INTERNATIONAL MONETARY FUND

The Nexus of Climate and Monetary Policy: Evidence from the Middle East and Central Asia

Nordine Abidi, Mehdi El-Herradi, Boriana Yontcheva, Ananta Dua

WP/24/90

2024
APR

WORKING PAPER

 WP/24/90

IMF Working Paper
Institute for Capacity Development and Middle East and Central Asia Department

The Nexus of Climate and Monetary Policy:
Evidence from the Middle East and Central Asia[1]

Prepared by Nordine Abidi, Mehdi El-Herradi, Boriana Yontcheva, Ananta Dua

Authorized for distribution by Ali Alichi
April 2024

ABSTRACT: This paper investigates the effects of climate shocks on inflation and monetary policy in the Middle East and Central Asia (ME&CA) region. We first introduce a theoretical model to understand the impact of climate risks on headline and food inflation. In particular, the model shows how climate shocks could affect the path of policy rates through food prices. We then use local projections to estimate the impact of climate shocks on headline and food inflation. The results show that price stability is more easily achievable under positive climate conditions. Overall, our findings shed new light on the importance of considering climate-related supply shocks when designing monetary policy, particularly in countries where food makes up a significant part of the CPI-basket.

RECOMMENDED CITATION: Abidi, Nordine, El-Herradi, Mehdi, Yontcheva, Boriana, Dua, Ananta. 2024. The Nexus of Climate and Monetary Policy: Evidence from the Middle East and Central Asia. IMF Working Paper 24/90. Washington, DC: International Monetary Fund.

JEL Classification Numbers:	E31, E52, E50
Keywords:	Monetary policy; inflation; climate change
Author's E-Mail Address:	nabidi@imf.org, melherradi@imf.org, byontcheva@imf.org

[1] The authors would like to thank Ali Alichi, Giovanni Melina, and Tolga Tiryaki for helpful comments on various drafts of this paper. The views expressed in this paper are those of the authors and do not necessarily represent those of the International Monetary Fund.

1 Introduction

Over the past few decades, climate change has emerged as an increasingly pressing issue, raising concerns and sparking debates about its impact on the global economy (Black et al., 2023; Gollier, 2022). The escalating frequency and intensity of natural disasters, such as floods and droughts, have already inflicted severe consequences on economic growth, development, and inequality.[1] One area where climate change can also have a substantial effect is inflation, particularly through its influence on food prices. The latter is a critical component of the consumer price index (CPI) for many developing and emerging market economies (Barrett, 2022). In fact, the recent surge in global inflation after COVID-19 has been partly driven by the rise in food prices (IMF, 2022).

There are two main ways in which climate change can contribute to higher food prices. First, climate shocks can disrupt agricultural production, leading to reduced crop yields. This can occur either directly through extreme weather events like droughts and floods or indirectly through changes in temperature and precipitation patterns that make crop cultivation more challenging.[2] Second, climate change can increase the cost of food production, as farmers are forced to invest in more expensive inputs such as irrigation and fertilizers.

In contrast to demand-driven inflation, where monetary policy is relevant to manage demand over the business cycle and stabilize prices (Gopinath, 2022), supply shocks are caused by changes in the availability or production costs of goods and services. As a result, central banks may have limited control over the underlying factors driving supply shocks, making it difficult to achieve price stability (Kara and Thakoor, 2023). In the case of food price shocks caused by climate change, central banks may face a dilemma between stabilizing inflation and supporting economic activity. In fact, tightening monetary policy to contain inflation could exacerbate the negative impact of the supply shock on growth and employment.

The Middle East and Central Asia (ME&CA) region is highly vulnerable to climate shocks, given its arid and semi-arid climate, along with high dependence on agriculture and natural resources (Duenwald et al., 2022). Climate change has already had a significant impact on the ME&CA region, leading to reduced water availability, increased occurrences of droughts and heatwaves, and higher risks of wildfires, among other effects.[3] These impacts have had severe economic consequences, particularly on food supply. In the medium-term, several ME&CA countries are expected to face severe droughts, which may result in a significant increase in food prices, thereby exacerbating the scarring effects of the recent shocks, including the COVID-19 pandemic and geopolitical tensions (Fuje et al., 2023).

