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The Impact of Climate Change on Food Inflation: The Mediating Role of Trade and Monetary Policies - A System GMM Analysis of 34 African Countries

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ABSTRACT

This article examines the impact of climate change (CC) on food inflation using a sample of 34 African countries from 2001 to 2022, employing the System Generalized Method of Moments (System GMM) estimators. The results show that high temperatures significantly contribute to the increase in food inflation, whereas precipitation has a positive but statistically insignificant effect. A second objective of this study is to introduce the moderating role of trade and monetary policies in addressing food inflation under climatic conditions (high temperatures). The findings indicate that a trade policy promoting food imports can mitigate the climate impact on food inflation, while a monetary policy directing credit toward the agricultural sector tends to amplify the climate effect on food inflation. Our results emphasize the crucial importance of monetary policies focused on sustainability objectives and CO_2 emission reduction.

Keywords: Food Inflation, Climate Change, Trade Policy, Monetary Policy, System GMM
JEL Classification: E31, Q54, F13, E52, C36

1. INTRODUCTION

Climate change refers to the evolution of average atmospheric and weather conditions observed over a prolonged period. According to the United Nations Intergovernmental Panel on Climate Change (IPCC), this concept involves the statistical analysis of climate data to identify any significant variations in means or fluctuations over several decades (Mukherjee and Ouattara, 2021). Meanwhile, the United Nations Framework Convention on Climate Change (UNFCCC) defines climate change as a change in the global climate system over a certain period, directly or indirectly attributable to human activities.

Climate change generates major risks that can disrupt both food and general inflation through various transmission channels (Kousar et al., 2022a; Semenova, 2024; Parker, 2018). These climate risks call for a reconsideration of the traditional monetary and fiscal determinants of inflation, highlighting the growing role of environmental factors (Nahoussé, 2019; Moser, 1995). African countries are among the most vulnerable to climate change globally, experiencing severe heatwaves, droughts, floods, and other hydrometeorological disasters (World Bank, 2022).

In Africa, climate change directly affects the agricultural sector, causing significant losses in key crops such as cereals, rice, vegetables, and fruits, which exerts increasing pressure on food prices. Food consumption accounts for nearly 40% of African household consumption baskets, thereby amplifying overall sensitivity to price volatility. Moreover, climate change also disrupts the energy sector: high temperatures lead to a decline in energy supply production while simultaneously driving up energy demand, notably for irrigation, food preservation, and air conditioning needs. Thus, the climate exerts a dual inflationary effect through both agricultural and energy channels. Consequently, monetary policy is exposed to the effects of climate change, which directly influences its fundamental objectives of controlling inflation, promoting economic growth, and preserving financial stability (MBASSI et al., 2023).

Using a panel of 34 African countries, we employ system generalized method of moments (System GMM) models as developed by Blundell and Bond (1998), in line with justifications from the empirical literature and specification tests performed (Table 1). These models incorporate interaction variables to capture the significant impact of climate risks on price stability, as well as the effect of trade and monetary policy instruments in regulating food prices. Furthermore, a reaction function is estimated based on the coefficients of the interaction variables, enabling the quantification of the marginal effects of these policies on food inflation.

Our results reveal a significant effect of average temperatures on food inflation. Trade policy plays a moderating role, mitigating the impact of temperature-related climate shocks on food prices. In contrast, monetary policy tends to amplify these effects, thus contributing to price increases during periods of climatic stress. Additionally, the reaction function allowed us to estimate these effects in a differentiated manner for each country in the panel (Figure 1).

This work is structured as follows: the first section is devoted to a literature review, highlighting existing studies and identifying the research gap that underpins the added value of our study. The second section presents the adopted methodology as well as the description of the variables. The third section is dedicated to the analysis and interpretation of the empirical results. Finally, we conclude with a discussion of the implications for monetary policy, followed by the general conclusion.

2. LITERATURE REVIEW

Numerous studies have examined the effects of climate change[1] on price stability. Climate change impacts price stability through the channels of growth and agriculture (Acevedo et al., 2018; Bandara and Cai, 2014; Dell et al., 2012), as well as through its effect on the energy sector (Odongo et al., 2022; Ngecu and Mathu, 1999; Cashin et al., 2017). These two transmission channels are the most significant in developing countries (Qi et al., 2025), particularly in African countries, allowing for a direct transmission of climate change effects on food inflation and an indirect effect on general inflation.

Firstly, climate change causes detrimental effects on agricultural production and supply (Batten et al., 2016). High temperatures contribute to the reduction of the cognitive capacity of the agricultural workforce (Seppanen et al., 2006), lead to migration flows of the active population toward urban areas (FMI, 2017), and cause damage to crops, especially those most vulnerable to temperature variations. Additionally, reduced precipitation levels result in a decline in agricultural supply, particularly when rainfall is an essential factor for irrigation (Dées and Weber, 2021). Extreme temperatures can also affect the storage of food products, necessitating increased use of fossil fuels for cooling. These risks, referred to as the physical risks of climate change, lead to a reduction in agricultural supply (Yusifzada, 2023), which in turn causes food inflation followed by general inflation[2], due to upward price adjustments aimed at rebalancing the goods and services market.

Table 1: Specification tests

Test	Value	Probability
Poolability test (F-statistic)	F=2.3166, df1=198, df2=510,	P=4.039e-14
Time effect (Honda test)	Normal=−0.64384	P=0.7402
Individual effect (Honda test)	Normal=27.924	P=2.2e-16

