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Impact of Climate shocks on Inflation and GDP: Evidence from Uganda

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Abstract

This study examined the impact of climate shocks on headline inflation and real gross domestic product (GDP) in Uganda. The study used quarterly data for 2000–2022 and applied vector autoregression (VAR) frameworks on macroeconomic and climate change indicators. The results show that climate shocks significantly affect both inflation and output. Headline inflation responds persistently, indicating prolonged price instability after climate disturbances. In contrast, the effect on GDP is transitory, reflecting a temporary decline in economic activity. These patterns highlight Uganda's structural vulnerability to climate risks. The findings underscore the need for the Bank of Uganda to incorporate climate risk factors into its modelling and policy frameworks to improve the effectiveness of monetary policy. Beyond macroeconomic policies, this study emphasizes the importance of building resilience through targeted investments in irrigation systems and drought-resistant crop varieties. Such measures are essential for mitigating the economic costs of climate variability and safeguarding long-term stability.

Keywords: Climate change; Inflation; Monetary policy

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I. Introduction

The primary mandate of the Bank of Uganda (BoU) is to maintain price stability. Achieving this objective requires continuous assessment of the risks that may hinder the attainment of low and stable inflation. This necessitates careful identification and evaluation of the nature and magnitude of the shocks that affect macroeconomic dynamics. In recent years, climate change has emerged as a critical source of such shocks, raising concerns about its implications for macroeconomic management and the formulation of monetary policy.

The increasing frequency and intensity of climate-related events such as droughts, floods, and erratic rainfall patterns have had significant repercussions on economic growth and price stability, particularly in low-income countries. These developments have sparked an important debate in the literature regarding the role of monetary policy in managing climate-induced risks (Barret, 2022). Given the potential for climate shocks to generate both inflationary and deflationary pressures, central banks face a complex policy dilemma, underscoring the importance of integrating climate risk assessments into monetary policy frameworks to ensure effective climate change responses.

Extreme weather events can directly impair agricultural production by reducing yields and disrupting supply chains, thereby exerting an upward pressure on food prices. In Uganda, such shocks often force farmers to adopt costly mitigation measures, including irrigation, fertilizers, and pest control, to preserve productivity. These additional input costs further increase in production expenses, reduce supply, and contribute to inflationary pressures (Abidi et al., 2024).
However, the relationship between climate shocks and inflation is not linear. In certain instances, extreme weather events may depress economic activity and reduce firm profitability. Moreover, post-disaster increases in loan defaults can cause banks to tighten credit conditions, resulting in a contraction in investment and consumption, which may introduce deflationary tendencies into the broader economy (Abbas et al., 2021). At the household level, the destruction of property and livelihoods due to climate events can lead to diminished consumption and aggregate demand, exacerbating downturns and reinforcing price declines.

As such, the net effect of climate shocks on inflation remains ambiguous and is contingent upon the relative strength of opposing forces. While some climate events may raise prices through supply constraints and cost-push inflation, others may depress demand and foster disinflationary pressures. Additionally, these effects are heterogeneous across sectors with differential impacts on food prices, services, and industrial goods. The complexity of this interplay highlights the analytical and policy challenges that central banks face in navigating climate-induced volatility (Kara & Thakoor 2023). This issue is particularly pertinent in Uganda, where food crops and non-alcoholic beverages constitute a significant share of the Consumer Price Index (CPI), accounting for approximately 27.1% of the CPI basket.

Despite the growing relevance of climate-related risks to monetary policy, empirical research on this nexus remains limited in low-income countries. Most existing studies have focused on advanced and emerging economies, where financial systems are more developed, and market-based policy tools are dominant. These studies often advocate the integration of climate risks into central bank mandates through instruments such as green quantitative easing, carbon-sensitive interest rates, and climate-aligned collateral frameworks. However, such recommendations may not be directly applicable to developing countries, such as Uganda, which face structural constraints, shallow financial markets, and increased exposure to climate variability.

In Uganda, the unique nature of climate shocks, particularly their supply side origins and direct impacts on food production, requires a more tailored approach. The effectiveness of monetary policy in this context requires a deep understanding of both the transmission channels of climate shocks and institutional and economic realities that shape policy responses. This study empirically investigates the effects of climate shocks on inflation and economic growth in Uganda, focusing on their implications for monetary policy design and implementation. This study seeks to understand how climate shocks influence the inflationary environment and whether the central bank's response is consistent with its inflation-targeting mandate.

Preliminary evidence suggests that the Bank of Uganda has greater flexibility in managing inflation during positive climate shocks, whereas negative climate shocks are associated with disinflationary pressures. Understanding the dynamics of this relationship is critical for informing policy adjustments in the face of increasing climate risk.

The remainder of this paper is organized as follows. Section 2 provides stylized facts on climate indicators while section 3 reviews the relevant literature on climate change, inflation dynamics, and monetary policy's role. Section 4 discusses the data sources of the key variables used in the analysis and outlines the methodological framework. Section 5 presents and discusses the main findings while section 6 provides the conclusion and policy implications as well as suggestions for future research.

II. Stylized Facts on Climatic Indicators in Uganda

The climate of Uganda is predominantly shaped by its equatorial location, varied topography, and the presence of significant water bodies, including Lake Victoria, Albert, and Kyoga. Most of the country experiences a bimodal rainfall pattern, with two distinct rainy seasons that occur from March to May and September to December. However, the northern Uganda region, which lies outside the central equatorial belt, is characterised by a unimodal rainfall regime with a single rainy season extending from March to October.

Despite its location within a relatively humid equatorial climate zone, substantial spatial variations in rainfall patterns have been observed throughout Uganda. These differences are driven by factors, such as altitude, prevailing wind systems, and proximity to lakes and rivers in the region. The Indian Monsoon system significantly influences seasonal rainfall in Uganda, particularly during the long rainy season. Furthermore, the air mass of the Congo, the Inter-Tropical Convergence Zone (ITCZ), and fluctuations in the Indian Ocean Dipole (IOD) significantly affect the distribution and intensity of rainfall and temperature patterns across the country.

