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A CAUSAL RELATIONSHIP BETWEEN INFLATION AND ECONOMIC GROWTH IN EAST AFRICAN COUNTRIES: NEW EVIDENCE FROM SYMMETRIC AND ASYMMETRIC CAUSALITY TESTS

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Abstract: *In this paper, we examine the direction of heterogeneous causality between inflation and economic growth in East African countries (EAC) for the period 1970–2023. Most regional studies, while finding single-regime inflation thresholds, remain silent on the directional and shock-contingent Granger causality. Motivated by this gap, we apply the Dumitrescu–Hurlin heterogeneous panel Granger non-causality framework, as well as the Hatemi-J asymmetric shock decomposition framework, to distinguish between positive and negative innovations. Symmetric panel results indicate unidirectional Granger causality running from inflation to real GDP per capita growth, though this aggregated result conceals shock-dependent dynamics. Furthermore, the asymmetric decomposition suggests that the relationship is primarily shock-dependent and asymmetric: that is, positive inflation shocks Granger-cause positive growth shocks, while negative growth shocks Granger-cause negative inflation shocks. No evidence of cross-regime effects is found. These findings suggest that the inflation–growth nexus appears to be asymmetric, regime-dependent in the EAC, and that it may be undesirable to impose uniform convergence criteria if the inflation–growth predictability differs systematically across expansionary and contractionary regimes. Broadly, our results highlight the need to allow for cross-country heterogeneity in estimation and to explicitly test for dependence of shocks in causality analysis of emerging monetary unions.*

Keywords: *Inflation; Economic Growth; East African Community; Panel Granger Causality; Heterogeneous Panels; Asymmetric Shocks*

JEL classification: *E31; O55; C23; O47; C33; F45*

1. Introduction

The design of monetary stabilization in developing regional blocs depends largely on the direction, stability, and shock-dependence of the inflation–growth relationship; however, the empirical evidence for this point is uncertain for low-income settings (Barro, 1995; Fischer, 1993). Although high levels of sustained inflation are generally believed to have a negative impact on macroeconomic stability as such, the theoretical relationship between moderate levels of inflation and real activity has been shown to be ambiguous and may depend on different institutional and market structures (Levine & Renelt, 1992; Bruno & Easterly, 1998). This ambiguity is especially evident in low-income nations with large structural impediments to income diversification, thin financial markets, and substantial external risk to economic activity; thus, changing the manner in which output and prices interact with one another (Pollin & Zhu, 2006).

Macroeconomic theories provide conflicting explanations of the causal ordering. The classical arguments for neutrality suggest that inflation, once anticipated, will not have a long-term impact on real output, even if it has an impact on relative prices and the allocation of resources (Friedman, 1977). In contrast, in the Keynesian framework, there is a potential for short-run non-neutrality where demand shocks can cause both output and inflation to rise together for a short period of time (Phillips, 1958). Endogenous growth models further suggest that inflation may also have long-term impacts on the economy because it reduces financial intermediation and decreases the effectiveness of capital accumulation (Azariadis and Smith, 1996). An important implication from this work is that the direction of causality between inflation and economic growth will vary based upon structural characteristics such as the level of financial depth, the degree of fiscal discipline, and how expectations are formed, and this relationship may also vary across countries belonging to the same integrating bloc (Gylfason and Herbertsson, 2001).

Empirical assessments of the inflation–growth causality vary widely based on estimation procedure or specification, the sample used, and the assumptions about cross-sectional properties of the data (e.g., common slopes) (Barro, 1995; Chimobi, 2010). Studies based on the assumption of common slopes among countries in panel analyses may be inaccurate due to differences in macroeconomic structure among those countries, and average results reported for the sample may fail to represent any one particular economy well. Similarly, linear symmetric specifications may obscure differences in responses to positive and negative shocks due to different channels of transmission for shocks (e.g., through demand, credit, and nominal rigidities) (Dumitrescu & Hurlin, 2012).

These issues are of particular importance to the East African Community (EAC) as it seeks to deepen integration towards the East African Monetary Union (EAMU). The EAMU convergence framework, including a proposed 8 percent inflation ceiling, essentially presupposes a symmetric and uniform inflation–growth relationship across member states (EAC, 2013). Recent EAC literature has overwhelmingly focused on threshold estimation (Yabu & Kessy, 2015; Ndoricimpa, 2017). Those estimates indicate levels of inflation beyond which the effects on growth rates become detrimental. They do not, however, determine whether inflation precedes cycles in growth rates, or vice versa, nor whether the relationships differ across expansionary and contractionary regimes. If the causal dynamics are shock-dependent, a uniform inflation ceiling can induce asymmetric and possibly procyclical real effects, complicating macroeconomic stabilization policy within a prospective union (De Grauwe, 2020; Oloo et al., 2021).

Against this background, in this study, we focus on the direction of the short-run Granger causality between inflation and real GDP per capita growth in the EAC over the period 1970-2023. Our empirical strategy proceeds in two steps. In the first step, we apply the Dumitrescu and Hurlin (2012) heterogeneous panel Granger non-causality test, as this allows the causal coefficients to differ across countries while ensuring valid panel inference. In the second step, to evaluate causality dynamics according to the direction of shocks, we appeal to the Hatemi-J (2012) decomposition into positive and negative cumulative innovations and re-estimate heterogeneous panel causality on these components. This design allows us to test if inflationary accelerations and disinflationary episodes contain different Granger causal content for growth dynamics, and if Granger causality is predicted differently on growth contractions versus expansions for disinflation and inflation, respectively. More broadly, the paper contributes to the literature on inflation–growth dynamics in developing monetary unions by illustrating how panel-level inference in heterogeneous frameworks should be interpreted cautiously when Granger-causal patterns are regime-contingent. The results inform the empirical coherence of uniform convergence criteria in the EAMU context and speak to the broader question of whether nominal targets are sufficient when macroeconomic transmission is shock-dependent. The remainder of the paper is structured as follows: Section 2 reviews the literature; Section 3 outlines the methodology; Section 4 presents the findings; and Section 5 discusses policy implications.