Source: Prepared by the authors

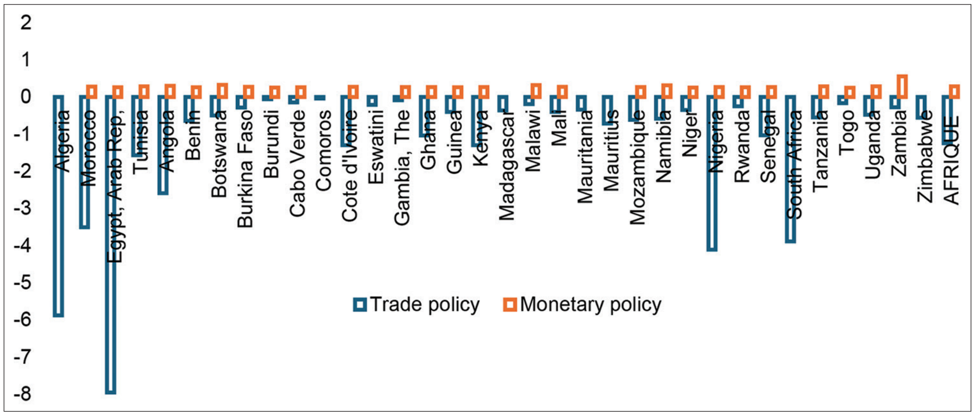
The study by Qi et al. (2025), conducted on a sample of 101 countries using System GMM estimators, highlights that climate change contributes to short-term increases in general price levels, particularly in low-income countries. Using the same methodology, Kunawotor et al. (2022) find that extreme precipitation contributes to rising general inflation in Africa during the period from 1990 to 2017. Both of these studies emphasize that central banks support inflation when they lower interest rates to stimulate the economy against climate change. Furthermore, the work of Li et al. (2023), conducted on a sample of 26 African countries, reports that inflation rises in response to the effects caused by temperature volatility. Other studies within the Eurozone corroborate these findings; for example, Beirne et al. (2024) use a panel structural vector autoregressive (SVAR) model over the period 1996 to 2021, and their results show that climate change exerts a cyclical, non-persistent effect on inflation.

Secondly, climate change (CC) could disrupt price stability through the energy channel, arguably the most significant one. In its report, the United Nations Intergovernmental Panel on Climate Change (IPCC) highlights that CC affects energy supply, energy consumption, energy demand, and the transportation of energy resources, impacting both supply and demand sides Ciccarelli et al. (2023). Extreme temperatures cause damage to energy infrastructure and reduce the efficiency of energy services. As a result, energy production decreases while consumption remains stable in the short term. To restore the balance between energy supply and demand, energy prices must adjust upward. Moreover, the transition to a green economy requires the imperfect substitution of fossil fuels by renewable energy sources, which leads to price increases due to invariant consumption behaviors in the short term. This channel may interact with the agriculture

1 Measured in the literature review by various indicators distinguished into two categories: physical risk indicators, such as temperature and precipitation, and others related to transition risks.

2 Given that food consumption accounts for approximately 40% of the overall household consumption in Africa, any volatility in food prices leads to volatility in the consumer price index.

Figure 1: Marginal effects of trade and monetary policies by country



Source: Authors' elaboration

and food channel, particularly when fossil fuels and energy are used as production factors in the agricultural and food sectors (Akan, 2023).

The study by Minghui et al. (2022) empirically examines the impact of temperatures on household energy consumption, showing that temperature fluctuations lead to a notable increase in residential electricity demand. Batten et al. (2020) found that temperature changes increase the volatility of agricultural and energy prices, thereby raising inflation volatility. Similarly, Köse and Ünal (2024) demonstrate that oil prices and temperature play important roles in reducing food inflation in Latin American countries. Ciccarelli et al. (2023) focus on various transmission channels, such as energy, agriculture, and services, and examine the concrete effect of climate change on consumer price increases[3].

The effect of climate change on price stability may differ depending on other variables such as development level, economic growth, and fiscal space. Additionally, African countries vary in their vulnerability to climate change according to the ND-GAIN index[4].

2.1. Literature Gap

This study aims to analyze the impact of climate change on food and general price indices by examining the contribution of climatic factors to inflation and reassessing the traditionally attributed roles of fiscal and monetary policies in the African context. To do so, we employ System GMM estimators, recognized for their ability to account for country heterogeneity and to correct for endogeneity bias. To the best of our knowledge, this is the first study explicitly integrating the role of trade and monetary policies in mitigating food price instability in response to climate shocks, which constitutes a genuine original contribution to the literature.

3. DATA AND METHODOLOGY

This study is based on annual data from 34 African countries (Table A1) distributed across the five sub-regions of Africa, covering a period of 22 years from 2001 to 2022. The selection of countries was determined by data availability. The average temperature and precipitation data used as climate change indicators are sourced from the Climate Change Knowledge Portal (CCKP). These indicators are consistent with the measures used in studies by Acevedo et al. (2018), Odongo et al. (2022), Ciccarelli et al. (2023), Nsabimana and Habimana (2017), et Boneva European Central Bank and Gianluigi Ferrucci (2022). Data on food and overall inflation, as well as the credit orientation index toward CO_2-emitting agriculture, come from the Food and Agriculture Organization of the United Nations (FAO). Real effective exchange rates and real interest rates were obtained from the International Monetary Fund (IMF), while GDP per capita data are sourced from the World Bank (WB). Unemployment rates come from the International Labour Organization (ILO), and food import data are extracted from the World Trade Organization (WTO). More detailed information regarding the variables used is available upon request.

In this work, we employ the System Generalized Method of Moments (System GMM) model developed by Blundell and Bond (1998) for several reasons. Statistically, our sample is characterized by a relatively large number of countries (N = 34) compared to the number of years (T = 22), which makes the System GMM model particularly suitable for this type of panel data. Moreover, specification tests (Table 1) reveal significant heterogeneity across countries, while a certain temporal homogeneity is observed. Finally, a review of empirical literature shows that this model is commonly used to study the impact of climate change on price stability, notably due to its ability to effectively handle endogeneity issues using appropriate instrumental variables.

In accordance with the empirical literature presented above, this research proposes an inflation model incorporating climate indicators, notably average temperatures and precipitation. The general equation is expressed as follows:

$$\pi_{it} = \pi_{it-1} + \beta_k X_{kit} + \theta_j Z_{jit} + w_s Y_{sit} + \alpha_i + \omega_t + \varepsilon_{it} \quad (1)$$

3 The significance of this research lies in the inclusion of sectoral and seasonal dimensions. According to the results, an increase in temperatures leads to a rise in inflation of unprocessed food items during the summer. Furthermore, consumer energy prices decrease in winter in Germany and Italy, but only in the initial months following the shock.