Over the past several decades, Uganda has experienced notable climatic changes, with a bias towards decreases in annual and seasonal rainfall. The most pronounced reduction occurred during the first rainy season (March–May), when an average decrease of approximately 6.0 mm per month per decade was observed. This trend has been particularly severe in the northern districts, which are already more vulnerable owing to their dependence on a single rainy season. Consequently, the frequency and intensity of drought episodes have increased, and several parts of the country have experienced prolonged dry spells over the past 60 years.

Simultaneously, rising temperatures have become a consistent feature of Uganda's climate. Since the 1960s, the country has recorded an average temperature increase of 1.3°C, with minimum temperatures rising by 0.5°C to 1.2°C and maximum temperatures increasing by 0.6°C to 0.9°C over the same period. The rate of warming has been estimated to be approximately 0.28°C per decade, affecting both diurnal and nocturnal temperature ranges. Over the past three decades, the country has witnessed a marked increase in the frequency of extreme weather events including floods, droughts, and landslides. In particular, flooding has become more frequent mainly because of the intensification of rainfall, a trend that is consistent with larger global patterns of climate change.

These climatic developments have significant implications for Uganda's agricultural productivity, water resource management, and macroeconomic stability and thus warrant integration into national development and macroeconomic policy frameworks, including monetary policies.

Table 1: Frequency of Natural Disasters in Uganda (1900-2020).

Natural Hazard 1900–2020	Subtype	Events Count	Total Deaths	Total Affected	Total Damage ('000 USD)
Drought	Drought	9	194	4,975,000	1,800
Earthquake	Ground Movement	5	115	58,100	71,500
Epidemic	Bacterial Disease	28	3,204	237,665	0
	Viral Disease	10	466	108,036	0
Flood	Flash Flood	4	76	8,614	0
	Riverine Flood	15	267	1,051,945	6,871
Storm	Convective Storm	1	23	47	0
Landslide	Landslide	8	540	151,546	0
	Mudslide	1	51	0	0

Source: World Bank

Climate change projections for Uganda indicate a continued rise in average temperatures, along with increased variability and intensity of precipitation patterns. These changes are expected to have profound implications for water access and distribution in all regions of the country. Flooding is projected to intensify in the central and southern regions, primarily because of the increasing frequency of high-intensity rainfall events. In contrast, other regions, particularly the north, northeast, west, and southwest, are expected to experience prolonged dry spells, reduced water availability, and frequent future drought episodes.

Climate change poses significant risks to climate-sensitive sectors, including agriculture, water resources, public health, wetlands, and forestry. The agricultural sector, which remains a critical source of income and employment in Uganda, is particularly vulnerable to excessive rainfall and drought-induced crop failure. Similarly, water scarcity and flooding threaten the sustainability of natural ecosystems and availability of clean water for domestic and industrial use in the region. In the health sector, climate-induced disruptions are expected to exacerbate the burden of diseases, particularly vector- and waterborne diseases.

Generally, the projected impacts of climate change underscore the urgent need for adaptive policy responses, particularly to enhance sectoral resilience and to integrate climate considerations into national planning and macroeconomic management.

III. Literature Review

The literature on the role of monetary policy in mitigating climate-related risks can be broadly categorized into two themes. The first strand views monetary policy as a complementary tool to climate policy, particularly for addressing climate-induced financial and macroeconomic risk. Scholars in this line of thought argue that climate strategies should not be implemented in isolation, but should be integrated within broader macroeconomic frameworks. Earlier studies, such as Kahn et al. (2021), assessed the long-term macroeconomic impacts of climate change using cross-country panel regressions. Although valuable for capturing broad trends, these studies often fail to explicitly account for business cycle dynamics, thereby overlooking the short-to medium-term transmissions of climate shocks.

Ciccarelli & Marotta (2024) attempted to fill this gap by employing a structural vector autoregression (SVAR) model covering 24 OECD countries between 1990 and 2019. Their empirical framework disentangled the macroeconomic effects of physical risks (e.g. climate-driven disasters) and transition risks (e.g. policy responses and technological changes). The findings of this authors showed that climate shocks behave like negative demand shocks, depressing economic activity, whereas green innovation and well-calibrated environmental policies can mitigate these adverse effects. Importantly, they argued for balanced policy mixes that combine demand support with technology-driven supply improvements tailored to country-specific conditions.

Cevik & Jalles (2024) investigated the macroeconomic effects of climate-induced natural disasters on inflation and output growth using a panel of countries from 1970 to 2020. Applying the local projection method, they estimated the dynamic responses of inflation and GDP growth to distinct disaster categories, accounting for both demand-and supply side transmission channels. The analysis revealed significant but heterogeneous effects across disaster types and regions. Advanced economies experience more contained and short-lived impacts, reflecting stronger fiscal capacities and institutional frameworks, whereas developing economies face more severe and persistent disruptions. These results underscore the critical role of economic structure and fiscal health in shaping resilience to climate shocks and highlight the persistent cross-country asymmetries in macroeconomic vulnerability.

Within the same strand, Benmir & Roman (2020) developed a macro-financial environmental Dynamic Stochastic General Equilibrium (E-DSGE) model to investigate how different policy instruments, fiscal, monetary, macroprudential, and carbon taxation, interact to shape the transition process toward clean technology. By embedding environmental considerations into monetary frameworks, they highlight how central banks can enhance macroeconomic stability while supporting their transition to a low-carbon economy. Chan (2020) extended the analysis by applying an E-DSGE model to assess the comparative effectiveness of monetary and fiscal instruments in addressing air pollution. Their simulations revealed that monetary policy can reduce pollution-related economic costs by lowering the general price level, although they underscored the superior effectiveness of carbon taxation when combined with monetary tools.