2. Literature Review

Despite decades of theoretical exposition and empirical investigations, no agreement has yet emerged on the direction of the causality between inflation and growth, especially in heterogeneous developing economies. Although there is strong evidence linking high and volatile inflation to poor long-run economic performance (Barro, 1995, 2001; Fischer, 1993), the details of the causal connections are elusive. By misjudging the direction of causality, monetary authorities can end up enacting procyclical stabilization policies that further increase rather than decrease output volatility (Bruno & Easterly, 1998). In this section, we explore the theoretical channels of transmission and the empirical evidence, focusing in particular on the tension between the homogeneous panel assumptions and the structural heterogeneity of African and EAC economies.

2.1 Theoretical Framework

The theoretical literature suggests various forms of causal relationships between inflation and economic growth, which range from unidirectionality to neutrality. The first set of theories, based on the Monetarist/Neoclassical tradition, suggests a unidirectional relationship from inflation to economic growth. Friedman (1977) and Barro (1995) suggest that inflation leads to price volatility, which results in uncertainty. Uncertainty affects the signalling properties of relative prices. Thus, inflation affects the economy through the uncertainty and financial intermediation channels, as opposed to the aggregate demand stimulation. Uncertainty hinders long-term planning, leading to a reduction in the rate of capital accumulation because firms tend to substitute productive capital with hedging activities, thus retarding the rate of economic growth (Fischer, 1993). In the context of developing countries, the effects of inflation on economic growth are likely to be intensified by "financial repression" because inflation leads to an increase in the asymmetry of information in the credit market, thereby affecting the efficiency of financial intermediation (Azariadis & Smith, 1996).

In contrast, the Keynesian and Structuralist approaches reverse the causality chain by implying that inflation emerges naturally as a consequence of the real sectors' growth and the accompanying friction that arises along the way. Moreover, the applied insight of the Phillips curve concept implies that brisk economic growth, especially surpassing potential output levels in an economy, automatically breeds demand-pulling inflationary pressures (Phillips, 1958). Similarly, the Phillips curve concept of economic growth triggering inflationary pressures is applicable in the context of African economies, with inflation arising due to the accompanying bottlenecks along the supply side of the economy resulting from an economy's inability to meet increasing demand levels in sectors such as food due to increasing incomes (Ghosh & Phillips, 1998).

The third view posits that there is bidirectional causation. This feedback loop tends to arise in countries where there are weak fiscal institutions; as a result of lower rates of economic growth, the tax base declines, which leads to a need for seigniorage (money printing) to cover the deficit. The increase in the money supply leads to a rise in inflation, which ultimately contributes to further erosion of the rates of economic growth (Bruno and Easterly 1998). The neutrality hypothesis, which is based on the Rational Expectations theory (Lucas 1973), posits that anticipated inflation shows no long-run causal relationship with real variables and thus has no effect on real variables in the long run (i.e., long-run superneutrality where all markets are fully flexible). However, this hypothesis is problematic in the case of developing economies because, in most cases, developing country markets are rarely frictionless.

Theoretical explanations for asymmetric inflation–growth dynamics are more convincingly grounded in models with nominal rigidities and state-dependent adjustments. In environments characterised by downward wage and price rigidity, negative demand shocks often generate disproportionately large real effects relative to positive shocks of similar magnitude. When nominal wages are resistant to downward adjustment, disinflationary episodes can be accompanied by output contractions that are larger than the expansions associated with moderate inflationary upswings (Ball & Mankiw, 1994). Similarly, menu cost and staggered price-setting models imply that firms adjust prices asymmetrically depending on the direction and persistence of shocks, thereby generating nonlinear output responses (Ball & Mankiw, 1994). In such frameworks, the inflation–growth relationship becomes inherently regime-contingent rather than symmetric across positive and negative disturbances.

2.2 Empirical Literature

Although significant amounts of research assess the magnitude or threshold effects of inflation on output, a fundamental question is temporal ordering. Does inflation systematically lead to changes in growth? Does growth create inflationary dynamics? Do the two variables work together in a feedback loop? Or are they relatively independent? In the empirical literature, all four views have been supported with no consistent relationship found across countries, income groups, or estimation methods.

2.2.1 Inflation → Growth

Many studies in the time-series literature have shown unidirectional Granger causality from inflation to growth. Several studies conducted in Pakistan (Mubarik, 2005; Hussain & Zafar, 2018), Turkey (Erbaykal & Okuyan, 2008), Nigeria (Omoke, 2010; Chimobi, 2010), Malaysia (Datta and Kumar, 2011), Bangladesh (Hossain et al., 2012), Qatar (Al-Khulaifi, 2018), and Liberia (Tenny, 2022) have found that inflation causes changes in the level of output with no sign of growth causing future inflation. In general, signs of the estimated effect have been shown to differ across

different countries; however, in many cases, the direction of the causal relationship runs from price level to level of output.
The majority of these, methodologically, rely on country-specific VARs, VECMs, or Granger causality tests. A smaller number use more sophisticated techniques, like Toda-Yamamoto causality tests. Again, a point worth emphasizing is that these types of analysis are essentially time series-based, individual country as opposed to cross-sections, which are much more representative at a regional level. The evidence collectively supports models with uncertainty, intermediation, or distortionary channels for the effects of inflation, reflecting that price volatility impounds forward-looking information for real activity.