4 The climate vulnerability index is used to structure adaptation strategies to climate change.

With $\pi_{it}t$ representing food or overall inflation for each country I at time t, π_{it-1} denoting the first-order lagged inflation level, X_{kit} represents the matrix of climate variables, Z_{jit} denotes the matrix of control variables, and Y_{sit} corresponds to the matrix of public intervention measures and central bank actions. More precisely, the model to be estimated is specified in equation (2):

$$CPI_{it} = CPI_{it-1} + \beta_1 A\_PRECIP_{it} + \beta 2 A\_TEMPET_{it} + \theta 1 GDP_{it} + \theta_2 INT_{it} + \theta_3 Unem_{it} + \theta_4 EXR_{it} + \theta_7 OilPrice_{it} + w_1 IMPORT_{it} + w_2 IndexOA_{it} + \alpha_i + \varepsilon_{it} \quad (2)$$

Where CPI_{it} denotes general and food inflation, GDP_{it} is the gross domestic product at constant 2015 prices, INT_{it} is the real interest rate reflecting the lending interest rate adjusted for inflation, $Unem_{it}$ is the unemployment rate defined as the proportion of unemployed individuals in the active labor force, EXR_{it} is the real effective exchange rate, calculated as the geometric mean of exchange rates, $OilPrice_{it}$ represents oil prices, $IMPORT_{it}$ refers to food imports, including agricultural imports measured in CIF[5] value, and $IndexOA_{it}$ is the credit orientation index toward the agricultural sector[6]. This index is calculated using the following formula:

$$IndexOA_{it} = \frac{\text{Share of agriculture in total credit to the economy i in period t}}{\text{Value added of agriculture} \times \text{Share of GDP of country i in period t}} \quad (3)$$

This research aims to investigate the effect of climate change on one of the primary mandates of monetary policy, namely price stability, using a diversified sample of African economies. Thus, the added value of this study lies in the introduction of two intervention measures to address food inflation caused by climate shocks. The first intervention is a public policy carried out by the state, consisting of food imports in response to climate shocks. These imports help to offset imbalances in the food market caused by insufficient local supply.

4. RESULTS AND STYLIZED FACTS

In this section, we analyze the evolution of climate and inflation in Africa by visualizing the interannual averages for the period from 1990 to 2022. Figure 2 illustrates the average precipitation and temperatures across the continent. Overall, Africa is characterized by significant climatic heterogeneity, with conditions varying markedly from one region to another. Central Africa is marked by particularly high temperatures, while North Africa appears less hot than East and West Africa. Furthermore, precipitation also shows strong regional variability. Significant rainfall anomalies are observed in Central Africa, vast areas of West Africa, the eastern Sahel region, Sudan, and parts of Southern Africa. In contrast, marked rainfall deficits are recorded in western North Africa, the Horn of Africa, some areas of Southern Africa, and Madagascar (World Bank, 2022).

Africa is also exposed to other climate risks, less frequent than temperature and precipitation variations, such as floods and hydrometeorological disasters. These phenomena have negative effects on agriculture and agricultural production, promote internal and external migratory movements, and exert inflationary pressures on food products, thereby contributing to worsening food insecurity (World Bank, 2022).

Figure 3 displays the levels of general and food inflation in Africa between 2001 and 2022. It also highlights differing regional dynamics. In North Africa, general inflation rates are generally low, with Morocco (1.7%), Algeria (4.4%), Tunisia (4.3%), and Egypt (10.1%) exhibiting relatively moderate rates. Although Egypt's inflation is somewhat higher than its neighbors, it experiences less inflationary pressure compared to other regions on the continent. Food prices in this region also remain under control, reflecting relatively effective management of staple products.

In contrast, East Africa is characterized by particularly high food inflation rates. Sudan (58.8%), South Sudan (72%), Ethiopia (16.5%), and Tanzania (8.5%) face sharp increases in food prices, exacerbated by political crises, armed conflicts, and climatic challenges such as droughts and floods. These numerous factors increase pressure on vulnerable households, which already allocate a large share of their income to food, representing an extremely difficult situation for these families.

Similarly, Central African countries such as the Republic of Congo and the Democratic Republic of Congo (DRC) exhibit relatively high food inflation levels (32.3% for the DRC). This reflects persistent structural challenges, including low agricultural productivity, inadequate infrastructure, and increased dependence on food imports. Central Africa overall shows moderate levels of general and food inflation compared to other regions, suggesting some economic stability in countries like Gabon (2.6%) and Equatorial Guinea (4.2%).

4.1. Descriptive Statistics

Table 2 presents all the variables used in our study. The analysis of the means reveals that food inflation averages 10.6%, compared to 8.7% for general inflation. Furthermore, the results of the Jarque-Bera test indicate that the variables generally follow a normal distribution.

4.2. Empirical Results and Economic Interpretation

4.2.1. Effect of climate change on inflation and food inflation

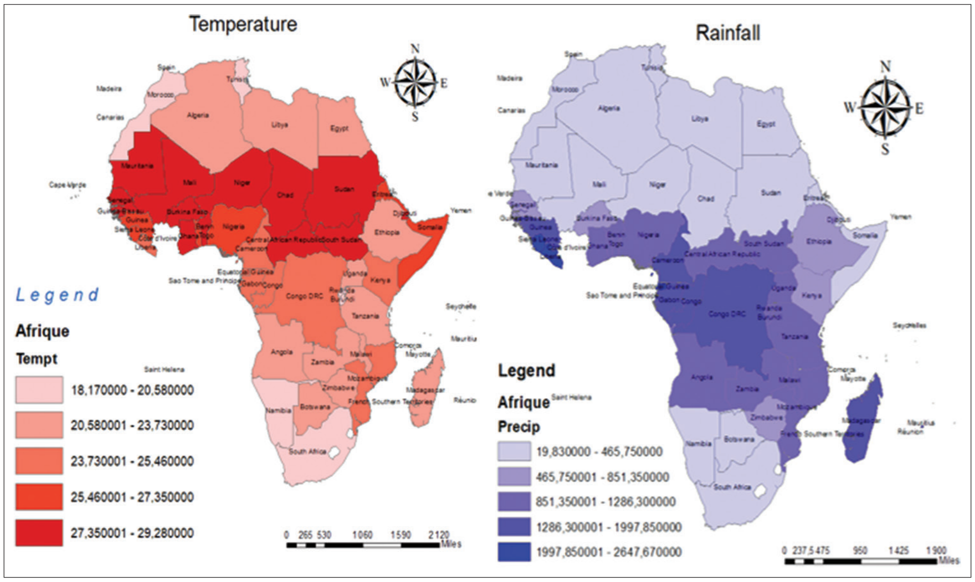
In this section, we address the effect of climate change on inflation and food inflation. We decompose equation (1) into a system of log-linearized[7] equations that allows us to quantify the effects of

5 This measure in the system of national accounts allows the inclusion in the total cost not only of the value of goods but also the transportation and logistics costs up to the importing country's border.