Similarly, Campiglio (2016) employed a theoretical financial market framework to examine the limitations of carbon pricing. He highlighted how structural market failures and underinvestment in low-carbon technologies undermine purely price-based approaches to climate policy. To address this, the author advocated for combining monetary policy with macro-prudential regulation through instruments, such as targeted credit allocation, green refinancing facilities, and differentiated capital requirements. Such measures are particularly relevant in emerging and developing economies, where central banks retain greater discretion in credit allocation.

The second strand of literature emphasizes the direct role of monetary policy in advancing climate objectives, particularly through innovative central banking. Notably, Böser & Senni (2020) developed a calibrated dynamic general equilibrium model to evaluate the effectiveness of a novel emission-based monetary policy interest rate, in which the cost of central bank liquidity provision to banks increases with the carbon intensity of their portfolios. Calibrated from Euro Area data, their simulations show that such climate-adjusted monetary policy mechanisms can enhance financing conditions for low-carbon sectors, incentivize cleaner technologies, and reduce long-term climate damage by reshaping credit allocation. Similarly, Boneva et al. (2022) adopted a policy-orientated institutional analysis to assess how central banks can foster green financial markets. They emphasized regulatory support for green bonds and liquidity facilities for green assets as mechanisms through which monetary policy can expand the availability of climate-aligned instruments to achieve net zero emissions.

McConnell et al. (2022) combined green policy instrument with a stylized general equilibrium model that includes a banking sector. They simulated the impact of "brown collateral haircuts", which apply steeper valuation discounts to carbon-intensive assets pledged as collateral to central banks. Their findings indicate that such measures redirect investments toward low-carbon sectors, reduce financing for high-carbon activities, and promote emission reductions, thus demonstrating a pragmatic and implementable green monetary policy instrument for the central bank. Taken together, these contributions highlight the growing recognition that monetary policy, through both conventional instruments (e.g. interest rate policy and open market operations) and unconventional tools (e.g. collateral frameworks and targeted refinancing), can significantly influence climate outcomes.

Beyond methodological innovations, the literature reflects a broader debate on the role of central banks. One school of thought emphasizes the maintenance of traditional mandates of price stability, growth, and financial stability while playing a supportive role in climate transition. Another, more interventionist perspective calls for embedding climate risks directly into monetary policy frameworks, recognizing that climate shocks, particularly in developing countries, often manifest as severe supply side disruptions with far-reaching macroeconomic consequences. This study is based on the latter perspective. In climate-vulnerable economies, such as Uganda, where extreme weather events and agricultural disruptions drive inflation volatility, demand management frameworks are inadequate. Addressing these challenges requires recalibrating monetary policy, rethinking inflation-targeting regimes, and adapting tools such as interest rate policy, liquidity provision, and open market operations to account for climate-related supply shocks. Thus, a climate-sensitive monetary policy is essential to maintain macroeconomic stability and support sustainable development amid intensifying climate risks.

IV. Data and Methodology

4.1 Data Description and Sources

Monthly precipitation data for Uganda was obtained from the Climate Research Unit (CRU) of the University of East Anglia. The rainfall measurements, recorded in millimeters, were aggregated quarterly by computing the arithmetic mean of the monthly observations within each quarter. To account for recurring intra-annual fluctuations, the data was seasonally adjusted using standard seasonal decomposition techniques. Finally, a natural logarithmic transformation was applied to the seasonally adjusted series to approximate the normality and enhance the interpretability of the results. To empirically assess the effect of climate variability, specifically, precipitation shocks on inflation, and monetary policy, rainfall was used as a proxy for climate shocks.

In the analysis, we used the 91-day treasury bill rate as a proxy for monetary policy. This choice accommodates the monetary and inflation targeting frameworks employed by the Bank of Uganda (BoU) between 2000 and 2022. The inflation-targeting framework became operational in July 2011, marking a shift in monetary policy implementation. The 91-day Treasury bill rate was used as the key monetary policy instrument in this study for several reasons. First, it provides consistency across different monetary policy regimes, covering both the monetary and inflation-targeting periods in Uganda. This continuity enables a coherent long-term analysis of monetary policy dynamics, as shown in Annex 1.

Second, the 91-day Treasury bill rate serves as a forward-looking indicator, capturing market expectations of future interest rates and inflation more effectively than other proxies such as the interbank rate. This forward-looking property is particularly relevant in an inflation-targeting regime in which expectations play a critical role in the transmission of monetary policy. Third, while money aggregates have traditionally functioned as intermediate targets of monetary policy, their effectiveness as proxies for monetary policy is limited, particularly in forward-looking frameworks. Unlike money aggregates, the 91-day Treasury bill rate directly reflects market perceptions of the central bank's policy intentions, making it a more reliable indicator of the BoU's monetary policy stance. Collectively, the use of the 91-day Treasury bill rate enabled a comprehensive assessment of the impact of monetary policy over time, capturing both historical and contemporary policy practices.

Inflation data were sourced from the Uganda Bureau of Statistics (UBoS) and included indices for headline (overall price level), core, and food crop inflation. The decomposition of headline inflation follows the Classification of Individual Consumption According to Purpose (COICOP) framework, which reveals the contributions of various expenditure categories to overall inflation.

Based on the two most recent rebasing exercises[1], the composition of the consumption basket is as follows: Food and non-alcoholic beverages: 27.1% (28.5%), housing, water, electricity, gas, and other fuels: 10.42% (11.9%), transport: 10.45% (13.8%), restaurants and accommodation services: 8.7% (5.7%). These components exert a substantial influence on the overall inflation rate, with food and nonalcoholic beverages being the largest contributors (Annex 3). In particular, food crop inflation significantly shapes headline inflation trends in Uganda. Periods marked by elevated food crop inflation frequently coincide with increases in the overall inflation, as shown in Annex 2. This strong relationship underscores the importance of closely monitoring and managing food crop prices to achieve price stability and to effectively control inflation. For the empirical analysis, inflation indices were seasonally adjusted and transformed using natural logarithms to ensure stationarity and facilitate interpretation.