2.2.2 Growth → Inflation
A second set of studies reverses the direction of causality; for example, evidence presented from Fiji (Gokal & Hanif, 2004), Nigeria (Bakare et al., 2015), Turkey (Özpence, 2016; Kanca, 2017), and Uganda (Abima, 2022), has found that the expansion in output precedes the inflationary dynamics, and reverse causality has not been established.
In general terms, these findings have been interpreted from a demand-pull perspective with rapid output growth putting pressure on resources, causing prices to rise. Some of these studies place a great deal of importance on structural issues such as import dependence and supply rigidity as mediating factors influencing demand-pull pressures on the economy; however, the majority of the evidence supporting these claims is based on country-level time series models that limit the generalizability of the findings to contexts of regional monetary integration.

2.2.3 Bidirectional Feedback
The third strand provides evidence of bidirectional causality. Cross-country panel evidence (Huang et al., 2009; Özylmaz, 2022) and country studies of China (Chang-shuai, 2012), Ethiopia (Rao, 2015), Japan (Singh, 2015), and BRICS (Behera, 2016) provide evidence of feedback mechanisms between the two variables where inflation and growth mutually reinforce each other.
Of particular note, several of the empirical analyses utilize panel causality techniques like the Dumitrescu–Hurlin framework. Nonetheless, the majority of the studies conducted in a panel environment have limitations related to their use of symmetric linear specifications and their failure to formally test for causal ordering that is contingent on the sign of macroeconomic shock.

2.2.4 No Causality: Superneutrality Evidence
A fourth empirical position states that there exists no significant causal linkage. For example, Brazil (Faria & Carneiro, 2001), Kenya (Kigume, 2011), Nigeria (Osuala, 2013; Shuaib et al., 2015), Turkey (Özçelik & Uslu, 2017), and ECOWAS member nations (Dada et al., 2017) have all concluded that there is no predictive causality present between the two variables.
In general, the results obtained in these studies provide evidence to support long-run superneutrality and weak transmission mechanisms of monetary policy. However, many of the existing studies are based on small-sample VAR specifications, which typically do not have enough power to identify heterogeneous and/or nonlinear relationships.

2.2.5 Asymmetric Causality in the Inflation–Growth Literature

A growing strand of literature challenges the assumptions of linear symmetric causality frameworks to fully explain macroeconomic phenomena. Utilising the approach of Hatemi-J on asymmetric decompositions, several papers find that positive and negative shocks transmit differently across economic variables. For instance, Syzdykova et al. (2022) employ the Hatemi-J asymmetric causality test on oil prices and macroeconomic stability and show that positive and negative oil price shocks differently affect domestic price levels. Similar results are found by Çelikel and Öndes (2025) using non-linear approaches on Turkey, for which inflation and GDP show an asymmetric cointegration pattern where rising inflation depresses output in the short term but a decline in inflation tends to promote economic growth. Olaniyi and Ologundudu (2022) assess the African context and use a bootstrap simulation with asymmetric causality tests to show that remittance shocks affect poverty differently depending on their sign. Olaniyi and Odhiambo (2024) also show how cross-country interdependence and asymmetry change causal inference in panel settings. Overall, this tract of literature suggests that macroeconomic causal mechanisms are regime contingent rather than symmetric.

Even with this understanding of asymmetry, much of the literature remains country-specific and, even so, it either explores nonlinear cointegration or sectoral transmission channels rather than inflation–growth causality within regional blocs. And even when asymmetric methods are adopted, they rarely combine the methodology with heterogeneous panel causality through which slope coefficients are estimated to depend on respective cross-sectional units (an important feature for small and structurally diverse monetary unions). To the best of our knowledge, no study has jointly combined heterogeneous panel Granger causality with asymmetric shock decomposition for the EAC. We seek to address this in the present study by combining heterogeneous panel Granger causality with asymmetric shock decomposition in a unified regional setting.

Combined, the empirical literature on causality is suggestive of three broad trends. Empirical findings are strongly estimator-dependent. Directional results change with lag selection, integration order, sample window, and model specification. The very existence of all four possible outcomes suggests that causal inference is sensitive to structural context and econometric design.

Second, most studies fall into the methodology of individual-country time series analysis: Because the studies reflect the dynamics of national bodies, the findings have poor external validity for a regional policy. A nascent monetary union, like the EAC, must design its policy on the basis of the panel level rather than attempting to infer findings from a group of national outlier cases.

Third, panel studies tend to impose slope homogeneity or linear symmetry. As Pesaran and Smith (1995) demonstrated, taking the cross-sectional averages of heterogeneous coefficients does not necessarily imply that the result corresponds to any single member state. Furthermore, linear symmetric models implicitly assume that inflation accelerations and disinflations have the same predictive effects, an assumption that may not be the case in countries exposed to commodity shocks, exchange rate effects, and demand surges.

Despite the increasing literature on the inflation–growth nexus, these findings are still somewhat limited for the EAC:

1. There is scarce evidence of panel-level causality specific to the EAC.
2. existing panel studies do not permit for slope heterogeneity within a small and heterogeneous monetary union;
3. No other study integrates heterogeneous panel causality with asymmetric shock decomposition in the EAC.