In this paper, we begin by introducing a theoretical model that examines the potential impact of climate shocks on headline and food inflation. Our model reveals that these shocks can either mitigate or amplify food prices movements, consequently affecting interest rates and sacrifice ratios. We find that the persistence of climate shocks could have a substantial impact on food inflation, making it challenging for the central bank to maintain price stability. This could lead to higher interest rates and lower output and, in some context, may potentially require a tighter monetary policy stance.[4]

[1] https://www.imf.org/en/Topics/climate-change/climate-and-the-economy
[2] https://climatechange.chicago.gov/climate-impacts/climate-impacts-agriculture-and-food-supply
[3] By 2050, average summertime temperatures could exceed 30 degrees Celsius in half the region's countries.
[4] Contrary to the traditional definition, we define the effectiveness of monetary policy as the central banks' ability to achieve

Next, we empirically investigate the impact of climate shocks on inflation and monetary policy transmission in the ME&CA region. Specifically, we study the influence of negative climate shocks – low rainfall or high temperature – on countries that are highly vulnerable to food price risks. In the context of weak monetary policy transmission, we also document the limited transmission of policy interest rates, which is consistent with existing evidence (Espinoza and Prasad, 2012; Gray and Karam, 2013).[5] Our key results indicate that changes in water availability and other climate-related disturbances can significantly impact food prices and inflation. Thus, our findings provide compelling evidence that important deviations in temperature and precipitations may hinder price stability.

To conduct our empirical analysis, we combine country-level data from Haver Analytics, global-level variables from Bloomberg, and other sources including IMF, World Bank and New-York Federal Reserve data. Our dataset covers 18 ME&CA countries over the period 2013Q1-2022Q2. Climate shocks are constructed using the Climate Change Knowledge Portal (CCKP) of the World Bank. Our methodology classifies episodes of climate shocks depending on the levels of temperature and precipitation across countries. This approach captures sharp exogenous variations in climate conditions that affect both food prices and inflation, making it possible to identify the causal effect of climate shocks on inflation.

To address concerns regarding endogeneity and potential confounding factors, we conduct a comprehensive set of robustness checks. We first include, among others, country fixed effects, which control for non-varying country-specific shocks. Additionally, we account for country time-varying characteristics (i.e. nominal effective exchange rates) and global shocks, such as commodity and food prices, as well as pressures from the global supply chain. To ensure the robustness of our results, we also explore alternative metrics for measuring monetary policy surprises, such as the U.S. shadow rate or effective fed fund rates for countries with fixed-exchange rate regimes. The results align consistently, providing further confidence in capturing the intended effect.

Our paper contributes to the literature on the climate-inflation nexus by showing the effects of climate risks on headline and food inflation, adding to the growing body of research on the impact of climate change on economic outcomes. Previous research examined the impact of climate shocks on various economic indicators, but our study specifically focuses on the transmission mechanism to inflation. Our results suggest that policymakers should consider the potential benefits of climate policies in mitigating inflationary pressures, particularly in countries with a high food share in the CPI (Arouri et al., 2015). This study also contributes to the ongoing debate over price stability and inflation targeting, especially in the context of climate shocks (Cantelmo et al., 2022; Jahan, 2012; Kabundi et al., 2022). While recent research has emphasized the role of institutional quality, market competition, and financial stability in explaining inflation dynamics (Guerrieri et al., 2010; Salahodjaev and Chepel, 2014; Sbordone, 2007), our paper demonstrates the importance of climate shocks in shaping the

price stability, as reflected in overall inflation rates. While monetary policy instruments primarily influence core inflation, in our paper, we define efficacy not in relation to the pass-through mechanism but with the final objective of attaining stable inflation rates, as this is most relevant for the economy's performance.

[5]The efficient transmission of policy signals to market rates relies on a well-diversified financial system with a range of institutions and instruments. In contrast, a thin market tends to exhibit increased interest rate volatility, making it challenging for market participants to discern policy signals amidst the noise. Consequently, this can impede the desired pass-through effect. Additionally, the presence of arbitrary lending limits and interest rate ceilings further hampers the transmission of interest rate movements.

inflation outlook, complicating the task of monetary policymakers under adverse scenarios. Finally, our theoretical model also highlights that under unfavorable climate conditions, particularly affecting agricultural output, the ability for central bankers to control prices may be considerably diminished.

Our findings caution against the fact that tightening monetary conditions, while necessary, may not always be sufficient to bring inflation down and could instead possibly result in a recession. In this context, policymakers should consider implementing supplementary strategies, such as effective climate policies, to better control headline inflation. Such policies should focus on building climate resilience, sustainable agriculture, and water conservation. These insights bear significant relevance for policymakers not only in ME&CA region, but also in areas where climate-linked supply shocks are prevalent.

