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Evaluating the transition to the east african monetary union through monetary transmission mechanisms

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Abstract

This paper evaluates the feasibility of the proposed East African Monetary Union (EAMU) by examining the effectiveness of monetary transmission mechanisms (MTMs) in the region. This study aims to determine how composite and idiosyncratic shocks propagate within the East Africa Community (EAC) and assess how smaller countries respond to shocks originating from Kenya, the largest economy in the region. We employ panel structural vector autoregression methodology to explore the short- and long-term effects of the dynamics of monetary transmission mechanisms in East African countries (Kenya, Uganda, Tanzania, Rwanda, Burundi, and South Sudan) from 1980 to 2018. Our empirical results prove that in the short run, (i) the contemporaneous response of the interest rate to the output gap shock is positive, (ii) the immediate response of the inflation rate to the output gap shock is negative, and (iii) the response of the inflation rate to the interest rate shock is negative. In the long run, (i) the response of the exchange rate to output gap shock is negative, (ii) the response of the inflation rate to output gap shock is negative, (iii) the response of interest rate to exchange rate shock is positive, (iv) the response of inflation rate to exchange rate shock is negative, and (v) the response of inflation rate to interest rate shock is negative. Overall, these findings shed light on the dynamics of monetary transmission mechanisms in East African countries. The study highlights the short- and long-term effects of various shocks on key macroeconomic variables, such as interest rates, inflation, and exchange rates. These findings have important implications for policymakers, as they seek to stabilize the economy, foster sustainable growth, and fulfill their monetary policy objectives.

Keywords: Monetary transmission mechanisms, East African monetary union, Panel structural VAR, Structural shocks, Short-run and long-run impulse responses, Monetary policy

JEL Classification: E43, E52, E58, F41

Introduction

Economic integration has become a global trend, and Africa has actively embraced this concept by forming regional blocs aimed at achieving economic, social, and political liberalization. Among these blocs, the East African Community (EAC) has made significant

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progress in integrating its member states for mutual benefit. Established in 2000 through the ratification of the Arusha Treaty, the EAC initially consisted of Kenya, Tanzania, and Uganda. Over time, its membership has expanded to include Rwanda and Burundi in 2007 and South Sudan in 2016, with the Democratic Republic of the Congo joining in 2022. With widened and deepened cooperation among the partner states, the EAC has emerged as one of the fastest-growing regional economic blocs globally. The implementation of crucial protocols, such as custom unions and the common market, and the ongoing progress toward the East African Monetary Union (EAMU), have set the stage for further integration. Additionally, plans for a political federation are being expedited. The groundwork for a fully-fledged monetary union by 2024 has been laid, with member states conducting studies on macroeconomic convergence criteria and institutional frameworks. To achieve the monetary union protocol, East African countries have committed themselves to harmonizing financial systems, payment and settlement systems, statistical information standards, monetary and fiscal policies, financial accounting, and reporting practices, and the establishment of an East African Central Bank.

While the protocols for customs unions and common markets have been relatively straightforward, the protocol for establishing the EAMU presents a complex scenario involving both risks and opportunities. The potential benefits of integration include price stability; efficient resource allocation, lower transaction costs, and increased access to financial, goods, and labor markets, all of which stimulate investment, trade and regional growth, stimulating investment, trade, and regional growth. However, concerns raised by scholars, such as Drummond et al. (2015), emphasize that adopting a unified monetary policy could require countries to relinquish their national policy autonomy and potentially overlook national economic conditions in favor of the entire region. This exposes countries to asymmetric shocks, particularly given the heterogeneity in institutional, economic, and financial structures among East African countries. These existing asymmetries, nominal and real rigidities, and increased costs associated with a region-wide monetary policy could create significant challenges (Weymark 2001; Dellas and Tavlas 2005; Hallett and Weymark 2004). The adoption of a monetary union would limit individual countries' ability to use local monetary policy tools to address these shocks.

Consequently, numerous studies have been conducted to assess the feasibility of the EAMU, with a focus on macroeconomic convergence, economic homogeneity, and monetary transmission mechanisms (MTMs). Notable contributions include studies by Bayoumi and Ostry (1995), Buigut (2006), Buigut and Valev (2005), Kishor and Ssozi (2011), Mafusire and Brixiova (2012), Masson and Pattillo (2004), Mburu (2006), Mkenda (2001), and Kamaludin et al. (2013). However, recent developments have made regional dynamics more complex. According to a UNECA report (2015), Kenya is the only non-least developed country in East Africa and the largest economy in the region, benefiting from geographical advantages, relatively strong economic infrastructure, robust institutions, and a skilled labor force. Nevertheless, Kenya faces challenges related to transformation in terms of output, employment, and exports. In contrast, countries such as Burundi (the smallest economy in the EAC) and South Sudan are fragile economies recovering from civil wars (AFDB 2014), with significant economic crises and contractions in GDP. These disparities suggest that policies within a single monetary framework are likely to be anchored in the economic realities of the dominant Kenyan economy, potentially overlooking the needs of smaller economies in the region. This highlights the importance of understanding individual member states' financial structures and MTMs to formulate common policies for the EAC effectively.

Despite the importance of this topic, limited literature exists specifically on MTMs in the EAC. Earlier studies (e.g., Cheng 2006; Maturu et al. 2010; Kim and Roubini 2000; Buigut 2009; Sichei and Njenga 2012; Misati et al. 2010; Montiel et al. 2012; Adam et al. 2016; Saxegaard 2006; Mugume 2011; Sayinzoga and Simson 2006; Rutayisire 2010) provide preliminary insights, but many employees use inferior methodologies or fail to account for the potential disparities in transmission mechanisms among smaller union members. Furthermore, no studies have comprehensively analyzed the economic performance of smaller countries under different monetary policy regimes, specifically comparing independent versus unified monetary policies.

This study seeks to fill these gaps by focusing on MTMs as crucial factors in evaluating the viability of the proposed EAMU. Understanding the effectiveness of MTMs is essential for determining their impact on key economic aggregates such as output and inflation (Taylor 1995). Heterogeneous policy instruments and transmission channels pose significant challenges in designing and implementing an appropriate common policy for the region. This study specifically aims to address two main questions: (i) How are composite and idiosyncratic shocks transmitted in a region characterized by heterogeneous economic structures and macroeconomic realities? (ii) How do shocks originating from the largest economy propagate to smaller, more vulnerable countries that may be susceptible to adverse asymmetric shocks?

To achieve this goal, the study examines the transmission of composite and idiosyncratic shocks across a panel of East African countries and assesses how smaller countries respond to shocks originating from Kenya, the largest economy in the region. We employ a macro model based on the works of Dlamini (2015), Svensson (1997, 2000), and Ball (1997, 1999) and methodologies used in leading multicountry models such as McKibbin and Sachs (1988, 1989), Mckibbin and Wilcoxen (1999), and Mckibbin (1998). The model encompasses four key equations: the Phillips curve (representing the supply side), the open economy IS curve, the exchange rate equation (demand side), and Taylor's policy rule (guiding central bank actions in manipulating interest rates to achieve inflation and output objectives).

The novelty of this research lies in its use of the PSVAR model, which allows us to analyze shocks in a multi-country setting with a focus on a developing region such as East Africa. Unlike previous studies, our research applies this advanced methodology to a group of smaller economies facing asymmetric shocks, which have not been thoroughly investigated before. The study also fills a gap in the literature in that it analyzes the region's susceptibility to external shocks, particularly from Kenya, using both common and idiosyncratic shocks, as explained in the results section. This distinction and focus make the work novel and impactful. Specifically, this research integrates EAC countries through a model that links goods markets, inflation rates, and interest rates to analyze the propagation of shocks. Kenya is used as the baseline economy due to its prominence and trade relationships within the region. The study assesses whether a single monetary policy can work effectively for the EAC, given its heterogeneous economic structures and strong interdependencies. Different policy regimes are evaluated, and simulations are conducted to compute the volatilities under both unified and independent policy regimes, allowing us to determine which policy performs more effectively.

This study stands out as the first to apply a macro model to analyze shock propagation in a relatively advanced country within the region and its impact on smaller economies. Additionally, this paper is unique in evaluating the performance of smaller countries in a monetary union under both independent and common policy regimes. Furthermore, unlike previous studies that employed SVAR, Bayesian VAR, and factor-augmented VAR, our study introduces a method known as P-SVAR, which has not been used before in regional studies. By comparing the results obtained from the macro model with those derived from the P-SVAR approach, we offer robust insights into the viability of a unified monetary policy in the region.

Our findings indicate that in the short run, the interest rate responds positively to an output gap shock, whereas in the long run, the exchange rate and inflation exhibit negative responses to the same shock. Furthermore, the interest rate responds positively to exchange rate shocks, whereas inflation reacts negatively to both exchange rate and interest rate shocks. The results also show that a structural shock in Kenya's exchange rate has a limited effect on the output gap but significantly influences interest and inflation rates. These findings align with the broader literature, further validating the reliability of our results.

The subsequent sections of the paper provide the theoretical framework for the optimal currency areas that underpin the study and further delve into an examination of the literature, encompassing studies conducted at both the country and cross-country levels. This is followed by an explanation of the empirical approach using the PSVAR models. The paper then proceeds to showcase the outcomes of the analysis, offering a comprehensive presentation of the results. Finally, the last sections of the paper encompass a discussion of the findings, as well as the concluding remarks and policy recommendations.

Theoretical framework for the optimal currency areas

The theoretical framework for optimal currency areas (OCA) provides a foundational understanding of the conditions under which monetary unions can operate effectively. Initially introduced by Mundell (1961), the concept has evolved over the past few decades to include traditional and new theoretical approaches. This section outlines key developments while incorporating recent research on the synchronization of business cycles and the implications for monetary policy transmission mechanisms.

A key criterion for evaluating the feasibility of an OCA is the synchronization of business cycles among participating economies. De Haan et al. (2008) examine business cycle synchronization within the European Monetary Union (EMU) and address two fundamental questions: whether business cycles have exhibited greater convergence over time and which factors drive this synchronization. Their findings suggest that while the euro area has experienced periods of both convergence and divergence, there is strong evidence of increased synchronization during the 1990s. Trade intensity is identified as a major driver of business cycle synchronization, although the magnitude of its effect varies significantly across countries. The influence of other potential determinants remains inconclusive, indicating the complexity of synchronization mechanisms in a monetary union. These findings contribute to the OCA literature by reinforcing the notion that deeper economic integration facilitates cyclical alignment, thereby enhancing the stability and effectiveness of a common currency area.

Robert Mundell's (1961) pioneering stationary expectations model emphasized factor mobility, such as the free movement of labor and capital, and price flexibility as a prerequisite for a successful currency union. According to Mundell, these factors help mitigate the need for nominal exchange rate adjustments during economic disturbances, especially when shocks are symmetric. In his later "International Risk-Sharing Model", Mundell (1973) highlighted the role of financial integration in smoothing asymmetric shocks, suggesting that capital market diversification could enhance resilience in monetary unions.

Other early proponents expanded these ideas. Mckinnon (1963) posited that greater economic openness facilitates faster transmission of devaluation effects, reducing reliance on exchange rate adjustments. Kenen (1969) emphasized production and consumption diversification as shock absorbers, whereas Ishiyama (1975) underscored inflation and wage stability as indicators of synchronized economic structures.

While foundational, these traditional criteria have been criticized for their lack of precision and applicability across diverse contexts. The ambiguity in defining and measuring factors such as shock symmetry and factor mobility has led to calls for a more comprehensive analytical framework.

In response to these criticisms, a new strand of OCA theory emerged in the 1990s, focusing on cost–benefit analysis and empirical assessments of monetary unions. This framework integrates diverse criteria, including the synchronization of business cycles, as a central determinant of optimal currency areas.