The present study aims to fill these gaps in the literature by combining the Dumitrescu–Hurlin heterogeneous panel framework with the Hatemi-J asymmetric shock decomposition. This allows the causal coefficients to differ across member states, while we also analyse whether the predicted dynamics differ across positive and negative macroeconomic regimes. In so doing, our analysis goes beyond the homogeneous panel averages and beyond the purely national time series evidence, directly testing whether the inflation–growth nexus in the EAC is both heterogeneous and shock-contingent.

3. Methodology

This section outlines the empirical strategy employed to examine both symmetric and shock-dependent asymmetric Granger-causal linkages between inflation and real GDP per capita growth in the EAC panel. The asymmetric specification combines the Dumitrescu–Hurlin panel test and the Hatemi-J (2012) positive and negative shock decomposition to analyse shock-dependent causality. The section also provides information about data and variables being used and how the panel causality testing framework will be conducted to address the research questions, given the possibility of heterogeneity and cross-sectional dependence.

3.1 Data and Variables

A balanced panel comprising annual data from 1970 through 2023 has been employed for the empirical analysis in this research study. The panel represents the five EAC member countries (Burundi, Kenya, Rwanda, Tanzania, and Uganda). Two macroeconomic variables are investigated using a dynamic relationship between them as the primary focus of this research study.

1. **Economic Growth** ($y_{i,t}$)**:** Measured as the growth rate of real Gross Domestic Product (GDP) per capita, calculated as the first difference of the natural logarithm of real GDP per capita (constant 2015 USD). This indicator is selected to capture improvements in the average standard of living rather than aggregate output expansion alone. Data are sourced from the World Bank's World Development Indicators (WDI).
2. **Inflation** ($\pi_{i,t}$)**:** is based on the annual CPI inflation rate (in percent) from WDI. Following Khan and Senhadji (2001), we apply the semi-log transformation $\pi_{i,t}$ = ln($\pi\_raw_{i,t}$ + 10), where $\pi\_raw_{i,t}$ is the raw CPI inflation rate (percent). The constant 10 ensures positivity when inflation is negative.

To conduct the asymmetric causality test, the stationary innovation components of inflation and of growth are decomposed into positive and negative partial sums based on the Hatemi-J (2012) procedure, and the test of causality is performed on all cumulative components.

3.2 Analytical Strategy: Heterogeneous Panel Causality

To derive reliable inference on the inflation-growth nexus, this paper employs a sequential econometric approach that recognizes the structural heterogeneity of EAC. Pooled estimators premised on slope homogeneity, such as the conventional Granger test, position the dynamic causal nexus as identical for all member states, which is most likely an invalid assumption in a heterogeneous region.
Accordingly, we use the Dumitrescu and Hurlin (2012) heterogeneous panel Granger non-causality framework, which has the advantage for the present study through the utilization of heterogeneous coefficients, allowing the causal slope coefficients to differ among cross-sectional units, so one does not have to assume common slopes. To do so, we follow a two-step approach. First, we apply Symmetric Heterogeneous Causality (Section 3.3.1) to isolate the directional relationships. Subsequently, we generalize our model to an Asymmetric Shock-Dependent Specification (Section 3.3.2), where the innovation stationary processes are decomposed into the sum of their respective positive and negative parts, as proposed in Hatemi-J (2012). This allows us to test if the causal relationship depends on the sign of the shock, i.e., if economic growth responds asymmetrically to inflationary vs. disinflationary shocks.

3.3.1 Symmetric Heterogeneous Causality Test

To examine the standard short-run Granger causal linkage between inflation and economic growth, while controlling for cross-country heterogeneity, this investigation resorts to the heterogeneous panel Granger non-causality test developed by Dumitrescu and Hurlin (2012). Unlike traditional pooled panel causality tests, where homogeneous slopes are considered, with this test, cross-sectional unit-specific causal coefficients are allowed to vary, yet valid panel-level inference can be made. Let $y_{i,t}$ denote real GDP per capita growth and $\pi_{i,t}$denote the transformed inflation rate for country $i$at time t. These specifications are implemented using stationary series, consistent with the panel unit root results reported in Section 4.1.2. The symmetric heterogeneous causality test is implemented using the following bivariate panel VAR specification:

$$y_{i,t} = \alpha_i + \sum_{k=1}^{p} \gamma_i^{(k)} y_{i,t-k} + \sum_{k=1}^{p} \delta_i^{(k)} \pi_{i,t-k} + \varepsilon_{i,t}$$

$$\pi_{i,t} = \alpha_i + \sum_{k=1}^{p} \phi_i^{(k)} \pi_{i,t-k} + \sum_{k=1}^{p} \theta_i^{(k)} y_{i,t-k} + \nu_{i,t}$$

where α_i is country-specific fixed effect, p denotes the optimal lag length selected via the Akaike Information Criterion (AIC) for each country-specific regression, and the slope coefficients $(\gamma, \delta, \phi, \theta)$ are allowed to vary across countries, thereby taking into account structural heterogeneity within the EAC.
The null hypothesis of homogeneous non-causality is formally defined as: $H_0: \delta_i^{(k)} = 0$ for all cross-sectional units i and all lags k, which implies that inflation does not Granger-cause growth in any EAC member state. The alternative hypothesis allows for heterogeneous causality: $H_1: \delta_i^{(k)} \neq 0$ for at least one i.