6 The share of agriculture in total credit to the economy, expressed as a percentage. As such, it can provide a more precise indication of the relative importance that national banks assign to financing the agricultural sector. The Agricultural Credit Orientation Index (IndexOA) normalizes the share of credit to agriculture by dividing it by the share of agriculture in the Gross Domestic Product (GDP).

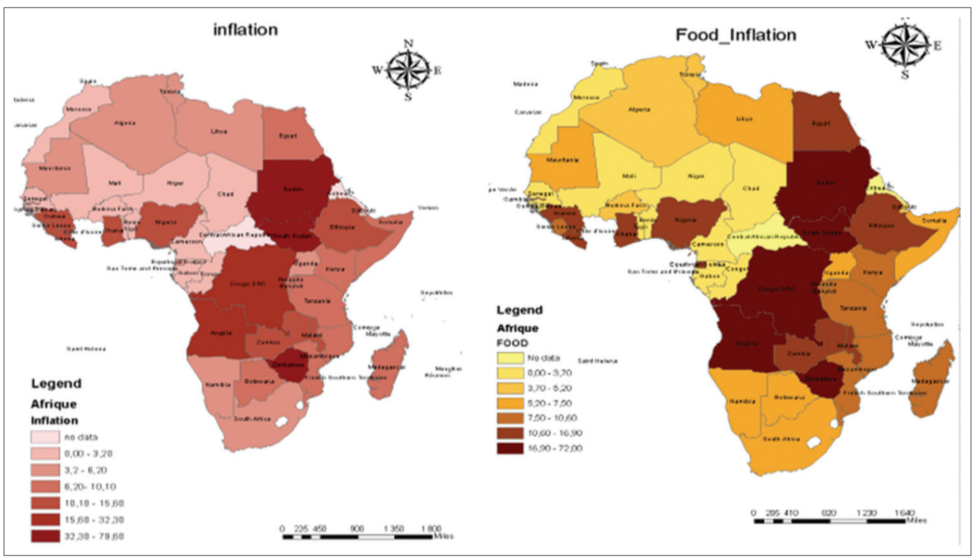
7 La variable d'inflation a été augmentée de 100 unités afin de supprimer les valeurs négatives, tout en conservant sa tendance générale inchangée. Cette transformation n'affecte en rien les coefficients estimés.

Figure 2: Precipitation and temperatures in Africa from 1990 to 2022



Source: Authors' elaboration, ArcMap 10.8

Figure 3: General and food inflation in Africa between 2001 and 2022



Source: Authors' elaboration, ArcMap 10

temperature and precipitation independently (equations 3 and 4) and simultaneously (equation 5):

$$CPI_{it} = CPI_{it-1} + \beta_2 A\_TEMPET_{it} + \theta_1 GDP_{it} + \theta_2 INT_{it} + \theta_3 Unem_{it} + \theta_4 EXR_{it} + \theta_7 OilPrice_{it} + w_1 IMPORT_{it} + w_2 IndexOA_{it} + \alpha_i + \varepsilon_{it} \quad (3)$$

$$CPI_{it} = CPI_{it-1} + \beta_1 A\_PRECIP_{it} + \theta_1 GDP_{it} + \theta_2 INT_{it} + \theta_3 Unem_{it} + \theta_4 EXR_{it} + \theta_7 OilPrice_{it} + w_1 IMPORT_{it} + w_2 IndexOA_{it} + \alpha_i + \varepsilon_{it} \quad (4)$$

$$CPI_{it} = CPI_{it-1} + \beta_1 A\_PRECIP_{it} + \beta_2 A\_TEMPET_{it} + \theta_1 GDP_{it} + \theta_2 INT_{it} + \theta_3 Unem_{it} + \theta_4 EXR_{it} + \theta_7 OilPrice_{it} + w_1 IMPORT_{it} + w_2 IndexOA_{it} + \alpha_i + \varepsilon_{it} \quad (5)$$

Table 3 presents the different estimations of equations 3, 4, and 5. The validity tests mainly include two assessments. First, the test for second-order autocorrelation of errors, with $P > 0.05$, except for first-order autocorrelation, which is acceptable in System GMM models. Second, the models undergo the over-identification test, evaluated by the Sargan test, which shows a P-value above 0.05, although it remains relatively low according to Roodman (2009) criteria.

First, we highlight a strongly significant and positive effect between average temperatures and food inflation. An increase in average temperatures leads, on one hand, to a reduction in agricultural production and, on the other hand, to damage to crops, which reduces the supply of agricultural and food products. This market imbalance necessitates an adjustment, resulting in an increase in food prices. These findings align with results reported by (Yusifzada, 2022; Kousar et al., 2022; Odongo et al., 2022; Diouf, 2007; Oulatta, 2016; Belloumi, 2014).