Exchange rate data was sourced from the Bank of Uganda. The data were prepared for analysis as follows: Monthly exchange rates were averaged to obtain quarterly averages. This ensured that the data aligned with the frequencies of the other economic variables considered. Quarterly exchange rates were logarithmically transformed. This step is essential for stabilizing the variance of the data and ensuring that the relationship between the variables is linear, which is a common assumption in many econometric models. GDP data was sourced from the UBoS.

This study used quarterly data covering the period from 2000Q1 to 2022Q4. This sample period was determined by the availability of quarterly GDP data, which is essential for capturing the real economic impact of climate shocks.

4.2 Methodology

This study investigated the impact of climate shocks on inflation and monetary policy in Uganda using a Vector Autoregression (VAR) framework. The VAR approach, is particularly suited for analyzing the dynamic interrelationships among macroeconomic time series. In this framework, each variable in the system is expressed as a linear function of its past values (lags) and the lagged values of all other variables in the model.

The baseline VAR model is specified as follows:

$$Y_t = \alpha + \sum_{j=1}^{p} \beta_j Y_{t-j} + \epsilon_t, \qquad (1)$$

where:

- Y_t is a vector of endogenous variables at time t,
- α is a vector of constants,
- β_j are coefficient matrices associated with j lags,
- ϵ_t is a vector of reduced-form error terms that are assumed to be white noise.

The set of endogenous variables included in the model is as follows.

[1] Figures in parentheses correspond to the 2009/10 rebased consumption basket, with weights derived from the Uganda National Household Survey

- the first difference of the logarithm of real GDP,
- the first difference of the logarithm of headline inflation,
- the 91-day Treasury bill rate (serving as the monetary policy rate), and
- the logarithm of the rainfall.

To identify the structural shocks underlying reduced-form residuals, the study specifically used Structural VAR (SVAR). SVAR extends the above specified VAR model by imposing economically motivated restrictions to disentangle contemporaneous relationships among variables and recover orthogonal structural innovations. Unlike reduced-form VAR, which lacks a theoretical structure and assumes the independence of shocks, SVAR allows for contemporaneous and dynamic interactions by imposing economically motivated restrictions. It is therefore most appropriate, considering that climate change operates largely as a supply side disturbance. This ensures that the identified shocks are both empirically tractable and economically interpretable, making the framework well suited for analyzing the macroeconomic effects of climate shocks.

The SVAR model can be represented as follows:

$$A_0 Y_t = \sum_{j=1}^{p} A_j \, Y_{t-j} + \mu_t, \qquad (2)$$

where:

- A_0 is a matrix of contemporaneous coefficients,
- A_j are matrices of lagged coefficients,
- μ_t is a vector of structural shocks assumed to be serially uncorrelated and economically interpretable.

The corresponding reduced-form VAR is

$$Y_t = \sum_{j=1}^{p} A_0^{-1} \, A_j Y_{t-j} + A_0^{-1} \mu_t, \qquad (3)$$

Thus, the reduced-form residuals ϵ_t are linear combinations of structural shocks: $\epsilon_t = A_0^{-1} \mu_t$. To recover the structural matrix A_0, we impose Blanchard and Quah (1989) type restrictions, which are widely used in macroeconomic applications for identification. These restrictions exploit long-term neutrality assumptions, typically assuming that certain shocks have no long-term effect on specific variables (e.g. monetary shocks do not affect output in the long run). We specify the order of the variables to ensure that climate shocks are identified separately from the other disturbances in the economy. In this framework, climate shock/rainfall, considered the most exogenous factor, is placed first, followed sequentially by CPI (headline inflation), GDP growth, and the policy interest rate (see Annex 2). This ordering reflects a recursive identification strategy guided by monetary theory, particularly the Taylor rule, which posits that central banks adjust their policy rates in response to inflation and output dynamics.

Additionally, two dummy variables were introduced to control for major exogenous shocks during the sample period.

- one capturing the 2008–2009 global financial crisis, and

- Another capturing the 2020–2021 COVID-19 pandemic.

Each dummy variable takes a value of one during the relevant period and zero otherwise.

V. Empirical Results

Table 2 presents the summary statistics for the key variables used in the empirical analysis, providing an overview of their distributional characteristics, including measures of central tendency and dispersion over the study period. The average growth of the real gross domestic product (GDP) was 6. 0%, with a median of 5.9%. The highest quarterly gross domestic product (GDP) growth rate was 39. 8%, whereas the lowest was –19.3%, reflecting considerable variation in economic performance over the period. Headline inflation had an average rate of 6.1%, with a median of 5.2%. The maximum headline inflation reached 24.1%, while the minimum was 4.3%, indicating notable volatility in consumer prices. Food inflation exhibited even greater variability, averaging 7.9% with a median of 6.3%. The highest rate of food inflation was 37.7 In response to inflation dynamics, the policy rate—proxied by the 91-day Treasury bill rate—averaged 10.3%, with a median of 9.4%. The highest recorded rate was 22.1%, while the lowest was 3.8%, indicating the wide range of monetary policy stances adopted over the sample period.

These summary statistics highlight substantial fluctuations in Uganda's macroeconomic conditions and underscore the importance of investigating the interaction between climate shocks, inflation, and monetary policy responses.