Individual Wald statistics W_i are computed for each cross-sectional unit and averaged across the panel: $\bar{W} = \frac{1}{N}\sum_{i=1}^{N} W_i$. The standardized $\bar{Z}$-statistic is then derived following Dumitrescu and Hurlin (2012). Given the panel structure of this study ($N = 5$, $T = 54$), where the time dimension substantially exceeds the cross-sectional dimension, the asymptotic properties of the D-H framework are appropriate.
Rejection of the null implies that Granger causality exists at least for a cross-sectional unit. This aligns with heterogeneous alternatives under Dumitrescu and Hurlin (2012). Although symmetric D-H test results reveal average short-run Granger causality patterns, there is no distinction between the impacts of positive and negative shocks. This brings the discussion closer to an asymmetric framework.

3.3.2 Asymmetric Heterogeneous Causality Test

To assess whether the relationship between inflation and economic growth is shock-dependent, we can extend the symmetric Dumitrescu–Hurlin model in an asymmetric way by introducing the asymmetric shock decomposition as proposed in Hatemi-J's (2012) work. This also enables the detection of causal relationships that could be missed by a purely symmetric, linear approach, like the effect of positive versus negative changes in inflation on economic growth.
Following Hatemi-J (2012), innovations in inflation and economic growth are decomposed into cumulative positive and negative partial sums. Let $\varepsilon_{i,t}$ denote the innovation component of the stationary variable, obtained from the estimated country-specific VAR residuals. The cumulative positive and negative shocks are constructed as:

$$x_{i,t}^{+} = \sum_{j=1}^{t} \max(\varepsilon_{i,j}, 0), x_{i,t}^{-} = \sum_{j=1}^{t} \min(\varepsilon_{i,j}, 0)$$

Applying this decomposition to both inflation and growth yields four cumulative series: $\pi_{i,t}^{+}$: cumulative positive inflationary shocks, $\pi_{i,t}^{-}$: cumulative negative (disinflationary) shocks, $y_{i,t}^{+}$: cumulative positive growth shocks (expansionary episodes), $y_{i,t}^{-}$: cumulative negative growth shocks (contractionary episodes). Since the decomposition is applied to stationary innovations, the resulting cumulative components are suitable for the asymmetric causality framework in Hatemi-J (2012).
The heterogeneous D-H causality framework is then applied to all eight possible directional combinations between positive and negative shock components:
Inflation shocks → Growth shocks.

1. $\pi^{+} \to y^{+}$
2. $\pi^{+} \to y^{-}$
3. $\pi^{-} \to y^{+}$
4. $\pi^{-} \to y^{-}$

Growth shocks → Inflation shocks.

5. $y^{+} \to \pi^{+}$
6. $y^{+} \to \pi^{-}$
7. $y^{-} \to \pi^{+}$
8. $y^{-} \to \pi^{-}$

For each pairing, the null hypothesis of homogeneous non-causality is tested using the D-H Wald and standardized statistics.
Asymmetric causality is inferred when the null hypothesis of non-causality is rejected for a given directional shock pairing but not for its corresponding opposite shock configuration, indicating differential Granger causality content across positive and negative innovations. For example, rejection of $\pi^{+} \rightarrow y^{-}$combined with non-rejection of $\pi^{-} \rightarrow y^{-}$constitutes evidence that inflationary and disinflationary shocks have asymmetric Granger causal effects on growth contractions. This asymmetric framework, therefore, allows the identification of shock-contingent causal mechanisms that may be particularly relevant for monetary policy design in structurally heterogeneous monetary unions such as the EAC.

4. Empirical Findings and Discussions

This section sets out the empirical results from our heterogeneous panel causality analysis and discusses what they imply for the interaction between inflation and growth in the East African Community. We do so in steps. First, we present the diagnostic tests confirming the validity of our econometric approach. Then, we present the symmetric heterogeneous causality results and thereafter the asymmetric shock-dependent outcomes.

4.1 Preliminary Data Diagnostics

Before proceeding to the heterogeneous panel causality framework, we first need to check the properties of the series in time and get an idea of whether cross-sectional dependence and stationarity exist.

4.1.1 Cross-Sectional Dependence

With economies in the East African Community increasingly integrated and member states sharing more exposure to similar terms of trade, climate-related impacts, and policy shocks, the assumption of independence across cross-sectional units is probably not very realistic. To formally assess this, we consider four complementary tests: the Breusch and Pagan (1980) Lagrange Multiplier test, the Pesaran (2004) scaled LM test, the bias-corrected scaled LM test of Baltagi et al. (2012), and the Pesaran (2004) CD test. This mix of statistics is appropriate for panels with a moderate time span and relatively small cross-sectional sets, such as in our study.

Table 1: Cross-Sectional Dependence Test Results

Variable	Breusch-Pagan LM	Pesaran-scaled LM	Bias-corrected scaled LM	Pesaran CD	Inference
y	37.63*** (0.000)	6.18*** (0.000)	6.13*** (0.000)	5.82*** (0.000)	CSD
π	87.54*** (0.000)	17.34*** (0.000)	17.29*** (0.000)	7.74*** (0.000)	CSD

Source: Authors' computations.
Note: y denotes real GDP per capita growth (Δln real GDP per capita), π inflation. The Breusch–Pagan LM, Pesaran scaled LM, bias-corrected scaled LM, and

Pesaran CD statistics are reported with corresponding p-values in parentheses. *** indicate significance at 1 per cent.