De Grauwe (1992) and Tavlas (2004) emphasized the role of monetary policy in stabilizing asymmetric shocks, whereas Bayoumi and Eichengreen (1997) used econometric modeling to assess the feasibility of currency unions. Frankel and Rose's (1998) "endogeneity hypothesis" further argues that trade integration fosters greater business cycle synchronization, enhancing the stability of monetary unions.

More recently, Beck (2021) provided a comprehensive review of the determinants of business cycle synchronization, highlighting factors such as trade integration, financial linkages, and institutional convergence. Stoforos et al. (2024) build on this by synthesizing the latest empirical evidence, demonstrating that fiscal coordination and structural reforms are critical for achieving synchronization. These studies underscore the evolving understanding of OCA criteria in light of globalization and economic interdependence.

The synchronization of business cycles is essential for the smooth functioning of a monetary union, as it reduces the risks associated with asymmetric shocks. Studies such as De Hann et al. (2008) and Beck (2022) highlight the interplay between monetary policy coordination and business cycle alignment. For example, Sethapramote (2015) demonstrated that coordinated monetary policies in ASEAN countries have strengthened business cycle synchronization among member states. Similarly, Chang et al. (2013) explore how shared monetary policies in developed economies foster economic stability by minimizing divergences in cyclical fluctuations.

The introduction of a common currency further amplifies these dynamics by eliminating exchange rate uncertainties and fostering deeper economic integration. However, robust institutional mechanisms are needed to ensure effective policy transmission and mitigate asymmetries. Beck (2021, 2022) highlights the importance of monetary policy linkages in harmonizing economic responses within monetary unions, offering valuable insights into the conditions under which such arrangements succeed.

By integrating both traditional and new OCA theories, along with contemporary research on business cycle synchronization and monetary policy coordination, this framework provides a robust basis for analyzing the viability of monetary unions. The recent emphasis on empirical studies and policy linkages offers actionable insights into how monetary unions can achieve stability and resilience in an increasingly interconnected global economy.

Literature review

Investigating the effects of monetary dynamics on the economy has always been of interest to researchers (Nzimande and Ngalawa 2017a, 2017b; Abdulqadir et al. 2020; Abdulqadir et al. 2020; Omoshoro-Jones and Bonga-Bonga 2020; Abdulqadir 2022; Bilgili et al. 2022; Miles 2022; Beck and Nzimande 2023).

Kenya and Cheng (2006) employ both recursive and non-recursive structural autoregressive (SVAR) models to empirically demonstrate the presence of traditional transmission channels for the period 1997–2005. The study argues that contractionary monetary policy initially leads to a price puzzle, followed by a statistically significant decline in prices over the next two years. An increase in output ensues, resulting in an output puzzle, which eventually subsides considerably. Interest rate shocks are found to explain approximately 30% of inflation dynamics and 10% of output fluctuations, aligning with the findings of impulse response analysis. With respect to interest rates, shocks are associated with initial depreciation followed by appreciation, indicating an influence on the exchange rate through inflation.

In contrast to Cheng (2006), Maturu et al. (2010) treat the broader money aggregate (M3) as a policy instrument, using a methodological approach similar to that of Cheng (2006) but for quarterly data from 2000 to 2010. Their results show statistically insignificant effects of exogenous shocks to M3. Additionally, expansionary monetary policy does not significantly impact real output, but it does lead to a rise in prices for approximately one and a half years.

In contrast to Cheng's findings, Maturu et al. (2010) also observe that a positive shock to the interest rate leads to falling prices with statistically insignificant effects. In both cases, the study employs Kim and Roubini's (2000) non-recursive SVAR model, obtaining similar results to those of the recursive model. While Maturu et al. (2010) make important attempts to explore different MTM channels, their methodology does not explicitly emphasize these channels, and no studies have endeavored to examine the relative importance of various channels.

Buigut (2009) conducted a study using yearly data on inflation, real output, and short-term interest rates for the founding members of the EAC between 1984 and 2006. The findings suggest a weak interest rate transmission mechanism, indicating that shocks to the interest rate do not significantly affect output or inflation. Furthermore, Buigut (2010) applied the vector error correction model to analyze the transmission of monetary policy in Kenya from 1979 to 2008. The results demonstrate the occurrence of a price puzzle, as predicted by Sims (1992). The research postulates that monetary tightening constrains banks' lending capacity, thereby compelling bank-dependent borrowers to curtail their investment activities. Furthermore, it demonstrates that the transmission mechanism of restrictive monetary policy extends beyond conventional interest rate channels, operating through direct constraints on bank credit extension.

Sichei and Njenga (2012) examine annual data from 37 banks in Kenya to investigate whether credit performs better through loan demand or supply, considering banks of different sizes and ownership systems. The study reveals that regardless of the bank's size or ownership structure, credit demand is not responsive to lending rates. However, monetary contractions lead to a reduction in loan supply, suggesting the presence of credit rationing. This finding suggests that the credit channel plays a more significant role in Kenyan monetary policy than price levels do, as it impacts large banks, which account for approximately 82% of total credit.

Misati et al. (2010) employ single equation methods to explore the role of financial innovation in the effectiveness of monetary policy in Kenya from 1996 to 2007. Financial innovations are proxied by the ratio of M2 to M1 and bank assets to GDP. The results indicate that financial innovations in Kenya have weakened the impact of the repo rate on GDP (output), thereby diluting the effectiveness of monetary policy transmission.

Buigut (2009) analyzes Tanzania's economy via SVAR models and annual data spanning 1984 to 2005. The results indicate that interest rate shocks have minimal impacts on output and inflation. However, the study's limited number of observations results in wide confidence intervals, which could account for these findings. Montiel et al. (2012) carried out a more comprehensive study from January 2002 to September 2010 to investigate MTMs in Tanzania. Their findings show that reserve money significantly impacts inflation rates in a recursive VAR model. Adam et al. (2016) adopt a single-equation approach to study inflation, and their results indicate that M3 has both short- and long-term effects on price levels.

Regarding Uganda, Peiris (2005) finds that a shock to M2 leads to inflationary pressures, whereas a shock to interest rates does not appear to significantly affect any variable. The study employs a six-variable recursive VAR model, although confidence intervals for the impulse responses are not provided, limiting the inclusiveness of the insights. In contrast, Saxegaard (2006) uses a threshold VAR model to examine MTMs in Uganda from 1990 to 2004. The study reveals that contractions in the money supply negatively and significantly affect inflation (CPI), and this impact is more pronounced when commercial banks exhibit low involuntary excess liquidity.

In contrast, Mugume (2011) employs SVAR models between 1999 and 2009 to demonstrate that all MTM channels in Uganda are ineffective. While it is noticeable that changes in Treasury bill rates transmit to lending interest rates, the influence of the interest rate channel is weak.

Few studies have been conducted in Rwanda, and no attempts have been made to study MTMs in Burundi and South Sudan. Implicit studies on Rwanda and Burundi, conducted by Sayinzoga and Simson (2006) and Rutayisire (2010), focus on the stability of money demand functions in Rwanda. The study of MTMs is essential for informing policy and guiding the East African Monetary Union (EAMU) project. However, the existing studies primarily serve as exploratory perspectives, lacking the intention of utilizing insights within the context of a fully unified monetary region. Furthermore, the studies are limited in scope, with some EAC candidates having no studies available. Therefore, expanding the study of MTMs to encompass the broader EAC region is crucial.

To analyze the potential feasibility of the East African Community, several cross-country studies have examined the implications of monetary integration in the EAC region, particularly focusing on the effectiveness of monetary transmission mechanisms (MTMs).

The seminal work by Bayoumi and Ostry (1995) highlights the importance of macroeconomic shocks and their impact on the viability of regional currency arrangements. This study emphasizes the need for robust MTMs to ensure the stability and sustainability of a monetary union. Buigut and Valev (2005) delve deeper into the analysis of MTMs in the EAC, emphasizing the role of monetary policy in transmitting shocks and fostering convergence among member economies.

A notable contribution by Kishor and Ssozi (2011) focuses on examining whether the EAC region qualifies as an optimal currency area. The study evaluates the degree of economic integration and homogeneity among member states, considering factors such as trade linkages, business cycles, and labor mobility. This study provides insights into the challenges and opportunities associated with monetary integration in the EAC.

A recent study by Garang and Erkekoglu (2020) investigated the feasibility of the proposed East African Monetary Union (EAMU) by analyzing business cycle synchronization, structural correlations, spectral decomposition, and regional clusters in East African countries. They found that cyclical movements are influenced by various shocks, with South Sudan and Burundi showing structural independence. Their study underscores the need for regional risk-sharing policies, adjustment mechanisms, and credible institutional infrastructure for EAMU success.

Mafusire and Brixiova (2012) explores the issue of asymmetric shocks and synchronization within the EAC. The study highlights the importance of addressing asymmetries among member economies to ensure effective MTMs and enhance the resilience of a monetary union. This underscores the need for policies that can mitigate the adverse effects of shocks on smaller and more vulnerable economies in the region.

Several studies have also examined the feasibility of monetary unions in other African regions. Masson and Pattillo (2004) analyze the West African Monetary Union and highlight the importance of fiscal discipline in maintaining the viability of a monetary union. Montiel et al. (2012) explore the feasibility of monetary union among Gulf Cooperation Council (GCC) countries, shedding light on the implications of common monetary policies in a different regional context.

The literature review indicates that while there is a growing body of research on the potential feasibility of a monetary union in the EAC, there are still significant gaps and challenges to address. Factors such as heterogeneity among member economies, asymmetric shocks, and the effectiveness of MTMs require careful consideration. Additionally, the studies reviewed often focus on a specific country within the EAC or provide broader regional analysis without fully capturing the nuances of each member state. To advance the understanding of the potential feasibility of a monetary union in the EAC, future research should aim to incorporate more comprehensive and up-to-date data, adopt robust econometric methodologies, and account for the specific economic characteristics of individual member states. Furthermore, examining the implications of

Table 1 Literature review

Authors	Country	Data	Key variables	Methodology	Main findings
Cheng (2006)	Kenya	Monthly data (January 1997– June 2005)	Real GDP, inflation, interest rates, M0 and M3, oil prices, U.S. federal rates of federal funds, commodity prices, repo, interbank rates, and NEER	Recursive and Structural VARs	A positive shock (i) leads to no significant influence on the output, (ii) first increases inflation and permanently leads to price falls, (iii) first leads to a significant depreciation in the exchange rate and subsequent persistent appreciation of the exchange rate. The ratio of interest rate shocks in forecast error variances of various variables was as follows: 33% of inflation, 50% of NEER, and 10% of output
Maturu et al. (2010)	Kenya	Quarterly data (2000q1–2010q2)	Real GDP, inflation, interest rates, M0 and M3, oil prices, U.S. federal rates of federal funds, commodity prices, repo, interbank rates, and NEER	Recursive and structural VARs	A negative shock to M3 leads to (i) the marginal decline in output, (ii) a decline in the price level that is statistically significant for up to four years, (iii) insignificant appreciation of the exchange rate, (iv) an insignificant rise in interest rate The ratio of M3 shocks in forecast error variances of various variables was as follows: 30% of inflation and 4% of output
Buigut (2010)	Kenya	Annual data (1979–2008)	Real private sector credit, real GDP, lending rate, and T-bill rate	VECM	A positive shock to the T-bill rate leads to (i) price puzzle, (ii) marginal negative effect on real GDP, (iii) permanent fall in loan quantity while loan rates respond positively. Confidence bounds of the Impulse responses are not shown
Misati et al. (2010)	Kenya	Monthly data (1996m1–2007m2)	The output gap, the real repo rate, the ratio of bank assets to GDP, and the ratio of M3 to M1	Single equation methods: ARDL and 2SLS	It underlines (i) the contractionary monetary effects, (ii) the average effect of the negative interest rate

Table 1 (continued)