Table 2: Summary Statistics of Key Macroeconomic Variables

Statistic	Rainfall (mm)	Real GDP Growth (log diff)	Food Inflation (log diff)	Policy Rate (91-day T-bill)	Headline Inflation (log diff)
Minimum	43.73	-0.1931	-0.2552	3.76	-0.0429
1st Quartile	79.14	0.0239	-0.0303	7.73	0.0266
Median	109.55	0.0586	0.0625	9.38	0.0515
Mean	105.84	0.0601	0.0788	10.30	0.0610
3rd Quartile	121.56	0.0834	0.1824	11.16	0.0806
Maximum	202.07	0.3982	0.3771	22.12	0.2408

Notes: This table presents summary statistics for the main variables used in the empirical analysis based on quarterly data from 2000Q1 to 2022Q4. Rainfall was measured in millimeters. Real GDP growth, food inflation, and headline inflation were expressed as the first differences in their natural logarithms. The policy rate refers to the 91-day treasury bill rate, expressed in percentage terms. The reported statistics include the minimum, 1st quartile, median, mean, 3rd quartile and maximum values over the sample period.

Visual inspection of the time-series plots (Annex 5) revealed that several variables used in the analysis exhibited distinct stochastic characteristics. In particular, headline inflation, food inflation, core inflation, exchange rate, and real GDP displayed non-stationary behaviour characterized by trends and persistent shocks. Conversely, rainfall and the 91-day Treasury bill rate exhibited mean-reverting tendencies, suggesting stationarity. We employ the augmented Dickey (ADF) test to formally assess the stationarity properties of these variables. The null hypothesis of the ADF test posits the presence of a unit root, indicating that the series is nonstationary, whereas the alternative hypothesis suggests stationarity. The results for the unit-root tests are presented in Annex 6.

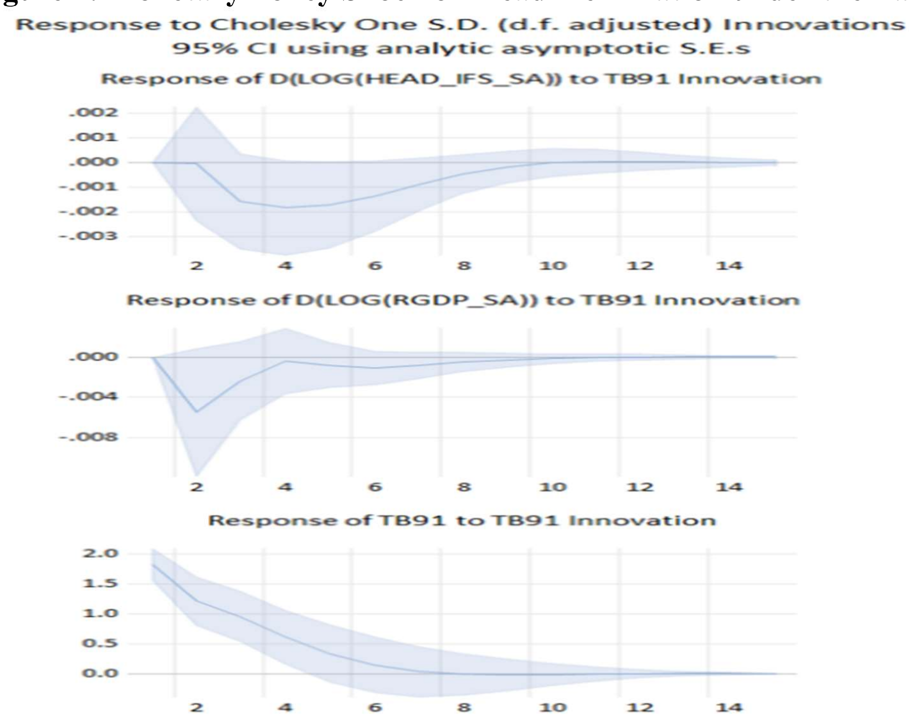
5.1 Impulse Response Functions

To investigate the dynamic effects of climate shocks on inflation and output, we employ impulse response functions (IRFs) derived from the estimated VAR and SVAR models. These IRFs enable analysis of how headline inflation and GDP respond to a one-standard-deviation structural innovation in the variables of interest.

5.1.1 Baseline VAR without Climate Variable

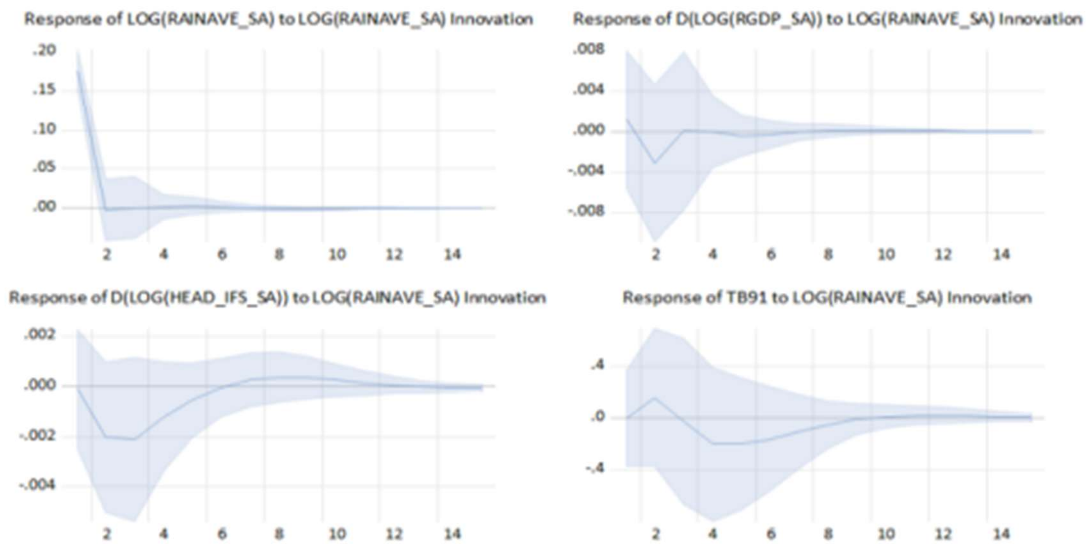
First, we estimate a baseline VAR model that excludes climate variables (rainfall). A one-standard-deviation monetary policy shock to headline inflation produces no immediate response in approximately two quarters. Thereafter, headline inflation declines by approximately 0.18 percentage points by the fourth quarter. This disinflationary effect is temporary; inflation gradually increases thereafter and the effect of the shock dissipates by the tenth quarter (Figure 1).