The findings, summarized in Table 1, strongly support rejection of the null hypothesis of no cross-sectional dependence at 1 percent, both for real GDP per capita growth rate and inflation. The corresponding Pesaran CD tests are 5.82 for real GDP per capita and 7.74 for inflation, considerably greater than critical values under the standard normal distribution. Collectively, these numbers indicate a high degree of contemporaneous interconnectedness among EAC countries. The cross-sectional dependence is consistent with the existence of common shocks affecting EAC member states simultaneously. For example, global supply-chain disruptions and commodity price volatility can transmit inflationary pressures and output fluctuations across the region through trade and financial linkages (Pesaran, 2006; Chudik and Pesaran, 2015).
Cross-sectional dependence has serious economic implications. According to Pesaran (2007), if there are unobserved common factors, using the first-generation panel unit root tests with the assumption of cross-sectional independence may produce misleading inferences about size. This may lead to spurious inferences regarding stationarity/non-stationarity of the data. Thus, the rejection of cross-sectional independence supports the use of second-generation unit root tests, such as CIPS and CADF.

4.1.2 Panel Unit Root Tests
Therefore, given that there is cross-sectional dependence, we make use of the Cross-sectionally Augmented IPS (CIPS) and Cross-sectionally Augmented Dickey–Fuller (CADF) tests to determine the order of integration. Unlike first-generation tests, such as ADF, which fail to deal with cross-sectional dependence and may have problems when there is an influence of unobserved common factors (O'Connell, 1998), in the second-generation tests, we deal with cross-sectional dependence explicitly by adding cross-sectional averages to the standard regression, as suggested by Pesaran (2007).

Table 2 summarizes the results. The null hypothesis assumes that the series contains a unit root.
Table 2: Panel Unit Root Test Results (CIPS)

Variables	**Level**		**1st Difference**		
	Without Trend	**With Trend**	**Without Trend**	**With Trend**	**Inference**
y	-6.026***	-6.095***	-6.139***	-6.311***	I(0)
π	-3.655***	-3.768***	-5.889***	-6.072***	I(0)

Source: Author's computations
Note: y denotes real GDP per capita growth (Δln real GDP per capita), π inflation. *** indicate significance at 1 per cent.

Table 3: Panel Unit Root Test Results (CADF)

Variable	Without Trend – At Level			Without Trend – 1st Diff.			With Trend – At Level			With Trend – 1st Diff.			Inference
	T-bar	Z-t-tilde-bar	P-value	T-bar	Z-t-tilde-bar	P-value	T-bar	Z-t-tilde-bar	P-value	T-bar	Z-t-tilde-bar	P-value	
	-3.07	-3.135	0.001***	-4.638	-6.946	0.000***	-3.106	-1.965	0.025**	-4.574	-5.783	0.000**	I(0)
	-3.178	-3.398	0.000***	-6.095	-10.489	0.000***	-3.202	-2.216	0.013**	-6.286	-10.233	0.000**	I(0)

Source: Author's computations
Note: y denotes real GDP per capita growth (Δln real GDP per capita), π inflation. ** and *** indicate significance at 5 per cent and 1 per cent, respectively.

These second-generation unit root findings are robust across the specifications. For real GDP per capita growth series, ($y_{i,t}$), CIPS statistics range from −6.026 to −6.095, and for the inflation series ($\pi_{i,t}$) values range from −3.655 to −3.768. In all instances, the unit-root null is rejected at 1 percent. The CADF statistics reported in Table 3 also reinforce these findings when considering both trend and without trend settings. In general, all the evidence suggests that both series are stationary in levels under CIPS and CADF specifications.
The fact that the inflation and growth series exhibit stationarity also holds important implications for the overall approach taken to our empirical estimation. The lack of stochastic non-stationarity in our inflation and growth series implies that there is no need to invoke the technique of panel cointegration or the vector error correction model in our empirical strategy. Moreover, we can employ the heterogeneous Granger causality approach of Dumitrescu and Hurlin at the levels of the series without risking spurious regression effects driven by common stochastic trends. This means, of course, that our proposed tests can be seen as tests of short-run Granger causality.

4.2 Symmetric Panel-Level Causality Results

To test for short-run Granger causality between inflation and per-capita real GDP growth for a panel of countries, we apply the Dumitrescu-Hurlin (2012) heterogeneous panel Granger non-causality test. The null hypothesis corresponds to homogeneous non-causality, denoted by HNC, where lagged values of the prior independent variable do not Granger-cause the dependent variable in any cross-sectional unit of the sample. The alternative hypothesis permits heterogeneous causality, implying that causality may exist for at least one country in the panel.

Table 4 reports the average Wald statistic ($\bar{W}$) and the associated standardized Z̄-statistic for the period 1970–2023.

Table 4: Results of the Symmetric D-H Panel Granger Causality Test

Causality direction	W̄-stat	Z̄-stat	P-value	Decision
$\pi \rightarrow y$	5.829**	2.583	0.045	$\pi \rightarrow y$
$y \rightarrow \pi$	5.128	1.943	0.220	

Source: Author's Computations
Notes: *y denotes real per capita GDP growth, π inflation. ** denote rejection of the null hypothesis at the 5 percent significance level. W̄-stat is the average Wald statistic, and $\bar{Z}$ -stat are the standardized Dumitrescu–Hurlin statistics. The arrow (⇒) indicates the direction of homogeneous Granger causality.*

The symmetric panel results indicate a unidirectional Granger causality running from inflation to real GDP per capita growth. The null hypothesis of homogeneous non-causality from inflation to growth is rejected at the 5 percent significance level ($\bar{Z} = 2.583,\ p = 0.045$). By contrast, the null that growth does not Granger-cause inflation cannot be rejected ($\bar{Z} = 1.943,\ p = 0.220$), providing no evidence of reverse Granger causal dynamics at conventional significance levels.
The rejection of homogeneous non-causality therefore suggests that the past values of inflation contain statistically significant Granger-causal content for growth in at least one member state of the EAC. This may be consistent with theoretical models, such as those where inflation affects real activity through mechanisms like uncertainty, financial intermediation, or the allocation channel (Friedman, 1977; Fischer, 1993).
Given that there is no reverse panel-level causality during this time, it implies that output expansions do not systematically predict inflation across the region. However, this should not be taken as evidence that there is no demand-driven inflation. Rather, it indicates that such demand-driven effects have yet to become sufficiently widespread in the panel to reject the null hypothesis of homogeneous non-causality used in the Dumitrescu-Hurlin approach.