Authors	Country	Data	Key variables	Methodology	Main findings
Sichei and Njenga (2012)	Kenya	Annual data (2001–2005)	Bank private credit, private deposit, prudential and liquidity measures, total bank reserves, and total capital ratio	Static panel data estimation: 3SLS	Concludes that (i) bank lending channels are stronger than lending rates, (ii) the credit of small, less capitalized, and less liquid foreign-owned banks is more responsive to lending rates
Buigut (2009)	Founding 3 EAC	(1984–2005)	Real GDP, CPI Inflation, and T-bill rate (discount rate for Tanzania)	Recursive VAR	The interest rate channel is weak, and the interest rate does not significantly affect output and inflation in all countries in the sample
Baldini, Poplawski- Ribeiro (2011)	EAC-5	(1980–2005)	Real GDP, CPI (GDP deflator), and reserve money (discount rate)	Recursive VAR	A positive shock to the reserve money (i) affects inflation both negatively and positively, depending on the horizons, although Burundi is affected positively, (ii) results in no confidence bounds shown for impulse responses The ratio of reserve shocks in forecast error variances of various variables was as follows: 4% of inflation in Rwanda, 5% in Burundi, 13% in Uganda, 15% in Tanzania and 31% in Kenya
Montiel et al. (2012)	Tanzania	Monthly data (December 2001–May 2010)	Exchange rate, reserve money, and price level (ordering in the six-variable VAR: exchange rate, broad money, reserve money, loan rate, price level, and output)	VAR	An expansionary monetary policy leads to (i) a rise in the inflation price level in all the models, (ii) no output and prices affect either VAR model
Saxegaard (2006)	Uganda	Quarterly data (1990q1– 2004q2)	The deposit rate, lending rate, ratio of excess reserves to total deposits, private credit to GDP ratio, and the output gap	Threshold VAR	Concludes that (i) MT is weakened by the existence of excess reserves that lessen the negative effect of monetary contraction on prices, (ii) it is evidence of low MTM in Uganda due to high excess reserves

Table 1 (continued)

Authors	Country	Data	Key variables	Methodology	Main findings
Mugume (2011)	Uganda	Quarterly data (1999q1–2009q1)	Real GDP, CPI, broad money, three-month T-bill rate, interest rate, nominal exchange rate, and credit to the private sector	Recursive VAR	A contractionary monetary policy leads to (i) low output and inflation, (ii) weak credit, and exchange rate interest rate channels Innovation in M2 does not significantly affect output and inflation
Peiris (2005)	Uganda	Monthly data (1993m6– 2004m6)	International oil prices, coffee prices, output gap, exchange rate, monetary aggregate (or interest rate), and consumer prices	Recursive VAR	A 1% increase in M2 leads to a 0.2 percent rise in core inflation in three months

different policy regimes and conducting comparative analyses between independent and unified monetary policy frameworks would provide valuable insights into the economic performance and stability of smaller countries within the union. In conclusion, the cross-country analysis of the potential feasibility of the EAC via monetary transmission mechanisms offers valuable insights into the challenges and opportunities associated with monetary integration in the region. While progress has been made in understanding the implications of MTMs and addressing macroeconomic convergence, further research is needed to effectively evaluate the viability of a monetary union in the EAC and develop appropriate policy frameworks for successful integration. A summary of the literature is provided in Table 1 below.

Data and methodology

This paper employs panel data for the East African Community (EAC). The cross-sections of the panel are Kenya, Uganda, Tanzania, Rwanda, Burundi, and South Sudan. The data were obtained from the International Financial Statistical (IFS) Yearbook (2019) and range from 1980 to 2018. The panel data include the output (GDP) gap, the official exchange rate (LCU per US$, period average), the real interest rate (%), and inflation (annual % consumer prices).

The theoretical framework of the variables is as follows:

Output gap: The output gap is an economic measure of the difference between an economy's actual output and its potential output (Jahan and Mahmud 2013). Potential output refers to the productive capacity of an economy when it is operating at the natural rate of unemployment. Since individuals regularly change jobs in the labor market, the natural rate of unemployment is assumed to be greater than zero. This implies that there will always be a certain level of unemployment in the economy. Therefore, potential output is not the maximum level of output that an economy can theoretically reach but rather a sustainable and long-term level (Owyang et al. 2013).

The output gap in this study is calculated via the Hodrick–Prescott (HP) filter, which is a widely adopted method for decomposing actual GDP into its trend (potential output) and cyclical (output gap) components. The robustness of the results is assessed by comparing outcomes via alternative methods such as the Kalman filter, which yields consistent results.

In the context of the East African Monetary Union, measuring the size of the output gap is crucial for the assessment of monetary transmission mechanisms. Differences in output across countries may lead to the fact that common monetary policies may not have the same effect across member countries. Therefore, the output gap is an important indicator for analyzing heterogeneous economic conditions within a monetary union.

Exchange rate: The exchange rate is the value of one country's currency against another currency. Since the transition to a monetary union requires countries to abandon their national currencies and use a common currency, the importance of exchange rate fluctuations decreases (Feldstein 1997). During the transitional period, a newly introduced currency is likely to exhibit fluctuations relative to global currencies, which may act as a buffer against region-wide economic shocks. These dynamic underscores the importance of robust exchange rate policies during the initial stages of monetary union implementation.

In theory, exchange rate regimes have a direct effect on monetary transmission mechanisms (Mishkin 1995). Under fixed exchange rate regimes, the ability of central banks to conduct an independent monetary policy is limited, which can affect inflation and interest rates (Mundell 1963; Fleming 1962). In a monetary union, countries abandoning their exchange rate policies cannot affect their import and export balances and consequently the price level (Lane 2006).

Interest rate: Interest rates are among the most important macroeconomic variables that directly affect savings, investment, and consumption decisions in an economy (Woodford 2003; Mankiw 2020). Central banks attempt to achieve macroeconomic objectives such as inflation and economic growth by controlling interest rates through monetary policy.

In the East African Monetary Union, the aim is to establish a common central bank and apply a single interest rate across member countries. In this case, interest rate policy may ignore the specific economic conditions of countries, which may have favorable or unfavorable consequences for some countries. The impact of interest rates, especially in combination with other variables such as the output gap and the exchange rate, is a key element in analyzing the transmission mechanisms of monetary policy.

Inflation rate: Inflation is a key variable in monetary transmission mechanisms, influencing price stability and purchasing power within the context of regional monetary integration.

Harmonization of inflation rates is highly important in the process of transition to a monetary union (Morales 2014). When a monetary union is established between countries with different inflation dynamics, a common monetary policy may not achieve the desired inflation targets in all member countries (Spitzer 2023). Therefore, convergence of inflation rates and common policy implementation are crucial factors for the success of a monetary union.

These four variables interact as key factors shaping the functioning of monetary transmission mechanisms. Especially for new organizations such as the East African Monetary Union, a proper understanding of the dynamic relationships between these variables is crucial for a successful integration process and macroeconomic stability.

In the analysis, first, the panel variables of the output gap (OG), exchange rate (EXC), interest rate (INT), and inflation rate (INF) are considered within the panel structural VAR (PSVAR) system. The purpose is to observe the responses of the variables to the structural innovations of other variables in the system. Second, the paper aims to analyze the responses of panel variables to structural shocks in the variables of Kenya within the PSVAR. Detailed information on the variables is presented in Table 2.

SVAR models are useful tools for analyzing the dynamics of a model by subjecting it to an unexpected shock (Gottschalk 2001). The SVAR model is widely preferred in the literature for analyzing different variables (Kilian 2009: oil prices into three components: oil supply shocks, aggregate demand shocks, and oil-specific demand shocks; Oyadeyi and Akinbobola 2022: inflation, unemployment, interest rate; Sanusi and Dickason-Koekemoer 2025: foreign private investment, stock prices, and financial development; Regmi et al. 2025: farm income, energy prices, exchange rates, and agricultural market).

Table 2 Data and variable descriptions

Variable	Related literature	Data source
Output Gap	Grigoli et al. (2015)	International Financial Statistical (IFS) Yearbook (2019) https://data.imf.org/?sk=4c514d48-b6ba-49ed-8ab9-52b0c1a0179b
Exchange Rate	Gnangnon (2023)	
Interest Rate	Ghauri et al. (2022)	
Inflation Rate	Oyadeyi and Akinbobola (2022)	

According to Breitung et al. (2004) and Lütkepohl (2006), the structural vector autoregressive (SVAR) model is mainly based on the VAR model structure. The SVAR model allows us to observe the output of impulse–response functions by introducing short- and long-term constraints to the model's calculation process. In this context, the panel SVAR model is estimated by following the VAR model to the lag order of p (Lee et al. 2012) as follows.

$$Ax_{it} = v_i + A_1x_{it-1} + A_2x_{it-2} + \cdots + A_px_{it-p} + Be_{it} = A(L)X_{it} + vi + u_{it} \quad (1)$$

where i and t represent the countries (cross-sections) and years, respectively. The term x_{it} is an $k \times 1$ vector that includes the panel variables of OG, EXC, INT, and INF; A_i (i = 0, 1, p) denotes an $k \times k$ coefficient matrix; p is the order of SVAR; B is a matrix of kxk, which includes the coefficient of a separate contemporaneous shock to each variable; L is a lag operator; v_{i} denotes the individual effect (kx1); and u_{it} represents a vector of the error term (kx1).

$$\Gamma_0x_{it} = \Gamma_1x_{it-1} + \Gamma_2x_{it-2} + \cdots + \Gamma_px_{it-p} + u_{it} \quad (2)$$

$$\Gamma_i = A^{-1}A_i$$

In Eq. (2), Γ is the parameter of the structural parameters ($k \times k$), and u_t is the parameter with a normal distribution with zero mean and constant variance, showing structural shocks. $\Gamma(K) = \Gamma_0 - \Gamma_1K - \Gamma_2K^2 - \cdots - \Gamma_{\mathrm{p}}K^{\mathrm{p}}$ follows the autoregressive polynomial process with an optimal lag order. The normalized form of the variance–covariance matrix of the structural error term is given below.

$$E(u_t\dot{u}_t) = \sum_u = I_k \quad (3)$$

Equation (3) depicts the structural shock of the variables in the model. Additionally, by definition, structural shocks are mutually unrelated. Finally, the variance of all structural shocks is normalized to be constant. Assuming that Γ_0 is invertible, Eq. (4) estimates the structural model.

$$x_{it} = \Gamma_0^{-1}\Gamma_1x_{it-1} + \Gamma_0^{-1}\Gamma_2x_{it-2} + \cdots + \Gamma_0^{-1}\Gamma_px_{it-p} + \Gamma_0^{-1}u_{it} \quad (4)$$

In Eq. (4), i refer to Kenya, Uganda, Tanzania, Rwanda, Burundi, and South Sudan, respectively. The term t depicts the period from 1980 to 2018. X_{it} vectors include the variables output gap (OG), exchange rate (EXC), interest rate (INT), and inflation rate (INF).