Table 2: Descriptive statistics of the variables

Variable	CPI (Food)	CPI (Overall)	A_PRECP	A_TEMPET	IndexOA
Mean	10.6	8.7	845.3	24.7	0.4
Median	6.8	5.6	947.0	24.4	0.2
Maximum	728.6	557.2	2018.7	30.0	5.7
Minimum	−10.9	−3.2	10.9	17.7	0.0
Std. Dev.	35.9	27.4	453.9	3.4	0.7
Jarque-Bera	2167304	2188797	16	36	16157
Probability	0.000	0.00000	0.000	0.00000	0.0000
Observations	748	748	748	748	390
Variable	**EX_RAT**	**GDP**	**OILPRICE**	**IMPORT**	**INT**
Mean	417.3	1642.9	66.5	1535.9	6.1
Median	110.4	1049.6	65.6	677.0	5.5
Maximum	3727.1	6485.6	103.3	17130.0	52.4
Minimum	4.0	263.4	25.2	31.0	−81.1
Std. Dev.	609.5	1384.2	25.1	2529.5	10.9
Jarque-Bera	3711	231	30	5776	4974
Probability	0.00000	0.000	0.00000	0.00000	0.000
Observations	748	748	748	510	748

Source: Authors' elaboration, R-Studio

Table 3: Effect of average temperatures and precipitation on food and general inflation

Variables	*Food inflation* (CPI_{it})			*Overall inflation* (CPI_{it})		
	Eq 3	Eq 4	Eq 5	Eq 3	Eq 4	Eq 5
CPI_{it-1}	0.877*** (0.042)	0.948*** (0.021)	0.854*** (0.047)	0.892*** (0.048)	0.961*** (0.023)	0.816*** (0.078)
A_TEMPET_{it}	0.146** (0.066)	------	0.157** (0.062)	0.122* (0.070)	------	0.190* (0.097)
A_PRECIP_{it}	------	0.010 (0.008)	0.010 (0.007)	------	0.007 (0.008)	0.013 (0.011)
$OilPrice_{it}$	0.018*** (0.006)	0.024*** (0.007)	0.020*** (0.004)	0.016*** (0.005)	0.019*** (0.006)	0.013* (0.008)
EXR_{it}	0.004 (0.003)	0.003 (0.002)	0.002 (0.003)	0.004 (0.002)	0.003* (0.001)	0.009** (0.004)
GDP_{it}	−0.0001 (0.008)	0.010 (0.007)	0.001 (0.005)	0.002 (0.006)	0.007 (0.008)	0.005 (0.011)
$Unem_{it}$	0.018* (0.011)	0.010 (0.007)	0.020** (0.009)	0.016 (0.010)	0.007 (0.008)	0.027* (0.016)
INT_{it}	−0.002 (0.001)	−0.002** (0.001)	−0.002* (0.001)	−0.001 (0.001)	−0.001* (0.001)	−0.002 (0.002)
No. Obs	748	748	748	748	748	748
No Years	22	22	22	22	22	22
No individus	34	34	34	34	34	34
Individuals effect	YES	YES	YES	YES	YES	YES
AR (1)	0.013255	0.008567	0.0091842	0.1019	0.1125	0.070284
AR (2)	0.12234	0.13115	0.13012	0.26737	0.27995	0.21204
Sargan test	26.94587 (0.1726)	33.60263 (0.71409)	33.78432 (0.81287)	21.38317 (0.43577)	22.55563 (0.36812)	25.55414 (0.37617)

Source: Authors' elaboration, R-Studio. *P<0.1; **P<0.05; *P<0.01

Similarly, it is observed that precipitation levels have a positive, though statistically insignificant, effect on both food and general inflation. High precipitation causes destruction of crops and agricultural products, thereby reducing the supply of foodstuffs. This decrease in supply disrupts the balance of the goods and services market. These results are consistent with the conclusions of (Li et al., 2023; Cevik et al., 2023; Ciccarelli et al., 2023).

Oil prices exert a positive, robust, and significant impact on inflation, whether general or food-related. An increase in oil prices leads to higher production costs across various economic sectors, notably transport, industry, and agriculture. According to the empirical literature review, energy price fluctuations are closely linked to temperature variations. Global climate shocks reduce energy production, causing a supply decline. Faced with relatively inelastic short-term energy demand, prices increase to rebalance the market. This price rise translates into a positive effect on general inflation due to the weight of energy goods in the consumption basket and on food inflation through its impact on the agricultural sector. These conclusions are similar to those of (Lacheheb and Sirag, 2019; Cologni and Manera., 2008; Mgbomene et al., 2025).

Table 4: Role of trade and monetary policies in stabilizing food prices

Variable	Dependent Variable: Food Inflation CPI_{it}			
	Trade Policy (Eq 6)		Monetary Policy (Eq 7)	
CPI_{it-1}	0.870***	0.675***	0.926***	0.828***
	(0.043)	(0.035)	(0.027)	(0.055)
A_TEMPET_{it}	0.153**	0.518***	0.095***	0.249***
	(0.069)	(0.074)	(0.023)	(0.076)
$OilPrice_{it}$	0.021***	0.004	0.004	0.002
	(0.006)	(0.007)	(0.008)	(0.002)
EXR_{it}	0.004	−0.002	0.004	0.002
	(0.003)	(0.002)	(0.003)	(0.002)
GDP_{it}	0.003	−0.018*	−0.001	−0.002
	(0.007)	(0.011)	(0.009)	(0.010)
$Unem_{it}$	0.018*	0.007	0.014	0.015*
	(0.010)	(0.008)	(0.008)	(0.009)
INT_{it}	−0.002	−0.003*	−0.001**	−0.001**
	(0.001)	(0.001)	(0.001)	(0.001)
$IMPORT_{it}$	−0.003**	−0.250***	--------	--------
	(0.001)	(0.001)		
$A\_TEMPET_{it}*IMPORT_{it}$	--------	−0.079***	--------	---------
		(0.016)		
$IndexOA_{it}$	--------	--------	0.003	0.295***
			(0.003)	(0.112)
$IndexOA_{it}*A\_TEMPET_{it}$	--------	--------	--------	0.094***
				(0.036)
No individus	34	34	26	26
No Year (Start 2008)	15	15	15	15
No observation	510	510	390	390
Individuals effects	YES	YES	YES	YES
AR (1)	0.0039605	0.0011608	0.001410	0.001102
AR (2)	0.12398	0.13139	0.443763	0.050837
Sargan test	30.12041	28.2387	23.42548	23.28385
	(0.4595)	(0.60882)	(0.7973)	(0.83864)

Source: Authors' elaboration, R-Studio. *P<0.1; **P<0.05; *P<0.01

This study highlights that climate has become a determining factor of inflation, based on the analysis of data from 34 countries across various categories and time periods. The results emphasize the importance of integrating climate change considerations into monetary policy formulation, given the positive and significant effect of temperature variations caused by climate change. Incorporating climate elements, according to their magnitude and duration, within the monetary policy framework enables better achievement of policy objectives, improved forecasting, better identification of sources of inflationary pressures, and formulation of appropriate responses to counter them within the framework of ecological monetary policy.