Looking forward, there are several initiatives that policymakers should implement to address the issue of food inflation. These include, *inter-alia*, increasing investment in agriculture, supporting small farmers, encouraging private sector investment, promoting research and development to improve agricultural productivity, increase the availability of high-yield and, drought-resistant crop varieties. The international community could help finance such project through environment-friendly facilities such as the Resilience and Sustainability Facility (RSF) of the IMF.[6] Overall, increasing domestic production will be key to reducing food inflation in countries where food prices have a high weight in the CPI basket. These recommendations can help mitigating the impact of climate shocks on inflation and achieve sustainable economic growth.

This paper is structured as follows. The first section presents the data and provides summary statistics. The second section describes the theoretical framework that examines how monetary policy is affected nunder various climate shocks. The third section discusses the empirical setup employed in the analysis. The fourth section presents the results obtained from the empirical analysis and discusses the robustness checks conducted. Finally, the last section concludes the paper.

2 Data and Summary Statistics

2.1 Data

Our study uses a country-level dataset that combines three key set of variables on – (i) prices, (ii) climate change, and (iii) monetary policy - covering the period from Q1-2013 to Q2-2022.

2.1.1 Data: On prices

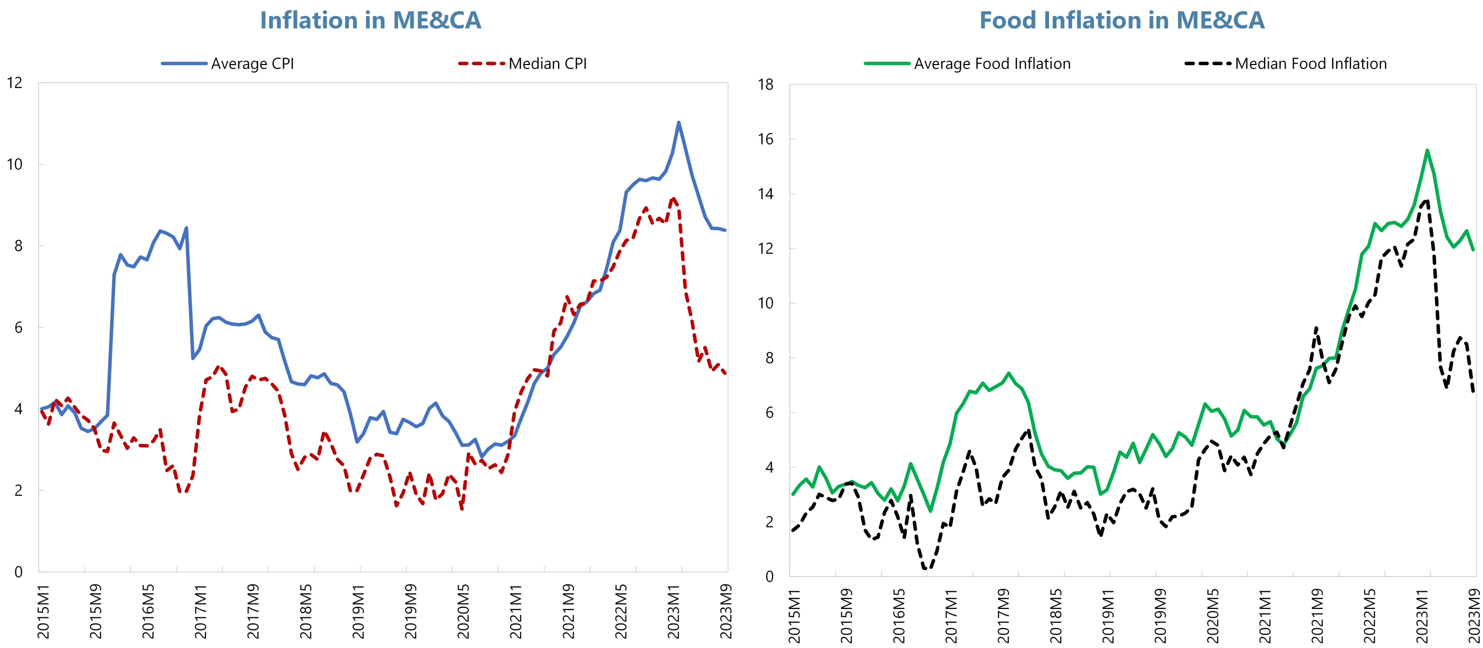
Figure 1 shows that the average inflation in ME&CA region has been rising in 2022-2023, reaching a 10-year high of about 12%.[7] This is due to several factors, including rising food and energy prices, as well as the depreciation of local currencies. To better understand the drivers of inflation in the ME&CA region, we collected data on Consumer Price Indices (CPIs) from Haver Analytics and the

[6]The RSF provides affordable long-term financing to countries undertaking reforms to reduce risks to prospective balance of payments stability, including those related to climate change and pandemic preparedness.