Thus, the response of each element of each x_t to the impact of u_t can be obtained (Behrendt 2017). To have a stationary VAR system, the differences in the relevant variables are as follows. The restrictions (A_{ij}) are shown in Eq. (5) and Eq. (6):

$$\begin{pmatrix} X_{it}^{OG} \\ X_{it}^{EXC} \\ X_{it}^{INT} \\ X_{it}^{INF} \end{pmatrix} = \begin{pmatrix} A_{11}(L) & 0 & 0 & 0 \\ A_{21}(L) & A_{22}(L) & 0 & 0 \\ A_{31}(L) & A_{32}(L) & A_{33}(L) & 0 \\ A_{41}(L) & A_{42}(L) & A_{43}(L) & A_{44}(L) \end{pmatrix} \begin{pmatrix} e_{it}^{OG} \\ e_{it}^{EXC} \\ e_{it}^{INT} \\ e_{it}^{INF} \end{pmatrix} \tag{5}$$

In Eq. (5), ΔX_{it}^{OG} is the change (difference) in the *OG*, ΔX_{it}^{EXC} is the change in *EXC*, ΔX_{it}^{INT} represents the change in *INT*, and ΔX_{it}^{INF} refers to the change in *INF*. The PSVAR model given in Eq. (5) is used to monitor the output of panel short-term and panel long impulse response matrix estimations. Equation (6) observes the output of panel short-run and panel long responses to, e.g., impulses of Kenya's exchange rate ($e_{it}^{EXC\_K}$).

$$\begin{pmatrix} X_{it}^{OG} \\ X_{it}^{EXC\_K} \\ X_{it}^{INT} \\ X_{it}^{INF} \end{pmatrix} = \begin{pmatrix} A_{11}(L) & 0 & 0 & 0 \\ A_{21}(L) & A_{22}(L) & 0 & 0 \\ A_{31}(L) & A_{32}(L) & A_{33}(L) & 0 \\ A_{41}(L) & A_{42}(L) & A_{43}(L) & A_{44}(L) \end{pmatrix} \begin{pmatrix} e_{it}^{OG} \\ e_{it}^{EXC\_K} \\ e_{it}^{INT} \\ e_{it}^{INF} \end{pmatrix} \tag{6}$$

In Eq. (6), ΔX_{it}^{OG} represents the change in *OG*, $\Delta X_{it}^{EXC\_K}$ represents the change in Kenya's exchange rate (*EXC_K*), ΔX_{it}^{INT} represents the change in *INT*, and ΔX_{it}^{INF} represents the change in *INF*. The structural shocks and impulse responses are estimated through the A and B matrices.

$$A = \begin{pmatrix} 1 & 0 & 0 & 0 \\ NA & 1 & 0 & 0 \\ NA & NA & 1 & 0 \\ NA & NA & NA & 1 \end{pmatrix}, B = \begin{pmatrix} NA & 0 & 0 & 0 \\ 0 & NA & 0 & 0 \\ 0 & 0 & NA & 0 \\ 0 & 0 & 0 & NA \end{pmatrix} \tag{7}$$

$$\begin{bmatrix} 1 & 0 & 0 & 0 \\ a_{21} & 1 & 0 & 0 \\ a_{31} & a_{32} & 1 & 0 \\ a_{41} & a_{42} & a_{43} & 1 \end{bmatrix} \begin{bmatrix} u_t^{OG} \\ u_t^{EXC} \\ u_t^{INT} \\ u_t^{INF} \end{bmatrix} = \begin{bmatrix} b_{11} & 0 & 0 & 0 \\ 0 & b_{22} & 0 & 0 \\ 0 & 0 & b_{33} & 0 \\ 0 & 0 & 0 & b_{44} \end{bmatrix} \begin{bmatrix} e_t^{OG} \\ e_t^{EXC} \\ e_t^{INT} \\ e_t^{INF} \end{bmatrix} \tag{8}$$

Following Eq. (1), Eq. (2), and Eq. (4), the relationship between the structural and reduced-form error terms or shock is written as:

$$u_t = A^{(-1)} B_{(e_t)} \rightarrow or\, A_{(u_t)} = B_{(e_t)} \tag{9}$$

Monitoring the descriptive statistics before SVAR analyses is important for understanding the size, center, and spread of the data. Table 3 presents the descriptive statistics of Kenya's variables. EXC-Kenya has the highest mean value, and OUTG_Kenya has the smallest mean value among the other variables in Table 7. On the other hand, INT-Kenya has a smaller Std. deviation value than the other variables do. EXC_Kenya has higher mean, median, and standard deviation values in the table. INF-Kenya follows the second-highest values of the mean and median.

Table 4 reveals the outputs of the descriptive statistics of the panel variables. EXC has the highest mean, median, and standard deviation values. Although OG seems

Table 3 Descriptive statistics of Kenya's variables

	EXC_KENYA	INF_KENYA	INT_KENYA	OUTG_KENYA
Mean	56.87998	11.97258	7.366321	−1.231886
Median	67.31764	9.980025	6.606220	1.034329
Maximum	103.4109	45.97888	21.09633	21.32804
Minimum	7.420187	1.554328	−8.009867	−45.55640
Std.Dev	30.67967	8.477022	6.421808	13.07146
Skewness	−0.300514	1.975373	0.096271	−0.959771
Kurtosis	1.679033	7.869592	2.881475	4.713096
Jarque–Bera	20.53534	383.3829	0.498430	64.53859
Probability	0.000035	0.000000	0.779413	0.000000
Sum	13,309.92	2801.583	1723.719	−288.2612
SumSq.Dev	219,309.4	16,743.36	9608.832	39,811.12
Observations	234	234	234	234

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Following equations from (1) to (9), the next section reveals the outputs of the panel structural VAR estimations

to have a relatively smaller mean and median in absolute values than EXC and INF do, it has the second-largest standard deviation value among the panel variables.

If the means and medians were similar, the data summarized in the tables would be symmetric. The greater the variation in the sample is, the more points will be spread out from the center of the data. The deviations between the mean and median are apparent in the panel variables. On the other hand, in Kenya's variables, the mean and median are close to each other. Hence, one might consider Table 4 variables asymmetric and Table 3 variables 'close to symmetric'. A higher standard deviation value indicates a greater spread in the data. The highest standard deviations appear in EXC_Kenya in Table 3 and EXC in Table 4. This implies that both EXC_Kenya and EXC show a greater spread in the data than do the other variables. However, INT_Kenya and INT follow a smaller spread in the data than do the other variables.

Empirical results and discussions

In our study, we build upon the literature, specifically the works of McKibbin and Sachs (1988, 1989), Mckibbin and Wilcoxen (1999), and Mckibbin (1998), by employing the PSVAR methodology within a multi-country model. This approach allows us to capture the interconnections among countries through the goods market. To examine the panel response to composite shocks, we utilize impulse response analysis.

To follow the stationary panel VAR system(s), the differences in the variables are employed. Hence, this paper monitors panel variables of the differenced output gap (DOG), the differenced exchange rate (DEXC), the differenced interest rate (DINT), and the differenced inflation rate (DINF) to discover the impacts of structural shocks in the system on the variables.

The number of lags of the variables (DOG, DEXC, DINT, and DINF) in VAR is chosen as 2 according to the VAR lag order selection criteria of the Schwarz information criterion (SC) and Hannan-Quinn information criterion (HQ) (see Table 7). The VAR system is stationary (stable) since the inverse roots of the autoregressive characteristic of VAR lie inside the unit circle (Fig. 5).

Figure 1 shows the Panel SVAR response estimates depicting the effects of composite shocks. Specifically, when confronted with contemporaneous one-standard deviation output gap shocks, the exchange rate exhibits a positive response, whereas the interest rate and inflation rate experience negative influences. The appendix provides the Panel SVAR response estimates for both common shocks and idiosyncratic shocks, which further validate the Panel SVAR response estimates for composite shocks (Figs. 6 and 7).

Analyzing the findings on the PSVAR response estimates to composite shocks (Fig. 1), we observe that when a contemporaneous one-standard deviation increase occurs in the output gap, the exchange rate initially responds with a slight positive movement up to the second period. However, it subsequently experiences a prompt decline and then becomes positive again by the fifth period. This pattern suggests that the impact of output gap shocks on the exchange rate is generally positive and significant in both the short and long term. These results are consistent with those of prior studies in the literature. For example, Engel and West (2005) find evidence that

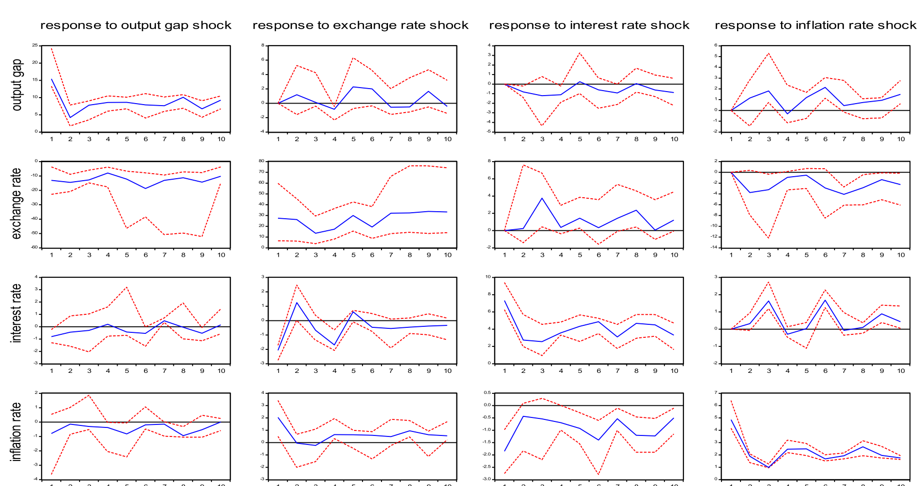

Fig. 1 Panel SVAR response estimates to composite shocks

positive output shocks lead to an appreciation of the domestic currency in the short run in a multi-country framework. They argue that this effect is driven by increased investor confidence and expectations of higher future interest rates. Additionally, Gourinchas and Rey (2007) conducted a study focusing on the impact of output shocks on exchange rates. They find that positive output shocks in the United States are associated with an appreciation of the U.S. dollar in the short run, indicating that economic expansions can lead to a stronger currency. Moreover, Forbes and Rigobon (2002) investigated the impact of output shocks on exchange rates across different countries. They find that positive output shocks lead to short-term currency appreciation, reflecting increased investor confidence and expectations of stronger economic performance, closely aligning with our findings.

In addition, the impulse response analysis reveals that a one-standard-deviation shock in the interest rate elicits a negative response in the output gap, both in the short and long term. Similarly, a positive shock in the inflation rate leads to a negative response in the output gap, both in the short and long term. These results are consistent with the negative signs observed in the PSVAR estimations. Traditional theories put forth by Friedman and Schwartz (1963), supported by Woodford (2000) and Mankiw and Reis (2002), predict that a contractionary monetary policy shock would result in a decrease in both output and inflation. However, our findings contradict this body of literature and suggest the possibility of a price puzzle, which refers to inflation arising from contractionary monetary policy. Similar findings have been established by studies conducted by Dlamini (2011), Hanson (2004), Calvo (1983), Chowdhury et al. (2006), Rabanal (2003), and Barth and Ramey (2001).

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In addition to the insights obtained from Fig. 1, which illustrates the short-term (1st and 2nd periods), medium-term (3rd and 4th periods), and long-term (5th to 10th periods) impulse responses, Table 5 shows short-run structural VAR estimates with A and B matrices and presents the immediate short-run impulse responses occurring within the same period.

Table 5 is divided into two panels. Panel I displays the A and B matrices, revealing the VAR estimates through the A matrix, which exhibits triangular structural constraints, and the B matrix, which presents diagonal constraints.