4.2.2. Stabilizing food prices: What role for monetary and trade policies?

In this section, after confirming the hypothesis that climate change exerts a positive effect on inflation, particularly food inflation through temperature—with the effect being highly significant—we apply the methodology of Huynh and Hoang (2024) to quantify the role of government and central bank interventions in moderating the effect of climate change on food inflation. This is done by estimating the interaction functions presented in equations (6) and (7):

$$CPI_{it} = CPI_{it-1}+\alpha_1 A\_TEMPET_{it}+\alpha_2 IMPORT_{it}+\alpha_3 A\_TEMPET_{it}*IMPORT_{it}+Z'_{it}B_k+\alpha_i+\varepsilon_{it} \quad (6)$$

$$CPI_{it} = CPI_{it-1}+\gamma_1 A\_TEMPET_{it}+\gamma_2 IndexOA_{it}+\gamma_3 A\_IndexOA_{it}*A\_TEMPET_{it}+Y'_{it}R_k+\alpha_i+\varepsilon_{it} \quad (7)$$

Government intervention through the importation of food products aims to stabilize local market prices by increasing local supply with foreign goods. Similarly, the central bank can intervene by directing credit toward the agricultural sector, thereby making it more productive. Based on these hypotheses, we expect that α_1 and γ_1 will be positive, while α_2 and γ_2 will be negative.

Based on Table 2, which presents the results of equations (6) and (7) in Table 4, average precipitation was excluded due to its insignificant effect on food inflation. The findings indicate that the interaction between food imports and local climate shocks helps to reduce food inflation. In contrast, central bank intervention appears to increase food inflation, as evidenced by the positive sign of its interaction with temperatures. The interaction of temperatures with food imports on one hand, and with the credit orientation index toward agriculture on the other, captures the role of these policies in moderating the effect of climate change on food inflation. To quantify this role, we must calculate the marginal first derivative of temperatures on food inflation for equations (6) and (7), respectively:

$$\begin{cases} \dfrac{\partial(CPI_{it})}{\partial(A\_TEMPET_{it})} = \alpha_1 + \alpha_3 * IMPORT_{it} & (\textit{Trade policy effects}) \\ \dfrac{\partial(CPI_{it})}{\partial(A\_TEMPET_{it})} = \gamma_1 + \gamma_3 * IndexOA_{it} & (\textit{Monetary policy effects}) \end{cases} \quad (6 \text{ and } 7)$$

With the condition: $\alpha_1 > \alpha_3$ and $\gamma_1 > \gamma_3$

Through the analysis of marginal effects, it appears that trade policies are effective when African countries experience local climate shocks, notably allowing for a reduction in food inflation, particularly in North African countries. This decrease ranges from −3.5% in Morocco, −5.8% in Algeria, -7.9% in Egypt, to -1.5% in Tunisia. These policies promote an increase in local supply, which alleviates price pressures, especially when imported products are cheaper or of better quality, thus incentivizing local producers to adjust their prices. However, in the context of global climate shocks, exporting countries face more restrictions on their exports to ensure national food security. Furthermore, these policies enable the importation of lower-cost products, thereby reducing local production costs, diversifying supply sources, and mitigating supply risks during adverse climatic conditions (Figure 3).

Central bank intervention, by directing credit toward the agricultural sector in climate-affected contexts, contributes to amplifying food inflation. Indeed, agricultural credit can stimulate demand for production factors, leading to an increase in their costs (Headey and Fan, 2008; Tassos et al., 2010). Such credit also facilitates the provision of low-interest loans to agricultural producers (Byerlee et al., 2009), thereby promoting CO_2-emitting agricultural activities. This leads to increased risks of global warming, with high temperatures reducing agricultural production and exacerbating food inflation due to market imbalances. Central bank intervention aimed at stabilizing production thus becomes a political trade-off, as it results in price increases.

4.2.3. Implications of monetary policy

Numerous studies confirm that once climate change reaches a certain threshold, it must be taken into account in the formulation of monetary policy. Battiston et al. (2021) also highlight the link between climate change and risks to the financial system, emphasizing that integrating this issue into monetary policy decisions is indispensable. Similarly, Ramlall (2017) addresses the impact of climate change on financial stability, underscoring that the involvement of central banks in environmental issues has become a necessity.

Our work recommends that monetary policy considers environmental factors when granting credit to banks and markets through several mechanisms, namely: Q easing (Lavoie and Fiebiger, 2018; Hilmi et al., 2022), collateral policies (Dafermos et al., 2021; Svartzman et al., 2021). Finally, we recommend integrating a climate component into the institutional and regulatory framework of monetary policy—in other words, “greening” monetary policy through green Taylor rules (Jawadi et al., 2024; Ramlall, 2023).

5. CONCLUSION

The analysis of the effects of climatic conditions on general and food inflation for a sample of 34 African countries between 2001 and 2022 revealed that increases in average temperatures have a positive and significant effect on inflation, particularly on the food component, whereas precipitation levels do not exert notable effects on prices.

Furthermore, this study highlights the role of trade policies as mitigating inflationary pressures caused by climate change, while central bank interventions through credit directed to the agricultural sector appear to amplify inflation levels in the African context. These results underscore the importance of integrating climatic factors into the implementation of monetary policies to better identify the sources of inflation and effectively control its evolution.

Although this study has contributed to a better understanding of inflation dynamics in Africa and their interactions with climatic and economic policy factors, certain limitations remain to be addressed to improve the quality and robustness of the results.

