust for total connectedness. The results of the total return and volatility spillover measures for the generalized variance decomposition approach and the Cholesky factorization are quite similar.

[2]The detailed Cholesky factorization analyses are not reported in this paper, but can be requested from the author.

6. Conclusions and recommendations

The objective of this paper was to empirically investigate the international spillover effects of US monetary policy shocks on developing countries such as Kenya and Uganda. Specifically, the study examines the impact of US monetary policy spillovers, proxied by the US Federal funds rate and US inflation, on Uganda and Kenya's inflation rates, interest rates and the exchange rates, key macroeconomic indicators of importance to macroeconomic stability, using the Generalized Vector Autoregressive framework proposed by Diebold and Yilmaz (2012) to quantify spillovers across the selected economies' markets. In line with the extant literature, the analyses of time-varying return and volatility spillovers reveal limited spillovers until the onset of the global financial crisis in 2007–2008 as evidenced by the behavior of the total spillover index before and after this crisis. In addition, total volatility spillover indices also reveal sharp increases volatility spillovers during periods of high uncertainty and market crises, particularly during the Global financial crisis of 2007–2008 and the European sovereign debt crisis period between 2010 and 2012. Thus the evidence points to the existence of significant international return and volatility spillovers the selected economies' markets. Further, the time varying analysis shows spillovers vary over time, with a steady increase that return and volatility spillovers following crisis periods. Also volatility spillovers are especially amplified during global crises periods.

The main results of the paper suggest that international spillovers from global economies like the US are significant in determining macroeconomic stability in developing countries such as Uganda and Kenya, underscoring the importance of international policy coordination. The study also finds that once the US dollar exchange rate is controlled for, return and volatility spillovers appear to be smaller in magnitude, suggesting that despite the concerted effort towards regional integration, the US dollar remains a major link to global markets in African economies. In addition, the pattern of transmission of macroeconomic shocks across borders appears to have changed in magnitude after the global financial crisis, an indication that the ongoing study of spillover effects between markets is important for policy makers as well as market participants because their impact varies through time. The findings of the study may inform the activities of the central banks of Uganda and Kenya in their pursuit of inflation and exchange rate policies aimed at supporting macroeconomic stability, especially during crisis periods. In order to address the trend of increased excessive international return and volatility spillovers especially during crisis periods, developing countries such as Uganda and Kenya should consider intensifying regional integration efforts and also lobby for global cooperation among national policymakers so that the benefits of globalization are retained through international policy coordination.

Future research should consider other variables that may also be relevant for macro stability and/or related to risk aversion in financial markets such as the VIX which reflects market fear and the BAA-AAA spread, which also reflects general credit conditions, can be very informative about the transmission of global shocks in small economies. It would also be interesting to see the interaction of US monetary policy with some index of real activity.

Conflicts of interest

The author declares no conflict of interest.

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