Structural VAR model, by employing restrictions and estimation of structural matrices, transforms the error terms (innovations) from VAR model into uncorrelated structural shocks. Equations (10), (11), and (12) present in short-run structural VAR estimates with A and B matrices.

$$AX_t = C + A_1^s X_{t-1} + \cdots + A_p^s X_{t-p} + Be_t \tag{10}$$

where C depicts a vector of constant terms (n × 1), A, with all of A_i^s, denotes n × n matrix of structural coefficients, p shows the order of the SVAR model, and e gives a vector of

Table 5 Short-run structural VAR estimates with A and B matrices

Panel I: A and B matrices with constraints

$$A = \begin{matrix} 1 & 0 & 0 & 0 \\ C(1) & 1 & 0 & 0 \\ C(2) & C(4) & 1 & 0 \\ C(3) & C(5) & C(6) & 1 \end{matrix}$$

$$B = \begin{matrix} C(7) & 0 & 0 & 0 \\ 0 & C(8) & 0 & 0 \\ 0 & 0 & C(9) & 0 \\ 0 & 0 & 0 & C(10) \end{matrix}$$

Panel II: Estimations of the restrictions

	Coefficient	Std. Error	z Statistic	Prob
C(1)	0.02828	0.06745	0.41927	0.675
C(2)	− 0.05361	0.00799	− 6.703.39	0.000
C(3)	0.27618	0.01284	21.4960	0.000
C(4)	− 0.00375	0.00806	− 0.46494	0.642
C(5)	− 0.00622	0.01179	− 0.52784	0.597
C(6)	0.42053	0.09943	4.22911	0.000
C(7)	76.5186	3.68150	20.7846	0.000
C(8)	75.8553	3.64959	20.7846	0.000
C(9)	8.99158	0.43260	20.7846	0.000
C(10)	13.1407	0.63223	20.7846	0.000

Model: Ae = where E[uu′] = I

Adjusted sample period: 1983–2018

Cross-sections: Kenya, Uganda, Tanzania, Rwanda, Burundi, and South Sudan

The 1st, 2nd, 3rd, and 4th columns of A and B depict the DOG, DEXC, DINT, and DINF, respectively

The number of observations is 216

Estimation method: Maximum likelihood via Newton–Raphson (analytic derivatives)

Convergence was achieved after 28 iterations

The structural VAR has just been identified

Following Eq. (12), since the estimated

structural shocks (n × 1). When each term is pre multiplied by the inverse of A ($=A^{-1}$), we obtain the reduced form of Eq. (7).

$$X_t = \theta + A_1 X_{t-1} + \cdots + A_p X_{t-p} + u_t \tag{11}$$

where $\theta = A^{-1}C$ and $A_i = A^{-1}A_i^s$ and u_t shows reduced form error terms. Equations (12)–(15) give the relationship between structural and reduced error terms as follows (Amisano and Gianni 2011; Ibrahim and Sufian 2014 Enders 2014):

$$Au_t = Be_t \tag{12}$$

$$u_t = A^{-1}Be_t \; or \tag{13}$$

$$C_i = A_i = A^{-1}A_i^s \tag{14}$$

$$u_t = Se_t \tag{15}$$

$$S = A^{-1}B \tag{16}$$

Coefficients of A are on the same side, the positive (negative) signs of the estimations should be considered negative (positive).

The structural form of the panel VAR system is presented in Matrix A. The first row of Matrix A indicates that the output gap does not respond contemporaneously to the exchange rate, interest rate, and inflation rate, but it may exhibit sensitivity to these variables with lags.

Moving to the second row of Matrix A, it states that the exchange rate responds contemporaneously to the output gap but responds to the interest rate and inflation rate with lags. Similarly, the third row reveals that the interest rate responds contemporaneously to the output gap and exchange rate, but it responds to the inflation rate with a lag. The fourth row suggests that the inflation rate responds contemporaneously to the output gap, exchange rate, and interest rate.

In Panel II, upon analyzing the estimation output, it becomes evident that the coefficients of [C(2)], [C(3)], and [C(6)] are significant and exhibit the expected signs in the contemporaneous period.

However, when the product of the AB matrix is interpreted, because the coefficients of A are expressed on the same side of the equation (Ae = Bu), the negative (positive) sign should be interpreted as positive (negative), as explained in Ibrahim and Sufian (2014).

The sign of the response of the interest rate to output gap shock (C2) is positive [(-1) *(-0.053618)]. The impulse response is contemporaneous, so the immediate response of the interest rate to the output gap shock is positive (0.053618). This is also confirmed in Figs. 1, 2, and 3. The sign of the response of the inflation rate to the output gap shock (C3) is negative [(-1) *(0.276186)]. The sign of the response of the inflation rate to the interest rate shock (C6) is also negative [(-1) *(0.420539)].

The output of Table 5 is confirmed by the output of structural VAR estimates with recursive short-run impulse response with the S triangular matrix given (Table 8).

When we estimate the same coefficients of Table 5 with recursive short-run impulse responses by the S Triangular matrix (instead of estimations from A and B matrices), we do not have to change the signs.

According to Table 8, which reveals short-term (contemporaneous) impulse responses, the contemporaneous response of the interest rate to the output gap shock is positive (4.094687). Table 8e also yields that the immediate response of the inflation rate to output gap shock is negative (-22.86881) and that the contemporaneous response of the inflation rate to interest rate shock is negative (-3.781310).

Granger causality tests also confirm the results in Table 5. According to Table 5, the A matrix estimations reveal that the estimated parameters C1, C4, and C5 are not significant. On the other hand, the estimated parameters C2, C3, and C6 are significant.

a. The DEXC does not respond significantly to the DOG (C1, 2nd row of A).
b. DINT does not respond significantly to the DEXC (C4, 3rd row of A).
c. DINF does not respond significantly to the DEXC (C5, 4throw of A).
d. DINT significantly responds to the DOG (C2, 3rd row of A).
e. DINF significantly responds to the DOG (C3, 4th row of A).

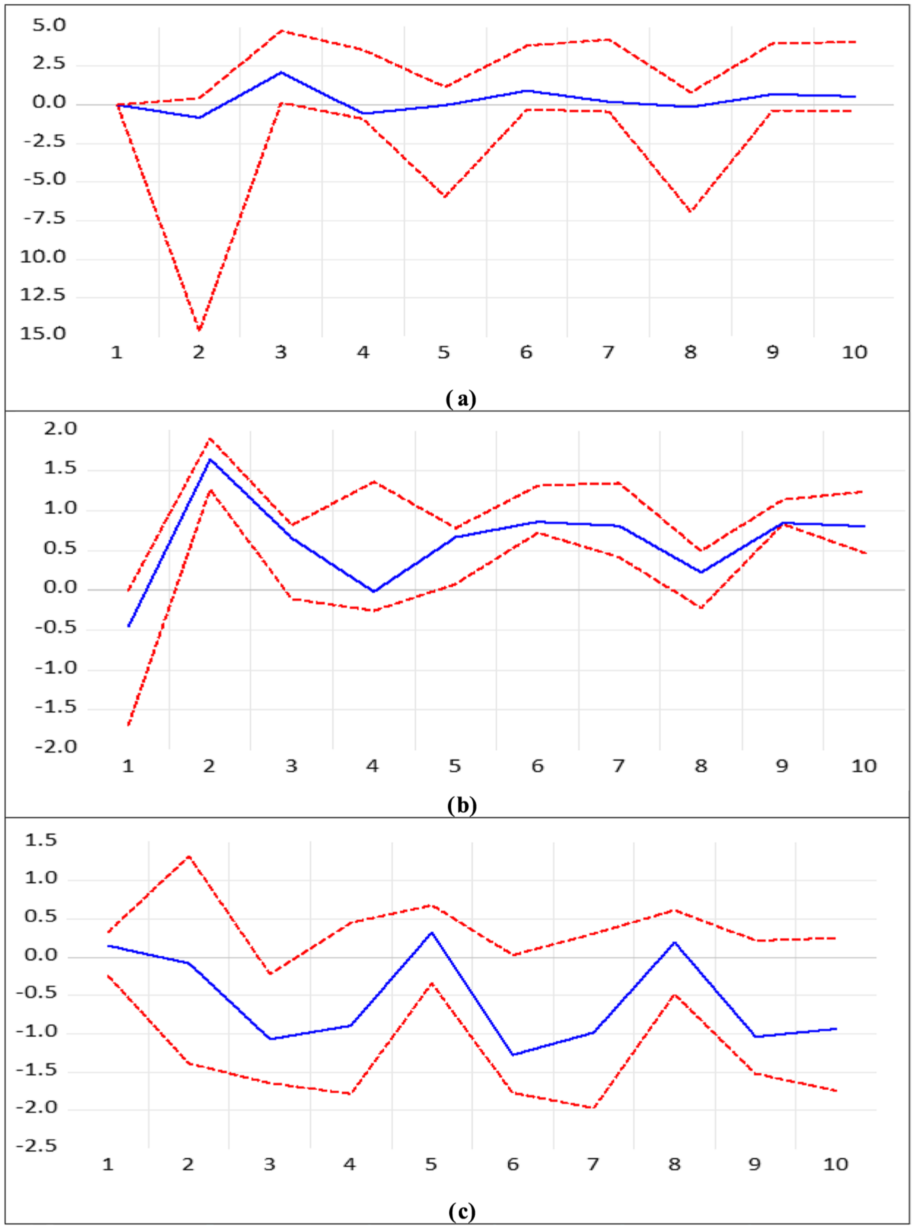

Fig. 2 Response of **a** output gap to shock in the exchange rate of Kenya, **b** interest rate to shock in the exchange rate of Kenya, and **c** inflation rate to shock in the exchange rate of Kenya. *Source* Authors' estimation (projection) from data

f. DINF significantly responds to the DINT (C6, 4th row of A).

Estimations from pairwise Granger causality tests with one lag also confirm outputs from (a) to (f), A matrix estimation (Table 9 in the appendix). Granger causality tests with lag = 2 (Table 10 in the appendix) also support impulse–response estimations from the A–B matrix given in Table 5. According to Table 10b, however, the response of DINF to DOG is significant at the 15% level.

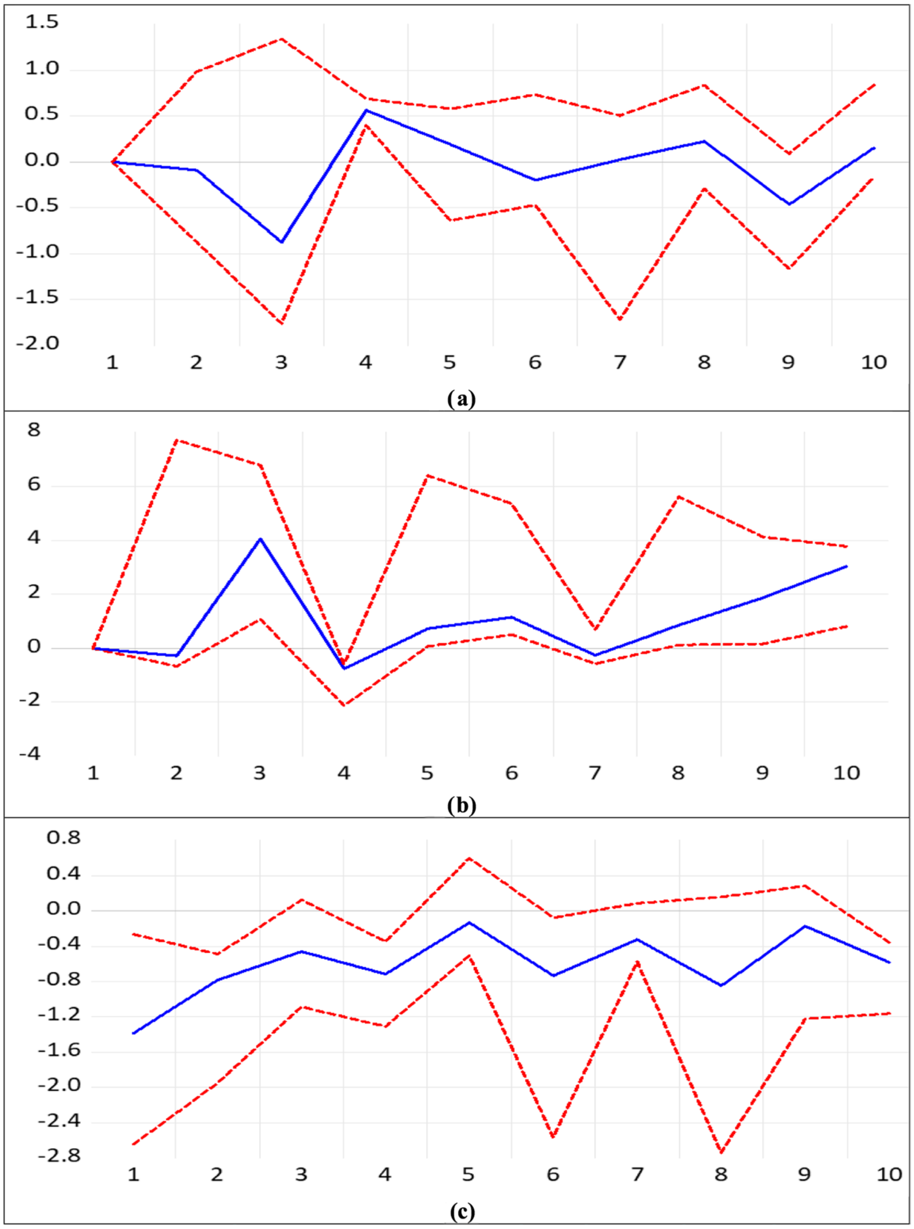

Fig. 3 Response of **a** the output gap to a shock in the interest rate of Kenya, **b** the exchange rate to a shock in the interest rate of Kenya, and **c** the inflation rate to a shock in the interest rate of Kenya. *Source* Authors' estimation (projection) from data

Table 6 shows the structural VAR estimates with recursive long-run impulse response via the F triangular matrix. The long-term response of the exchange rate to output gap shock (C2) is negative (-22.00563). The response of the inflation rate to the output gap shock in the long run (C4) is negative (-10.45279). The response of the interest rate to the exchange rate shock in the long run (C6) is positive (2.563314). The long-term response of the inflation rate to the exchange rate shock (C7) is negative (-2.776936). The response of the inflation rate to the interest rate shock in the long run (C9) is negative (-3.328340).