4.3 Asymmetric Panel-Level Causality Results

To determine if the symmetric panel-level causality identified in Section 4.2 is hiding a shock-dependent mechanism, we perform the Hatemi-J (2012) decomposition and re-estimate heterogeneous panel causality from positive cumulative shocks as well as negative cumulative shocks. The Dumitrescu-Hurlin framework is then applied for each of the eight directional combinations.
For clarity, the results in Table 5 are grouped into three categories: (i) within-regime positive shocks, (ii) within-regime negative shocks, and (iii) cross-regime transmissions (− → + and + → −).

Table 5: Asymmetric Dumitrescu–Hurlin Panel Causality Results (Shock-Dependent Specification)

Shock Pairing	Causality Direction	W̄-stat	Z̄-stat	P-value	Decision
Positive Shocks	$\pi^+ \rightarrow y^+$	8.330**	4.866	0.04	$\pi^+ \rightarrow y^+$
	$y^+ \rightarrow \pi^+$	3.781	0.713	0.67	No causality
Negative Shocks	$\pi^- \rightarrow y^-$	2.403	−0.545	0.77	No causality
	$y^- \rightarrow \pi^-$	14.680**	10.662	0.01	$y^- \rightarrow \pi^-$
Cross-Regime (− → +)	$\pi^- \rightarrow y^+$	5.993	2.732	0.24	No causality
	$y^+ \rightarrow \pi^-$	4.863	1.701	0.47	No causality
Cross-Regime (+ → −)	$\pi^+ \rightarrow y^-$	4.982	1.81	0.48	No causality
	$y^- \rightarrow \pi^+$	3.597	0.545	0.64	No causality

Source: Author's computations.
Notes: y denotes real per capita GDP growth, π inflation. ** denote rejection of the null hypothesis at the 5 percent significance level. W̄-stat is the average Wald statistic, and Z̄ -stat are the standardized Dumitrescu–Hurlin statistics. The arrow (⇒) indicates the direction of homogeneous Granger causality.

The asymmetric results in Table 5 indicate that the inflation–growth relationship in the EAC is regime-contingent rather than symmetric. Specifically, we find evidence of unidirectional causality from positive inflation shocks to positive growth shocks ($\pi^+ \rightarrow y^+$), implying that inflationary accelerations contain predictive information for expansionary output episodes. This suggests that during periods of rising prices, nominal demand pressures may coincide with short-run output gains, consistent with models featuring temporary non-neutrality of money and short-run Phillips-type trade-offs (Phillips, 1958; Friedman, 1977).
Importantly, this transmission mechanism does not extend to negative regimes. In the contractionary domain, the direction of causality reverses. Negative growth shocks significantly predict negative inflation shocks ($y^- \rightarrow \pi^-$), whereas disinflationary shocks do not Granger-cause output contractions. This pattern indicates that recessions in the EAC precede and predict disinflationary dynamics, consistent with aggregate demand compression mechanisms in which declining output reduces price pressures (Fischer, 1993).
Equally important is the absence of cross-regime causality. Neither negative inflation shocks predict expansionary growth episodes nor positive inflation shocks predict

output contractions. The lack of significance in these cross-shock pairings implies that transmission mechanisms operate within regimes rather than across them.
All the evidence points to the conclusion that the inflation–growth nexus in the EAC depends on the nature of the macroeconomic shock. The results of the symmetric panel suggest that the inflation–growth relationship is largely due to behaviour in the presence of positive shocks to inflation. However, once the shock decomposition is accounted for, the dynamic relationship between inflation and growth can be seen to occur via both a forward and backward channel, with inflationary upswings leading to economic expansion and output declines resulting in disinflation. The linear symmetric models conceal the existence of this regime-specific structural relationship.
It is very important to understand that evidence of Granger causality asymmetry, rather than structural causation, should be read from these results. The Dumitrescu - Hurlin Framework identifies temporal precedence among different groups of countries, but does not provide evidence of structural transmission channels. The conclusions about asymmetrical behaviour can provide very important insights into the design of monetary stability in a future monetary union exposed to both common and idiosyncratic shocks.