First, decomposing the sample into subgroups based on homogeneous characteristics would better capture the differentiated effect of climate change on inflation in Africa. Additionally, considering other moderators such as fiscal space or agricultural policies would lead to more comprehensive public policy recommendations. It is also important to recognize that annual variations in temperature and precipitation are insufficient to fully capture meteorological dynamics, hence the usefulness of employing monthly data and other climate indicators such as humidity levels, wind, etc.

Addressing these limitations will contribute to a deeper understanding of the climatic effects on inflation in Africa and enable the formulation of more effective mitigation policies.

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REFERENCES

Acevedo, S., Mrkaic, M., Novta, N., Pugacheva, E., Topalova, P. (2018), The effects of weather shocks on economic activity: What are the channels of impact? United States: International Monetary Fund.

Akan, T. (2023), Can renewable energy mitigate the impacts of inflation and policy interest on climate change? Renewable Energy, 214, 255-289.

Bandara, J.S., Cai, Y. (2014), Impact of Climate Change on Food Crop Productivity, Food Prices and Food Security in South Asia Impact of Climate Change on Agriculture Productivity, Food Prices and Food Security in South Asia. Available from: https://www.gtap.agecon.purdue.edu/events/conferences/default.aspglobaltradeanalysisprojecthttps://www.gtap.agecon.purdue.edu

Batten, S., Sowerbutts, R., Tanaka, M. (2020), Climate change: Macroeconomic impact and implications for monetary policy. In: Ecological, Societal, and Technological Risks and the Financial Sector. Berlin: Springer, p13-38.

Batten, S., Sowerbutts, R., Tanaka, M. (2016), Staff Working Paper No. 603 Let's Talk about the Weather: The Impact of Climate Change on Central Banks. Available from: https://www.bankofengland.co.uk/research/pages/workingpapers/default.aspx

Battiston, S., Dafermos, Y., Monasterolo, I. (2021), Climate risks and financial stability. Journal of Financial Stability, 54, 100867.

Beirne, J., Dafermos, Y., Kriwoluzky, A., Renzhi, N., Volz, U., Wittich, J. (2024), Weather-related disasters and inflation in the euro area. Journal of Banking and Finance, 169, 107298.

Belloumi, M. (2014), Investigating the Linkage Between Climate Variables and Food Security in ESA Countries. Available from: https://www.com/hdl.handle.net/10568/149673

Blundell, R., Bond, S. (1998), Initial conditions and moment restrictions in dynamic panel data models. Journal of Econometrics, 87, 115-143.

Boneva European Central Bank, L., Gianluigi Ferrucci, C. (2022), Inspire Sustainable Central Banking Toolbox Inflation and Climate Change: The Role of Climate Variables in Inflation Forecasting and Macro Modelling. London: London School of Economics and Political Science.

Byerlee, D., De Janvry, A., Sadoulet, E. (2009), Agriculture for development: Toward a new Paradigm. Annual Review of Resource Economics, 1(1), 15-31.

Cashin, P., Mohaddes, K., Raissi, M. (2017), Fair weather or foul? The macroeconomic effects of El Niño. Journal of International Economics, 106, 37-54.

Cevik, S., Jalles, J.T., Berger, H., Duval, R., Ferrucci, G., Hasna, Z., Jaumotte, F., Massetti, E., Richmond, C., Schimmelpfennig, A., Starovoits, G., Zhang, A.T. (2023), APR eye of the storm: The impact of climate shocks on inflation and growth eye of the storm: The impact of climate shocks on inflation and growth. United States: International Monetary Fund.

Ciccarelli, M., Kuik, F., Hernández, C.M. (2023), The Asymmetric Effects of Weather Shocks on Euro Area Inflation (March, 2023), ECB Working Paper No. 2023/2798. Available from: https://ssrn.com/abstract=4397490

Cologni, A., Manera, M. (2008), Oil prices, inflation and interest rates in a structural cointegrated VAR model for the G-7 countries. Energy Economics, 30(3), 856-888.

Dafermos, Y., Gabor, D., Nikolaidi, M., Pawloff, A., Van Lerven, F. (2021), Greening The Eurosystem Collateral Framework How To Decarbonise The ECB'S Monetary Policy. Available from: https://www.neweconomics.org

Dées, S., Weber, P.F. (2021), Les conséquences du changement climatique pour la politique monétaire. Revue d'Economie Financière, 138(2), 243-257.

Dell, M., Jones, B.F., Olken, B.A. (2012), Temperature shocks and economic growth: Evidence from the last half century. Journal Macroeconomics, 4(3), 66-95.

Diouf, M.A. (2007), Modeling Inflation for Mali: Mame Astou Diouf; IMF Working Paper 07/295; 2007.

FMI. (2017), FMI (Fonds Monétaire International) (2017), United States: Fonds Monétaire International.

Headey, D., Fan, S. (2008), Anatomy of a crisis: The causes and consequences of surging food prices. Agricultural Economics, 39(Suppl 1), 375-391.

Hilmi, N., Djoundourian, S., Shahin, W., Safa, A. (2022), Does the ECB policy of quantitative easing impact environmental policy objectives? Journal of Economic Policy Reform, 25(3), 259-271.

Huynh, C.M., Hoang, H.H. (2024), Climate change and income inequality in Asia: How does institutional quality matter? Journal of the Asia Pacific Economy, 30(3), 737-761.

Jawadi, F., Rozin, P., Cheffou, A.I. (2024), Toward green central banking: Proposing an augmented Taylor rule. Energy Economics, 134, 107539.

Köse, N., Ünal, E. (2024), The effects of the oil price and temperature on food inflation in Latin America. Environment Development and Sustainability, 26(2), 3269-3295.

Kousar, S., Sabir, S.A., Ahmed, F., Bojnec, Š. (2022a), Climate change, exchange rate, twin deficit, and energy inflation: Application of VAR model. Energies, 15(20), 7663.

Kousar, S., Sabir, S.A., Ahmed, F., Bojnec, Š. (2022b), Climate change, exchange rate, twin deficit, and energy inflation: Application of VAR model. Energies, 15(20), 7663.

Kunawotor, M.E., Bokpin, G.A., Asuming, P.O., Amoateng, K.A. (2022), The impacts of extreme weather events on inflation and the implications for monetary policy in Africa. Progress in Development Studies, 22(2), 130-148.