Through Eqs. (15) and (16), the short run restrictions are as follows:

Table 6 Structural VAR estimates with recursive long-run impulse responses by the F triangular matrix

Panel I: F matrix with constraints

$$F = \begin{matrix} C(1) & 0 & 0 & 0 \\ C(2) & C(5) & 0 & 0 \\ C(3) & C(6) & (C8) & 0 \\ C(4) & C(7) & C(9) & C(10) \end{matrix}$$

Panel II: Estimations of the restrictions

	Coefficient	Std. Error	z Statistic	Prob
C(1)	26.44030	1.272110	20.78461	0.000
C(2)	−22.00563	9.623196	−2.286727	0.022
C(3)	0.559619	0.410302	1.363921	0.172
C(4)	−10.45279	0.878828	−11.89400	0.000
C(5)	140.5729	6.763320	20.78461	0.000
C(6)	2.563314	0.390401	6.565849	0.000
C(7)	−2.776936	0.708216	−3.921027	0.000
C(8)	5.443887	0.261919	20.78461	0.000
C(9)	−3.328340	0.676814	−4.917659	0.000
C(10)	9.664663	0.464991	20.78461	0.000
Log-likelihood	−4128.651			

Model: e = Phi*Fu where E[uu′] = I

The 1st, 2nd, 3rd, and 4th columns of A and B depict the DOG, DEXC, DINT, and DINF, respectively

Adjusted sample period: 1983–2018

Cross-sections: Kenya, Uganda, Tanzania, Rwanda, Burundi, and South Sudan

The number of observations is 216

Estimation method: Maximum likelihood via Newton–Raphson (analytic derivatives)

Convergence was achieved after 34 iterations

The structural VAR has just been identified

Here, in recursive long-run impulse response F triangular estimations (above estimations), we do not need to change the signs

$$u_t = Se_t$$

$$S = A^{-1}B$$

The information on A and B matrices are sufficient to compute both short run estimates (S) and long run estimates (F). Then, long run restrictions are as follows:

$$\varnothing u_t = Fe_t \tag{17}$$

$$F = \varnothing S \tag{18}$$

$$\varnothing = (I - A_i)^{-1} \tag{19}$$

$$\left(I - A_1 - A_2 - \cdots - A_p\right)^{-1} u_t = Fe_t \tag{20}$$

Turning to the panel response to shocks originating from Kenya, we examine the impulse response graphs presented in Fig. 2. The figures represent the responses of panel variables (in differences) to the shocks in variables of Kenya (in differences). Specifically, in Fig. 2a, it is observed that a positive shock of one standard deviation in the exchange rate of Kenya does not appear to have a significant effect on the output gap. The output gap exhibits a slightly negative response to innovations in the exchange rate of Kenya during periods 1 and 2, subsequently a predominantly positive response in later periods. Notably, the output gap is more positively influenced by structural shocks in the exchange rate, as depicted in Fig. 1.

Figure 2b shows that the interest rate responds positively to structural shocks in the exchange rate of Kenya. In Fig. 1, the impact of an exchange rate shock on the interest rate is asymmetric. On the other hand, as illustrated in Fig. 2c, the inflation rate responds negatively to structural shocks in the exchange rate of Kenya. Notably, the inflation rate displayed a positive response to the shock in the exchange rate, as shown in Fig. 1. This contradiction has been resolved, favoring a negative impact, through long-run recursive impulse response matrix estimations, yielding a coefficient of -2.776936.

The relevant literature explicitly concludes that exchange rate devaluation is a significant factor contributing to an increase in inflation, as evidenced by studies conducted by Kamin (1996), Odedokun (1996), London (1989), Canetti and Greene (1991), Calvo et al. (1995), and Elbadawi (1990). Kamin's (1996) research, for example, highlights the real exchange rate level as a primary determinant of inflation in Mexico during the 1980s and 1990s. Similarly, temporary components of inflation were found to be correlated with the real exchange rate in Brazil, according to Calvo et al. (1995). Elbadawi (1990) also noted that the sharp depreciation of the parallel exchange rate exerted a significant effect on inflation in Uganda. Similar findings for selected African countries are presented by Odedokun (1996), Canetti and Greene (1991), Egwaikhide et al. (1994), and London (1989).

In Fig. 3a, it is evident that a positive structural shock in the interest rate of Kenya elicits a negative response in the output gap during the 1st, 2nd, and 3rd periods. Subsequently, the shock asymmetrically influences the output gap from the 4th to the 10th period. Figure 3b and c examine the positive impact of a shock in the interest rate of Kenya on the exchange rate and the negative impact of a shock in the interest rate of Kenya on the inflation rate, respectively.

The mainstream literature argues that contractionary (expansionary) shocks to interest rates lead to contractions (expansions) in both interest and output. However, our findings regarding the panel responses to the Kenyan monetary policy shock contradict this theory. The results align with the panel reactions to composite shocks, suggesting the possible presence of a price puzzle. Various explanations have been proposed in the literature to account for these contradictory findings. Barth and Ramey (2001) and Ravenna and Walsh (2006) propose that price puzzles arise due to the cost channel of monetary policy transmission, wherein firms' marginal costs are directly linked to nominal interest rates. A negative shock to the interest rate increases firms' marginal costs in the short run, eventually leading to price increases and a decline in aggregate demand. Sims (1992), Christiano et al. (1998), and Balke and Emery (1994) associate price puzzles with policymakers' reactions to high inflation and expectations of supply shocks, wherein they raise policy interest rates. They

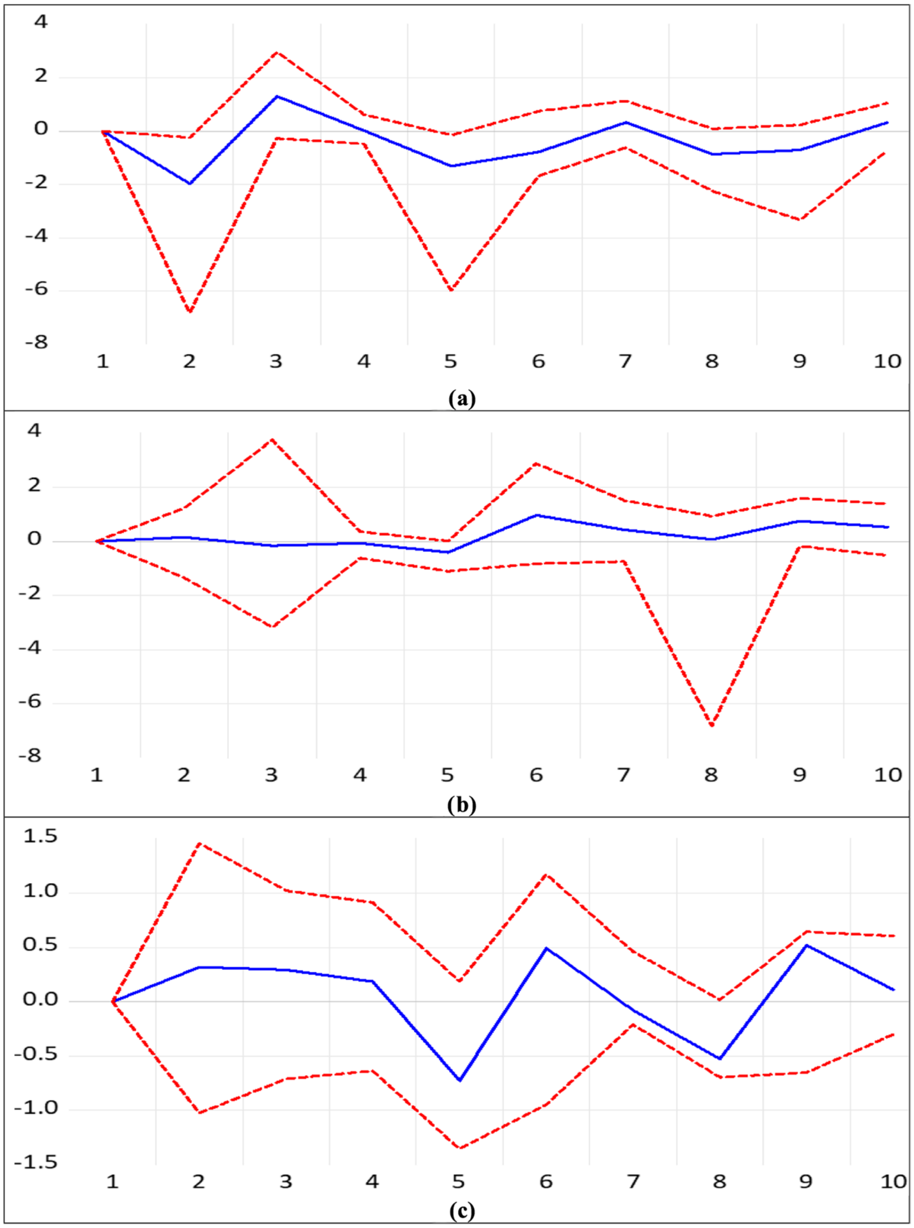

Fig. 4 Response of **a** output gap to shock in the inflation rate of Kenya, **b** exchange rate to shock in the inflation rate of Kenya, and **c** interest rate to shock in the inflation rate of Kenya. *Source* Authors' estimation (projection) from data

argue that the VAR system may be insufficiently identified with information on future inflation and that increases in inflation fail to fully offset inflationary consequences.

Further examination of the impulses, as depicted in Fig. 4a, reveals the negative influence of a structural shock in the inflation rate of Kenya on the output gap. Considering that our study adopts a multi-country analysis of transmission mechanisms, this result is particularly significant and aligns with the traditional literature. This suggests that inflation shocks originating from the largest economy in the region are transmitted and negatively impact the output of constituent member countries of the East African

Community, likely due to trade links between these countries, as noted by Dungey and Fry (2000). Other results include Fig. 4b, which presents no substantial evidence of the effect of structural innovations in the inflation rate of Kenya on the exchange rate, and Fig. 4c, which emphasizes the statistical observation that the interest rate responds positively to the structural shock in the inflation rate of Kenya during the 1st, 2nd, 3rd, and 4th periods, followed by an asymmetric influence on the interest rate from the 5th to the 10th period.