4.4 Discussion: Regime-Contingent Inflation–Growth Causality Dynamics in the EAC

The findings of both the symmetric and asymmetric tests suggest that the inflation-growth nexus in the EAC is shock contingent. The findings of the symmetric test of Dumitrescu and Hurlin support the existence of a unidirectional predictive relationship from inflation to growth; however, the findings of the Hatemi-J decomposition reveal that the panel test results are regime-specific. In particular, positive inflation shocks lead positive growth shocks, and negative growth shocks lead disinflation; there is no support for any cross-regime effects.
This may well be one contributory reason why the recent evidence from the EAC and Africa seems rather mixed when analyzed using techniques like linear or level-based approaches. A major strand within the very recent literature emerging from the EAC refers to thresholds for inflation, often via consideration of inflation as a force acting to slow growth once it exceeds some particular range (Yabu and Kessy, 2015; Ndoricimpa, 2017; Ezako, 2023; Mbowe and Mpango, 2024). This body of literature offers some insight into "how much inflation is too much," but does not address which leads in the short term—inflation or growth?—or for which regimes. Our paper extends this literature by indicating that the lead-lag relationship depends on the sign, in agreement with the idea that the inflation-growth linkage changes over contractionary vs. expansionary periods.
The results also align with broader recent panel evidence for Africa that stresses heterogeneity and instability in the inflation–growth nexus, where average effects can conceal conditional dynamics (Ndong et al., 2024). In particular, the finding that output contractions predict disinflation is consistent with demand-compression mechanisms highlighted in macro-growth interpretations of inflation dynamics, and it is compatible with regional work that documents the importance of common shocks and cyclical co-movements in EAC macro outcomes (Espinoza et al., 2010; Ezako, 2023). At the same time, the positive-regime result, where inflationary accelerations precede expansions, is consistent with short-run non-neutrality interpretations in which demand pressures temporarily raise both output and prices (Phillips, 1958;

Friedman, 1977). Taken together, the comparison suggests that parts of the existing evidence are not contradictory, but instead are capturing different regimes, samples, or identifying assumptions.
Two implications follow for the EAMU. First, convergence rules such as a uniform inflation ceiling implicitly treat inflation as uniformly informative about macroeconomic overheating and uniformly costly for growth. Our results suggest a more conditional interpretation: inflationary upswings coincide with expansionary episodes, while disinflation often reflects contractionary conditions rather than successful stabilization. Second, surveillance and coordination should therefore be explicitly shock-aware. The same inflation outcome can reflect different underlying conditions depending on whether the region is in an expansionary or contractionary regime, which matters for the calibration and timing of common policy responses (De Grauwe, 2020; Oloo et al., 2021).
Again, the overall body of evidence points to the regime-contingent approach because the presence of transmission is detectable within regimes, not detectable between regimes, and the symmetric approach hides these relevant distinctions. This approach reiterates the interpretation of the symmetric panel result while bringing it into line with the emerging body of recent EAC and African literature on the asymmetry between inflation and growth.

5. Conclusion

This paper examines the short-run Granger causality between inflation and real GDP per capita growth for the East African Community (EAC) over the period 1970-2023, using heterogeneous panel Granger causality methods. The motivation for this study stems from the EAC commitment towards the East African Monetary Union (EAMU), and the implicit assumption in the convergence criteria that the inflation-growth relationship for the EAC is stable and symmetric. We adopt the Dumitrescu and Hurlin heterogeneous panel causality methods, combined with the Hatemi-J decomposition, to determine whether causal relationships depend on the sign of the macroeconomic shocks (Dumitrescu & Hurlin, 2012; Hatemi-J, 2012; EAC, 2013).
Three key results can be noted. First, as revealed by the diagnostic evidence, the hypothesis of no cross-sectional dependence is rejected for both inflation and economic growth. Second, as revealed by second-generation unit root tests, both series appear to be stationary at levels, which means we can proceed directly to a causality analysis without needing to resort to any kind of cointegration-based correction mechanisms. Third, as revealed by the Dumitrescu–Hurlin test, which was carried out in its symmetric version, we can observe a one-way Granger causality running from inflation to economic growth at the panel level without any reverse causality from economic growth to inflation.
The main contribution of the paper is that this symmetric panel inference masks a pronounced asymmetry revealed by shock decomposition. In the expansionary regime, positive inflation shocks Granger-cause positive growth shocks ($\pi^+ \rightarrow y^+$), whereas the reverse direction is not supported. In contrast, in the contractionary regime, negative growth shocks Granger-cause negative inflation shocks ($y^- \rightarrow \pi^-$), while negative inflation shocks do not predict growth contractions. Cross-regime channels are statistically insignificant. Taken together, the results imply that inflation–growth interactions in the EAC operate within regimes rather than across them, and

that linear symmetric approaches may obscure sign-dependent Granger causal structure (Hatemi-J, 2012; Dumitrescu & Hurlin, 2012).

These findings suggest that uniform monetary convergence criteria may have heterogeneous macroeconomic implications across regimes. In particular, policy frameworks that respond mechanically to observed inflation outcomes may produce different real effects depending on whether inflationary or disinflationary dynamics are driven by positive or negative underlying shocks. While the present analysis does not estimate an explicit monetary policy reaction function, the asymmetric predictive relationships documented here indicate that regime-contingent considerations may be relevant for policy coordination within the EAC (De Grauwe, 2020; Oloo et al., 2021).

The findings should be interpreted with appropriate caution. Granger causality in this case measures predictability rather than structural causation, and the asymmetry by itself does not shed light on the true mechanisms at play to induce the observed regime dependence. Another drawback is that the EAC panel is small in the cross-sectional dimension, and the model with just two variables excludes some possibly important mediating channels, such as the role of fiscal dominance, exchange rate effects, and the role of external price shocks. All this hints at avenues along which this study could be extended in the future.

In short, the results suggest that, for the EAC, there is no simple, symmetric cause-and-effect relationship between inflation and growth. The Granger causality in this case depends on the particular type of shock: in this case, positive inflation shocks are predictive of positive growth shocks, whereas downturns are followed by a decrease in inflation. It is, therefore, important to consider this asymmetry to credibly conduct policy, specifically in terms of possible convergence criteria for monetary unions.

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