Lacheheb, M., Sirag, A. (2019), Oil price and inflation in Algeria: A nonlinear ARDL approach. Quarterly Review of Economics and Finance, 73, 217-222.

Lavoie, M., Fiebiger, B. (2018), Unconventional monetary policies, with a focus on quantitative easing. European Journal of Economics and Economic Policies Intervention, 15(2), 139-146.

Li, C., Zhang, X., He, J. (2023), Impact of climate change on inflation in 26 selected Countries. Sustainability, 15(17), 3108.

Mbassi, C.M., Hyoba, S.E.C., Shahbaz, M. (2023), Does monetary policy really matter for environmental protection? The case of inflation targeting. Research in Economics, 77(3), 427-452.

Mgbomene, C., Ashakah, F.O., Metieh, F.C., Okoro, E.N., Dim, H.C., Opara, F.N. (2025), Crude oil price volatility and the Nigerian economy. International Journal of Energy Economics and Policy, 15(3), 390-402.

Minghui, L., Jianglong, L., Guanfei, M., Xiuwang, Y. (2022), How does temperature shocks affect household energy consumption? Insights from demand heterogeneity. Journal Xi'an Jiaotong University (Social Science), 42, 74-85.

Moser, G.G. (1995), The Main Determinants of Inflation in Nigeria. In: Papers-International Monetary Fund. Vol. 42. United States: International Monetary Fund.

Mukherjee, K., Ouattara, B. (2021), Climate and monetary policy: Do temperature shocks lead to inflationary pressures? Climatic Change, 167(3-4), 32.

Nahoussé, D. (2019), The determinants of inflation in West Africa. International Journal of Economics and Financial Research, 55, 100-105.

Ngecu, W.M., Mathu, E.M. (1999), The El-Nino-triggered landslides and their socioeconomic impact on Kenya. Environmental Geology, 38(4), 277.

Nsabimana, A., Habimana, O. (2017), Asymmetric effects of rainfall on food crop prices: Evidence from Rwanda. Environmental Economics, 8(3), 137-149.

Odongo, M.T., Misati, R.N., Kamau, A.W., Kisingu, K.N. (2022), Climate change and inflation in Eastern and Southern Africa. Sustainability (Switzerland), 14(22), 14764.

Oulatta, M. (2016), Munich Personal RePEc Archive Modeling Inflation in the WAEMU's Zone Modeling Inflation in the WAEMU's Zone. MPRA Paper.

Parker, M. (2018), The impact of disasters on inflation. Economics of Disasters and Climate Change, 2(1), 21-48.

Qi, C., Ma, Y., Du, M., Ma, X., Xu, Y., Zhou, X. (2025), Impacts of climate change on inflation: An analysis based on long- and short-term effects and pass-through mechanisms. International Review of

Economics and Finance, 98, 103846.
Ramlall, I. (2017), Internalizing CO_2 emissions via central banks' financials: Evidence from the world. Renewable and Sustainable Energy Reviews, 72, 549-559.
Ramlall, I. (2023), Should central banks manage climate change risk via a CO_2 emissions augmented Taylor rule? Evidence using a DSGE approach. Journal of Environmental Management, 343, 117989.
Roodman, D. (2009), How to do xtabond2: An introduction to difference and system GMM in Stata. The Stata Journal, 9(1), 86-136.
Semenova, A. (2024), Rising temperatures and rising prices: The inflationary impacts of climate change and the need for degrowth-based solutions to the ecological crisis. Globalizations, 21(1), 103-120.
Seppanen, O., Fisk, W.J., Lei, Q.H., Org, E., Seppänen, O. (2006), Title Room Temperature and Productivity in Office Work Permalink, Publication Date Room Temperature and Productivity in Office Work Room Temperature and Productivity in Office Work. Available from: https://escholarship.org/uc/item/9bw3n707; https://www.hut.fi
Svartzman, R., Bolton, P., Despres, M., Pereira Da Silva, L.A., Samama, F. (2021), Central banks, financial stability and policy coordination in the age of climate uncertainty: A three-layered analytical and operational framework. Climate Policy, 21(4), 563-580.
Tassos, J.B., The, H., Bank, W. (2010), Placing the 2006/08 Commodity Price Boom into Perspective. Available from: https://econ.worldbank.org
World Bank. (2022), État du Climat en Afrique. United States: World Bank.
Yusifzada, T. (2022), Response of Innovation to the Climate Stress: Evidence from Azerbaijan. Germany: Munich Personal RePEc Archive.
Yusifzada, T. (2023), Evaluating the global impact of climate change on agricultural inflation: An innovative climate condition index approach. Environment Development and Sustainability, 26, 18411-18438.

APPENDIX

Table A1: List of countries included in the research sample

Pays	Code ISO3	Region	Pays	Code ISO3	Region
Algeria	DZA	North Africa	Madagascar	MDG	East Africa
Morocco	MAR	North Africa	Malawi	MWI	East Africa
Egypt	EGT	North Africa	Mali	MLI	West Africa
Tunisia	TUN	North Africa	Mauritania	MRT	West Africa
Angola	AGO	Southern Africa	Mauritius	MUS	East Africa
Benin	BEN	West Africa	Mozambique	MOZ	Southern Africa
Botswana	BWA	Southern Africa	Namibia	NAM	Southern Africa
Burkina Faso	BFA	West Africa	Niger	NER	West Africa
Burundi	BDI	East Africa	Nigeria	NGA	West Africa
Cabo Verde	CPV	West Africa	Rwanda	RWA	East Africa
Comoros	COM	East Africa	Senegal	SEN	West Africa
Cote d'Ivoire	CIV	West Africa	South Africa	ZAF	Southern Africa
Eswatini	SWZ	Southern Africa	Tanzania	TZA	East Africa
Gambia	GMB	West Africa	Togo	TGO	West Africa
Ghana	GHA	West Africa	Uganda	UGA	East Africa
Guinea	GIN	West Africa	Zambia	ZMB	Southern Africa
Kenya	KEN	East Africa	Zimbabwe	ZWE	Southern Africa

Source: Prepared by the author