The findings of the study have important economic and financial implications for both policymakers and the broader academic literature on monetary transmission mechanisms (MTMs), particularly in the context of the East African Monetary Union (EAMU). By employing the Panel Structural Vector Autoregression (PSVAR) model to assess the effects of composite and idiosyncratic shocks, we can derive several critical insights that affect macroeconomic stability and growth in the region.

Macroeconomic implications of output gap shocks

The impulse response analysis reveals that positive output gap shocks generally lead to currency appreciation and lower inflation in the short run, which is consistent with Engel and West (2005) and Gourinchas and Rey (2007). This implies that periods of economic expansion in the region tend to strengthen the exchange rate due to increased investor confidence and higher expected returns. In a region such as East Africa, where economic performance is variable and asymmetries exist between countries, such results suggest that monetary policy must be carefully calibrated. For example, while stronger economic activity might benefit larger economies such as Kenya through currency appreciation, smaller countries may face challenges in maintaining external competitiveness if their currencies appreciate too quickly.

Additionally, the study's findings of a decline in inflation following an increase in the output gap indicate that supply-side factors may play a role in stabilizing prices during periods of economic growth. This is especially relevant for the region's inflation-targeting central banks, which must balance growth with inflationary pressures. The results highlight the importance of ensuring that monetary policy not only fosters growth but also addresses potential inflation risks, particularly in smaller, more vulnerable economies.

Interest rate shocks and the price puzzle

The analysis also identifies a price puzzle, where contractionary monetary policy shocks (i.e., an increase in the interest rate) lead to a counterintuitive rise in inflation. This finding is consistent with those of previous studies, such as Barth and Ramey (2001) and Ravenna and Walsh (2006), which suggest that the cost channel of monetary policy transmission can drive this phenomenon. Higher interest rates may increase firms' borrowing costs, leading to higher production costs and, consequently, higher prices.

From a policy perspective, this suggests that monetary authorities in East Africa may need to account for these cost-push factors when designing interest rate policies. Traditional monetary policy tools that rely on raising interest rates to control inflation may not always yield the desired results, particularly if the underlying inflationary pressures are supply-side driven. The persistence of price puzzles could complicate the task of achieving inflation targets, especially in economies where supply-side constraints (e.g., infrastructure, energy) are significant.

Inflation and exchange rate dynamics

The study's findings show that exchange rate shocks originating from Kenya, the largest economy in the region, have a relatively limited direct impact on the output gap of smaller economies. However, these shocks significantly affect inflation rates, reinforcing the idea that exchange rate movements play a crucial role in determining inflation dynamics in open economies such as those in East Africa. The impact of exchange rate devaluation on inflation is well-documented in the literature (Kamin 1996; Odedokun 1996), and our results confirm that a depreciation in the exchange rate can drive inflation higher through imported goods prices.

For policymakers, this underscores the importance of exchange rate stability, particularly in economies that are highly dependent on imports for essential goods. Managing exchange rate volatility is critical to controlling inflation, and regional cooperation on monetary policy could help mitigate some of the inflationary pressures that arise from currency depreciation. Furthermore, as the region progresses toward deeper monetary integration, policymakers must ensure that exchange rate policies are harmonized to prevent destabilizing inflationary shocks.

Implications for smaller economies and the role of Kenya

The study highlights the dominant role of Kenya in influencing regional economic dynamics through its monetary policy and exchange rate shocks. The fact that shocks originating from Kenya have significant spillover effects on smaller economies suggests that regional monetary policies need to consider these interdependencies. Smaller economies may not be able to respond effectively to monetary shocks without assistance or coordination from larger economies such as Kenya.

This has important implications for the EAMU, where a single monetary policy is implemented across diverse economies. If policies are overly influenced by the economic conditions in Kenya, smaller economies may suffer from inappropriate policy settings that fail to address their unique challenges. This could exacerbate vulnerabilities and increase the risk of asymmetric shocks, which could undermine the benefits of monetary integration.

As noted in the literature (Dellas and Tavlas 2005), the heterogeneity in economic structures between large and small economies is a critical factor in determining the success of a monetary union. Policymakers must ensure that the regional monetary framework allows for sufficient flexibility to address these disparities. This could involve implementing compensatory mechanisms or adjustment funds to help smaller economies weather adverse shocks.

Financial market stability and risk management

Understanding the dynamics of monetary transmission mechanisms is crucial for safeguarding financial stability in a region. By analyzing the responses of interest rates, inflation rates, and exchange rates to monetary policy shocks, this study provides insights that can help policymakers identify potential vulnerabilities in financial markets. For example, if higher interest rates are associated with rising inflation due to supply-side factors, then sudden tightening of monetary policy could inadvertently destabilize financial markets, especially if inflation expectations are not well anchored.

The findings also suggest that regional policymakers need to develop stronger mechanisms for managing exchange rate volatility, as it has direct implications for inflation and overall economic stability. The coordination of monetary and exchange rate policies across member states is crucial to avoid destabilizing spillover effects that could threaten financial market stability.

Conclusion and suggestions

This paper examines the dynamics of monetary transmission mechanisms in East African countries, focusing on the transmission of composite and idiosyncratic shocks. The study specifically investigates how smaller countries in the region respond to shocks originating from Kenya, the largest economy.

Using a panel structural vector autoregression model, the paper analyzes the short and long-term effects of monetary transmission mechanisms in six East African countries: Kenya, Uganda, Tanzania, Rwanda, Burundi, and South Sudan. The analysis covers the period from 1980 to 2018.

The empirical results of the study reveal several key findings.

In the short run, the analysis shows that (i) an expansionary monetary policy response is triggered in response to a positive output gap,suggesting an attempt to stimulate economic growth during periods of slack, and (ii) an increase in the output gap,reflecting stronger economic activity,leads to a decrease in inflation. Higher output levels contribute to lower price pressures, and (iii) an increase in interest rates is associated with a reduction in inflation. A tighter monetary policy leads to decreased spending and lowers inflationary pressures.

In the long run, the study finds that (i) an expansionary shock,leading to increased output,is associated with a depreciation of the exchange rate. This indicates that a region's currencies tend to weaken when economic activity expands. (ii) Sustained economic growth,represented by a positive output gap,leads to lower inflation rates over time. (iii) An appreciation of the exchange rate prompts an increase in interest rates. This response aims to curb potential inflationary pressures arising from an appreciation of the currency; (iv) an appreciation of the exchange rate is associated with lower inflation levels over time; and (v) an increase in interest rates leads to lower inflation in the region over the long term.

The findings of our study suggest the presence of price puzzles in two models: composite and idiosyncratic shocks. These price puzzles arise because monetary policy shocks induce negative reactions in inflation and output, contrary to the predictions of the traditional literature. However, in regard to shocks to the exchange rate, our results align with the literature. We find that output contracts follow negative exchange rate shocks, which is consistent with the expectations outlined in previous studies. These findings support the arguments put forth by Barth and Ramey (2001) and Ravenna and Walsh (2006). These researchers argue that the current literature tends to focus more on demand-side shocks, neglecting the supply-side transmission of monetary policy. The price puzzles observed in our study could be explained by the limited attention given to supply-side transmission channels. Moreover, our study provides evidence for the relative importance of Kenyan shocks in the region. These shocks could be transmitted through trade channels, as suggested by Dungey and Fry (2000).

This study provides important evidence on how composite and idiosyncratic shocks are transmitted across East African economies, with particular attention given to the role of Kenya. The findings have several key policy implications:

- Policymakers should consider the possibility of price puzzles when using interest rates to control inflation, as supply-side cost factors may counteract traditional monetary policy tools.
- Exchange rate stability is crucial for controlling inflation in a region heavily reliant on imports. As a region moves toward a monetary union, harmonized exchange rate policies will be essential to mitigate inflationary pressures.
- The dominant role of Kenya in influencing regional economic dynamics suggests the need for compensatory mechanisms or flexible policies to prevent smaller economies from being adversely affected by asymmetric shocks.
- Financial market stability requires close monitoring of the effects of monetary policy, particularly in light of the potential for unintended consequences such as the price puzzle.

This study has several limitations that should be considered when interpreting the results. First, the study relies on a limited number of countries and a relatively short time span. This limits the generalizability of the findings to other countries and periods. Second, the study uses a structural vector autoregression model, which is a complex and sometimes difficult to interpret econometric model. This could lead to some uncertainty in the interpretation of the results. Third, the study does not explicitly account for supply-side shocks. This could bias the results and lead to an underestimation of the importance of supply-side transmission channels. In conclusion, the findings of this study offer valuable insights into the functioning of monetary transmission mechanisms in East Africa, providing a basis for future policy formulation and research. Regional policymakers must ensure that monetary integration does not overlook the unique challenges faced by smaller economies and that financial stability remains a priority as the EAMU continues to evolve. Future research could address some of the limitations of this study by using a larger sample of countries, a longer time span, and a more comprehensive econometric model. Additionally, future research could explicitly investigate the supply-side transmission of monetary policy and explore the impact of monetary policy on other macroeconomic indicators.

Appendix 1

See Figs. 5–7 and Tables 7–13.

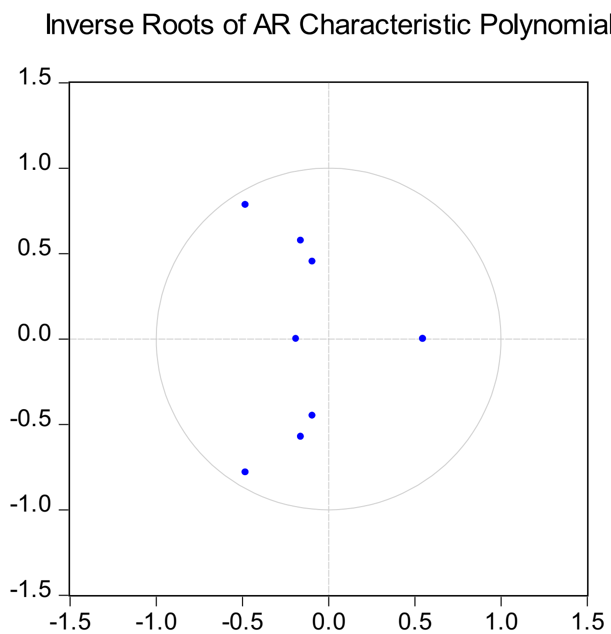

Fig. 5 VAR with Lag 2 (Endogenous variables: DOG DEXC DINT DINF)

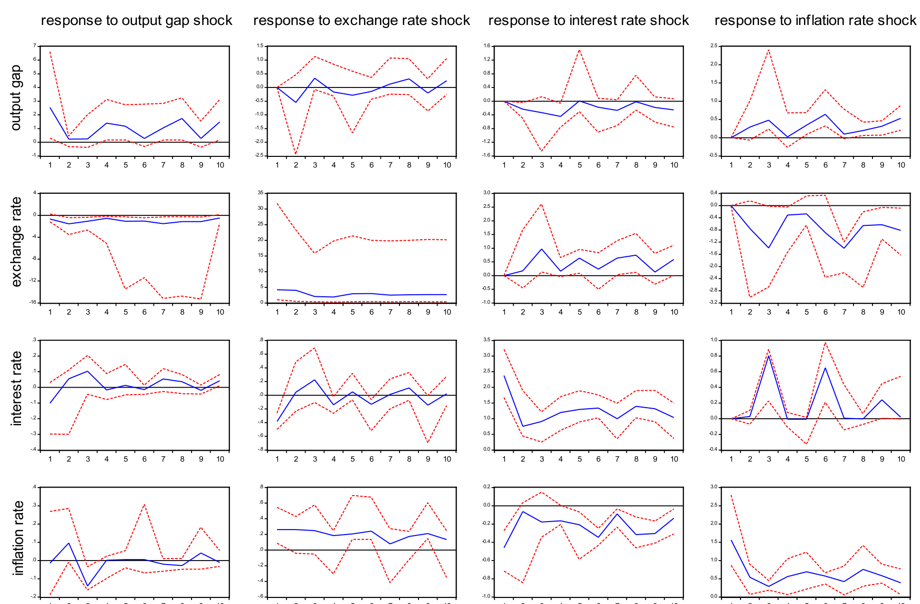

Fig. 6 Panel SVAR response estimates to common shocks (Endogenous variables: DOG DEXC DINT DINF)