Figure 1: Monetary Policy Shock on Headline Inflation under the Baseline Scenario



In response to the same monetary policy shock, GDP contracts by approximately 0.5 percentage points in the second quarter. The contraction is short-lived as the economy recovers to its pre-shock level by the fourth quarter, after which the effect of the shock fades away. This finding is consistent with expectations that tighter monetary conditions dampen economic activity in the short term.

Figure 2: Responses of Headline Inflation, Policy Rate, and GDP to Various Shocks in Uganda (2001-2022).

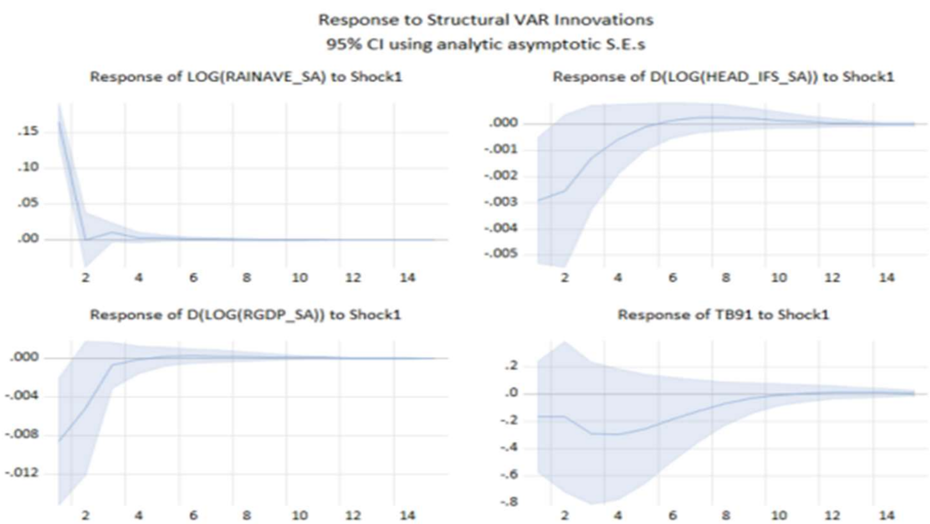


5.1.2 VAR with Climate Shocks

In the second phase of the analysis, we re-estimated the VAR model by incorporating rainfall as a proxy for climate shocks. The impulse response of headline inflation to a climate shock indicated an initial decline of approximately 0.2 percentage points by the second quarter. This is followed by a short plateau, after which inflation increases modestly for two quarters before the shock effect diminishes.

The response of the GDP to climate shocks was immediate and pronounced. Real output contracts by approximately 0.3 percentage points by the third quarter, before beginning a gradual recovery, with the shock fading thereafter (see Figure 2).

Figure 3: Responses of Headline Inflation, Policy Rate, and GDP to Rainfall Shock in Uganda (2001-2022).



In figure 3, the results show a SVAR estimation which represent a more rigorous identification of structural shocks involving imposing contemporaneous restrictions. The results indicate that a climate shock leads to a decline in headline inflation of approximately 0.3 percentage points. This is followed by a sustained increase in inflation over the six quarters, suggesting that the effect of the shock is persistent and may influence the monetary policy transmission mechanism over an extended horizon.

The SVAR results for GDP reveal a sharper contraction: real output declines by 0.8 percentage points following a climate shock, before beginning to recover over the subsequent four quarters. Although the shock eventually dissipated, its immediate effects were significant. However, it should be noted that the duration and magnitude of the impact of a shock may depend on the type and severity of the climate event. For example, extreme floods are likely to generate more profound and prolonged effects than moderate rainfall anomalies.

5.2 Variance Decomposition

To assess the relative contribution of different structural shocks to system variability, we perform a variance decomposition of the endogenous variables. The decomposition results revealed that the variation in rainfall is largely explained by its own shocks (84%).

For headline inflation, own shocks account for approximately 74% of the forecast error variance, followed by a policy rate of 17%, highlighting the importance of monetary policy in price dynamics. In the case of GDP, 86% of the variance is attributed to own shocks, whereas climate shocks (rainfall) contribute approximately 9%, underscoring the significant role of climate variability in output fluctuations.

Lastly, policy rate dynamics are largely influenced by innovations in headline inflation and GDP, indicating that the central bank responds to both price and output developments when setting monetary policy.

Table 3: Forecast Error Variance Decomposition

Variance Decomposition of LOG(RAINAVE_SA):					
Period	S.E.	Shock1	Shock2	Shock3	Shock4
1	0.173696	90.46692	2.980936	4.080392	2.471748
2	0.179381	84.82405	2.921265	8.164209	4.090475
3	0.180043	84.52831	3.168179	8.158528	4.144980
4	0.180270	84.34001	3.351770	8.139097	4.169121
5	0.180358	84.27080	3.430469	8.132868	4.165861
6	0.180384	84.24916	3.453943	8.130673	4.166221
7	0.180393	84.24100	3.457523	8.130985	4.170489
8	0.180399	84.23545	3.457318	8.132080	4.175155
9	0.180404	84.23089	3.457749	8.132969	4.178394
10	0.180408	84.22764	3.458859	8.133441	4.180060
Variance Decomposition of D(LOG(HEAD_IFS_SA)):					
Period	S.E.	Shock1	Shock2	Shock3	Shock4
1	0.011755	6.086572	73.65667	2.449434	17.80732
2	0.013943	7.618075	75.97318	2.948428	13.46032
3	0.014546	7.766201	77.07533	2.711274	12.44719
4	0.014730	7.727060	76.65152	2.776112	12.84531
5	0.014825	7.633837	75.75374	3.018118	13.59430
6	0.014902	7.563500	75.02193	3.248148	14.16643
7	0.014962	7.528228	74.61551	3.393627	14.46263
8	0.015001	7.516288	74.45138	3.462138	14.57019
9	0.015021	7.514637	74.40867	3.485753	14.59094
10	0.015030	7.515670	74.40747	3.490534	14.58632
Variance Decomposition of D(LOG(RGDP_SA)):					
Period	S.E.	Shock1	Shock2	Shock3	Shock4
1	0.032388	7.052893	0.780667	88.70259	3.463850
2	0.033039	9.198846	0.799490	86.55266	3.449000
3	0.033139	9.193320	0.824615	86.43629	3.545771
4	0.033181	9.172055	0.824250	86.30384	3.699851
5	0.033212	9.157555	0.851378	86.19197	3.799093
6	0.033234	9.150802	0.894681	86.10582	3.848701
7	0.033246	9.148469	0.932301	86.05236	3.866874
8	0.033252	9.147937	0.955728	86.02512	3.871218
9	0.033254	9.147922	0.966922	86.01371	3.871444
10	0.033255	9.147948	0.970972	86.00981	3.871268
Variance Decomposition of TB91:					
Period	S.E.	Shock1	Shock2	Shock3	Shock4
1	1.957871	0.708792	18.52449	11.08911	69.67761
2	2.635469	0.769832	11.28432	15.22034	72.72550
3	3.086080	1.421271	13.91497	16.91661	67.74715
4	3.353893	1.968830	17.91103	16.95574	63.16440
5	3.491848	2.335477	20.88581	16.63535	60.14335
6	3.552241	2.532584	22.58166	16.35225	58.53351
7	3.574318	2.617199	23.34240	16.19392	57.84648
8	3.581095	2.643282	23.59026	16.13286	57.63360
9	3.583218	2.646817	23.62980	16.12105	57.60233
10	3.584370	2.645301	23.61765	16.12499	57.61206

VI. Conclusion and Policy Implications

This study investigated the macroeconomic effects of climate shocks proxied by precipitation variability on inflation and output in Uganda. The empirical findings reveal that climate shocks have a persistent impact on headline inflation, whereas their effects on real GDP, although negative, tend to be short lived. Notably, headline inflation is heavily influenced by food prices, which are vulnerable to climate shocks. The results thus imply that incorporating climate indicators into macroeconomic modelling is essential, particularly for economies such as Uganda, where weather-sensitive sectors such as agriculture contribute significantly to both output and price dynamics.

From a policy perspective, the results underscore the importance of enhancing the resilience of the Ugandan economy to climate change. Given the significance of food in the Consumer Price Index (CPI), targeted investments in climate adaptation strategies are critical. These may include expanding irrigation infrastructure, promoting adoption of drought-resistant seeds, supporting reforestation initiatives, and improving environmental management.

The findings therefore emphasize the importance of integrating climate considerations into monetary policy frameworks. In weather-dependent economies, climate variability is a supply side concern, and a potential source of inflationary volatility. Therefore, central banks such as the Bank of Uganda should explore avenues to incorporate climate-related risks into inflation forecasting and macroeconomic policy design.

However, further research is needed to examine the disaggregated effects of climate shocks, specifically on food inflation, which more directly captures agricultural price movements, and agricultural GDP, which may respond differently to aggregate outputs. In addition, future research should distinguish between positive and negative climate shocks. For example, the economic and inflationary consequences of droughts may differ significantly from those of floods given their distinct effects on agricultural production, infrastructure, and supply chains.

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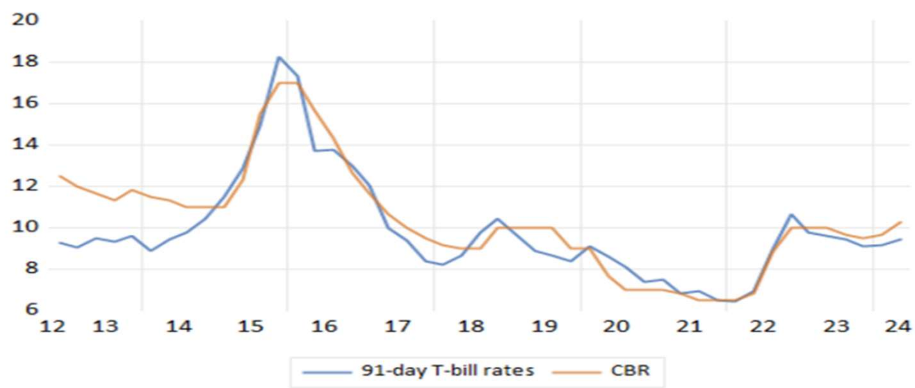
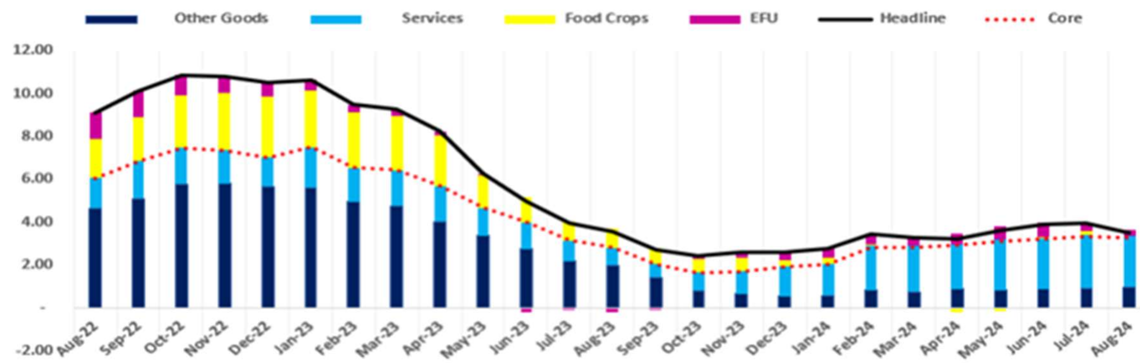
Annexes