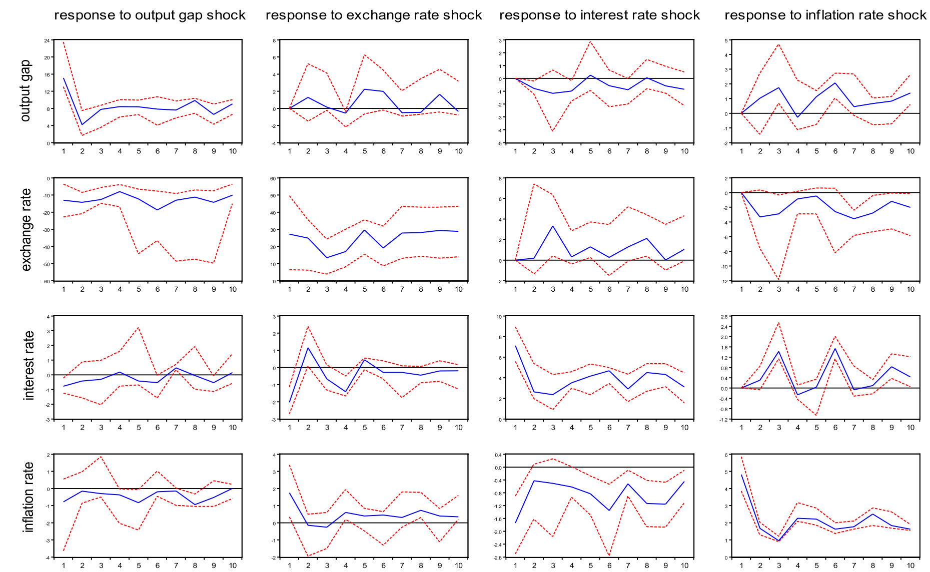

Fig. 7 Response estimates to idiosyncratic shocks (Endogenous variables: DOG DEXC DINT DINF)

Table 7 VAR lag order selection

Endogenous variables: DOG DEXC DINT DINF.
Exogenous variables: C.
Included observations: 180

Lag	LogL	LR	FPE	AIC	SC	HQ
0	−3645.473	NA	4.79e+12	40.54970	40.62065	40.57847
1	−3502.100	278.7805	1.16e+12	39.13445	39.48922	39.27829
2	−3455.995	87.59996	8.33e+11	38.79994	39.43853*	39.05886*
3	−3437.682	33.98030	8.13e+11	38.77425	39.69666	39.14824
4	−3411.765	46.93964	7.29e+11*	38.66405*	39.87028	39.15312
5	−3400.344	20.17627	7.68e+11	38.71493	40.20498	39.31908
6	−3388.994	19.54791	8.12e+11	38.76660	40.54046	39.48582
7	−3382.276	11.27112	9.04e+11	38.86973	40.92741	39.70403
8	−3364.760	28.60879*	8.93e+11	38.85289	41.19439	39.80227

* Denotes lag order selected by the criterion

LR: likelihood ratio, sequential modified LR test statistic (5% level), FPE: final prediction error, AIC: Akaike information criterion, SC: Schwarz information criterion, HQ: Hannan-Quinn information criterion

Table 8 Structural VAR estimates with recursive short-run impulse responses by the S triangular matrix

Model: e = Su where E[uu’] = I

S=	C(1)	0		0	0
	C(2)	C(5)		0	0
	C(3)	C(6)		C(8)	0
	C(4)	C(7)		C(9)	C(10)
	Coefficient	Std. Error		z-Statistic	Prob
C(1)	76.51866	3.681506		20.78461	0.0000
C(2)	−2.163996	5.162353		−0.419188	0.6751
C(3)	4.094687	0.643028		6.367822	0.0000
C(4)	−22.86881	1.441117		−15.86880	0.0000
C(5)	75.85536	3.649593		20.78461	0.0000
C(6)	0.284454	0.611953		0.464830	0.6421
C(7)	0.352561	0.930551		0.378874	0.7048
C(8)	8.991583	0.432608		20.78461	0.0000
C(9)	−3.781310	0.912436		−4.144194	0.0000
C(10)	13.14075	0.632235		20.78461	0.0000
Log-likelihood	-4128.651				
Estimated S matrix:					
76.51866	0.000000	0.000000	0.000000		
−2.163996	75.85536	0.000000	0.000000		
4.094687	0.284454	8.991583	0.000000		
−22.86881	0.352561	−3.781310	13.14075		

Here, in recursive short-run impulse response S triangular estimations (above estimations), we do not have to change the signs

Adjusted sample period: 1983–2018

Cross-sections: Kenya, Uganda, Tanzania, Rwanda, Burundi, and South Sudan

The number of observations is 216

Estimation method: Maximum likelihood via Newton–Raphson (analytic derivatives)

Convergence was achieved after 30 iterations

The structural VAR has just been identified

Table 9 Pairwise granger causality tests: Lags = 1

No	Null Hypothesis	Obs	F-Statistic	Prob
1	DEXC does not Granger Cause DOG	222	0.00166	0.9676
2	DOG does not Granger Cause DEXC		0.37623	0.5403
3	DINT does not Granger Cause DOG	222	3.30359	0.0705
4	DOG does not Granger Cause DINT		10.7188	0.0012
5	DINF does not Granger Cause DOG	222	13.6174	0.0003
6	DOG does not Granger Cause DINF		13.6674	0.0003
7	DINT does not Granger Cause DEXC	222	1.40590	0.2370
8	DEXC does not Granger Cause DINT		0.76627	0.3823
9	DINF does not Granger Cause DEXC	222	0.00171	0.9671
10	DEXC does not Granger Cause DINF		0.51364	0.4743
11	DINF does not Granger Cause DINT	222	15.7770	0.0001
12	DINT does not Granger Cause DINF		15.5069	0.0001

Table 10 Pairwise granger causality tests: Lags = 2

No	Null Hypothesis	Obs	F-statistic	Prob
1	DEXC does not Granger Cause DOG	216	0.26077	0.7707
2	DOG does not Granger Cause DEXC		0.19489	0.8231
3	DINT does not Granger Cause DOG	216	9.67564	0.0001
4	DOG does not Granger Cause DINT		7.34518	0.0008
5	DINF does not Granger Cause DOG	216	2.06185	0.1298
6	DOG does not Granger Cause DINF		2.24851	0.1081
7	DINT does not Granger Cause DEXC	216	2.48110	0.0861
8	DEXC does not Granger Cause DINT		1.48030	0.2299
9	DINF does not Granger Cause DEXC	216	0.16751	0.8459
10	DEXC does not Granger Cause DINF		0.25621	0.7742
11	DINF does not Granger Cause DINT	216	5.68694	0.0039
12	DINT does not Granger Cause DINF		5.14592	0.0066

As explained in Sect. "Empirical results and discussions" (Empirical results and discussions)

To follow the stationary panel VAR system(s), the differences in the variables are employed. Hence, this paper monitors panel variables of the differenced output gap (DOG), the differenced exchange rate (DEXC), the differenced interest rate (DINT), and the differenced inflation rate (DINF) to discover the impacts of structural shocks in the system on the variables.

Tables 11–13 present the correlation values between the variables.

Table 11 Covariance analysis: ordinary

Correlation t-statistic probability				
	DOG	**DEXC**	**DINT**	**DINF**
DOG	1.000.000			
	–			
	–			
DEXC	− 0.008853	1.000.000		
	[− 0.133094]	–		
	(0.8942)	–		
DINT	0.534745	− 0.001827	1.000.000	
	[9.513439]	[− 0.027473]	–	
	(0.0000)	(0.9781)	–	
DINF	− 0.759967	0.014413	− 0.445604	1.000.000
	[− 17.57764]	[0.216700]	[− 7.482873]	–
	(0.0000)	(0.8286)	(0.0000)	–

* The values in brackets and parentheses represent t-statistics and prob values, respectively

Table 12 Covariance analysis: ordinary (uncentered)

Correlation t-statistic probability				
	DOG	**DEXC**	**DINT**	**DINF**
DOG	1.000.000			
	–			
	–			
DEXC	− 0.007320	1.000.000		
	[− 0.110290]	–		
	(0.9123)	–		
DINT	0.534510	0.012303	1.000.000	
	[9,528587]	[0.185381]	–	
	(0.0000)	(0.8531)	–	
DINF	− 0.759956	0.009763	− 0.445604	1.000.000
	[− 17,61588]	[0,1470999]	[− 7,4994109]	–
	(0.0000)	(0.8832)	(0.0000)	–

* The values in brackets and parentheses represent t-statistics and prob values, respectively

Table 13 Covariance analysis: spearman rank-order

Correlation t-statistic probability				
	DOG	**DEXC**	**DINT**	**DINF**
DOG	1.000.000			
	–			
	–			
DEXC	− 0.386642	1.000.000		
	[− 6,302663]	–		
	(0.0000)	–		
DINT	− 0.072765	0.030372	1.000.000	
	[− 1,09689]	[0.4567979]	–	
	(0.2739)	(0.6483)	–	
DINF	− 0.125343	0.067126	− 0.276740	1.000.000
	[− 1,8,992,919	[1,011408]	[− 4,3,294,049	–
	(0.0588)	(0.3129)	(0.0000)	–

* The values in brackets and parentheses represent t-statistics and prob values, respectively

1. Tables 11 and 12 show very similar correlation values, suggesting that they might be from different methodologies (ordinary and ordinary uncentered) but represent similar relationships:

DOG and DINT have a moderate positive correlation (≈0.535)

DOG and DINF are strongly negatively correlated (≈-0.760)

DINT and DINF have a moderate negative correlation (≈-0.446)

DEXC has negligible correlations with all other variables

2. Table C shows different correlation patterns when we follow the Spearman rank order correlation values

DOG and DEXC have a moderate negative correlation (-0.387)

DOG and DINF have a weak negative correlation (-0.125)

DINT and DINF maintain a negative correlation but are weaker (-0.277)

Most correlations are weaker in magnitude than those in Tables A and B

3. Statistical significance:

The p values (in parentheses) are as follows:

In Tables 11 and 12, the correlations between DOG-DINT and DOG-DINF are highly significant ($p = 0.0000$)

In Table 13, only the DOG-DEXC and DINT-DINF correlations are statistically significant at the 1% level, and DOG-DINF is statistically significant at the 10% level

Abbreviations

MTMs	Monetary transmission mechanisms
P-SVAR	Panel structural VAR
EAC	The east african community
EAMU	Customs unions, common market to east african monetary union
OCA	Optimal currency areas
GDP	Gross domestic product
CPI	Consumer price index
IFS	International financial statistics
OG	Output gap
EXC	Exchange rate
INT	Interest rate

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Data availability

Data of this work were derived from public domain resources. The data that support the findings of this study are available in the International Financial Statistical (IFS) Yearbook (2019), https://data.imf.org/?sk=4c514d48-b6ba-49ed-8ab9-52b0c1a0179b (Accessed: 20 December 2021). All data sources are given in the reference list of this work.

Declarations

Ethics approval

This manuscript has not been published and is not under consideration for publication elsewhere and its publication is approved by all authors. If accepted, it will not be published elsewhere in any form or in any other language, without the written consent of the copyright holder.

Competing interests

All authors declare that we have no financial or personal relationship that could cause a conflict of interest regarding this article which could inappropriately bias our work. The authors also declare that we have no competing interests.

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