Annex 1: Evolution of 91-Day Treasury Bill Rate and Central Bank Rate (CBR)



Note: **The x-axis represents quarters, whereas the y-axis represents interest rates in percent.**

Annex 2: Contribution of Inflation Components to Headline Inflation.



Annex 3: Components of Headline Inflation in Uganda (CPI Weights)

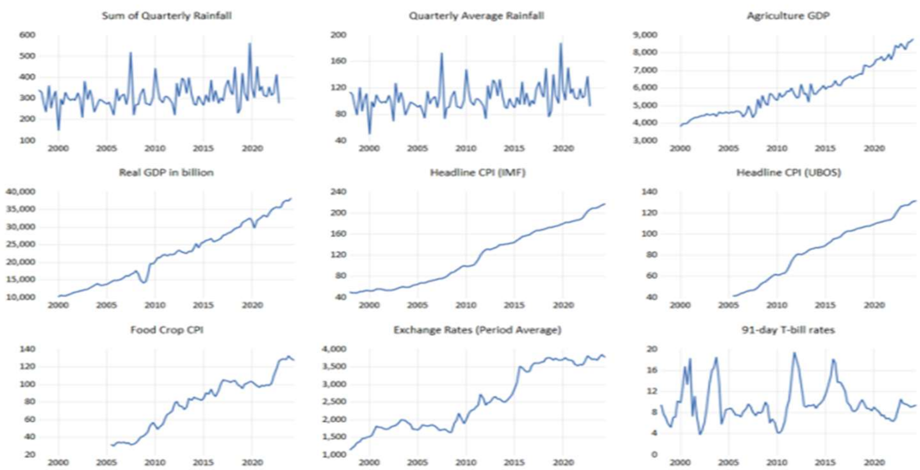
CPI Component	2016/17 (%)	2009/10 (%)
Food and Non-Alcoholic Beverages	27.1	28.5
Alcoholic Beverages, Tobacco and Narcotics	3.9	2.8
Clothing and Footwear	7.0	5.1
Housing, Water, Electricity, Gas and Other Fuels	10.4	11.9
Furnishings, Household Equipment and Routine Household Maintenance	4.8	3.9
Health	4.7	5.8
Transport	10.5	13.8
Information and Communication	4.4	5.2
Recreation, Sport and Culture	5.0	5.5
Education Services	5.8	5.5
Restaurants and Accommodation Services	8.7	5.7
Insurance and Financial Services	2.3	6.4
Personal Care, Social Protection and Miscellaneous Goods	5.4	0.0
Total	**100.0**	**100.0**

Note: CPI weights are derived from the Uganda National Household Survey. The values reflect the rebasing in 2009/10 and 2016/17.

Annex 4: Lag Selection and Diagnostic Tests

The optimal lag length is selected based on standard information criteria, including the Schwarz Bayesian Criterion (SBC) and Hannan–Quinn Criterion (HQC). Both criteria suggest inclusion of one lag in the VAR system. After the estimation, the VAR model was subjected to a series of diagnostic tests: Stability tests (AR roots) confirmed that all the roots lie within the unit circle, indicating that the system is stable, and Serial correlation tests indicate that the residuals are not autocorrelated, confirming the adequacy of the model specification.

Annex 5: Trends of the Variables Used in the Study (2001-2022).



Note: The figure presents a graph of headline inflation, policy rate (TB-91), oil prices, food inflation, and GDP. The x-axis represents the quarters, while the y-axis depicts fluctuations in inflation and growth rates.

Annex 6: ADF Unit Root Test Results

Variable	Specification (c,t,l)	P-value	Order of Integration
log(Headline Inflation)	(c,t,0)	0.7192	I(1)
log(Food Inflation)	(c,t,0)	0.7818	I(1)
log(Core Inflation)	(c,t,0)	0.7329	I(1)
log(Real GDP Growth)	(c,t,0)	0.7328	I(1)
log(Exchange Rate)	(c,t,0)	0.3592	I(1)
log(Rainfall)	(c,0,0)	0.0000***	I(0)
91-Day Treasury Bill Rate	(c,0,0)	0.0056**	I(0)
Δlog(Headline Inflation)	(c,t,0)	0.0083**	I(0)
Δlog(Food Inflation)	(c,t,0)	0.0000***	I(0)
Δlog(Core Inflation)	(c,t,0)	0.0000***	I(0)
Δlog(Real GDP Growth)	(c,t,0)	0.0000***	I(0)
Δlog(Exchange Rate)	(c,t,0)	0.0000***	I(0)

Note: This table reports the augmented Dickey (ADF) unit root test results. The variables include the log of real GDP growth, the 91-day Treasury bill rate (policy rate), and the logs of headline, food, core inflation, exchange rate, and rainfall. Where necessary, the first differences were applied to achieve stationarity. Specification columns (c,t,l) indicate the inclusion of a constant, trend, and lag order, respectively. The null hypothesis states that the variable contains a unit root (nonstationary). Asterisks denote the significance levels: *** 1%, ** 5%, and * 10%. I(0) denotes stationarity, and I(1) indicates non-stationary.