[7]The median overall inflation demonstrates a lower increase of 10%, but its trajectory remains unchanged. The calculations are performed using data from the entire Middle East and Central Asia (ME&CA) region, comprising 17 countries with available data on monetary policy variables.

IMF. Our final sample includes 17 ME&CA countries with complete data on food and headline inflation. Our dataset includes CPIs for all ME&CA countries, and is very granular for most of them, allowing us to observe consumer prices at the product category level (see Table A1 in the Appendix). We constructed both CPI and food-CPI series, and seasonally adjusted them to remove any fluctuations.

Figure 1: Headline and food inflation in ME&CA

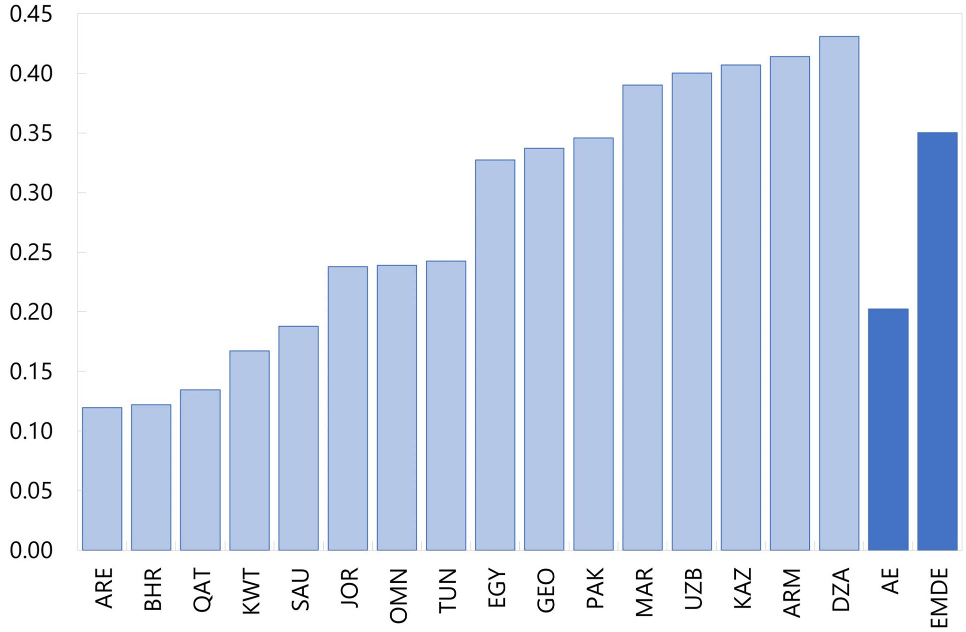


Notes: The figure depicts headline and food inflation in ME&CA contries over the period 2015-2023.
Source: Haver Analytics and IMF databases, authors calculations.

Figure 1 illustrates that inflation in the ME&CA region remained moderate during the onset of the COVID-19 pandemic, a trend that persisted in the early crisis months. saw a moderation of inflation in the ME&CA region, which continued well into the early months of the crisis. However, from 2020 inflationary pressures began to intensify, with inflation rates rising significantly. The cost of living in 2021 increased more than previous five years combined, fueled by higher food and energy prices, and local currency depreciation. A key factor of this inflation spike is the rising cost of food, which has become a major inflation driver since 2023. Food- CPI inflation has gradually increased, hitting a decade high of over 15 percent recently, due to rising global food prices and weather disruptions such as droughts . This trend is particularly concerning for economies in the region where food carries a significant weight in the CPI basket, and may put central banks in a difficult situation to manage inflation in the presence of permanent supply shocks.

As shown in Figure 2, most ME&CA countries are highly exposed to food price shocks, with food weighting more than the EMDE average of 35 percent of the CPI basket in more than half of countries in our sample and seventy five percent of them are well above in the advanced economies average of 20 percent. Thus, changes in food prices impact overall inflation and the cost of living for households.

Figure 2: Food Weights in CPI Basket



Notes: The figure provides insight into the composition of the consumer price index (CPI) basket in ME&CA countries along with an average of advanced economies and emerging and developing economies, specifically highlighting the share of food. On average, food comprises approximately 35% of the CPI basket in these countries. This substantial weighting underscores the significance of food prices in shaping overall inflation dynamics in the region. Source: Haver, authors' calculations.

2.1.2 Data: On Climate

In our analysis, we use the Climate Change Knowledge Portal (CCKP) as our primary data source to aggregate climate-related information at the country-level. This allows us to examine the impact of climate shocks on food and non-food inflation in the ME&CA region.

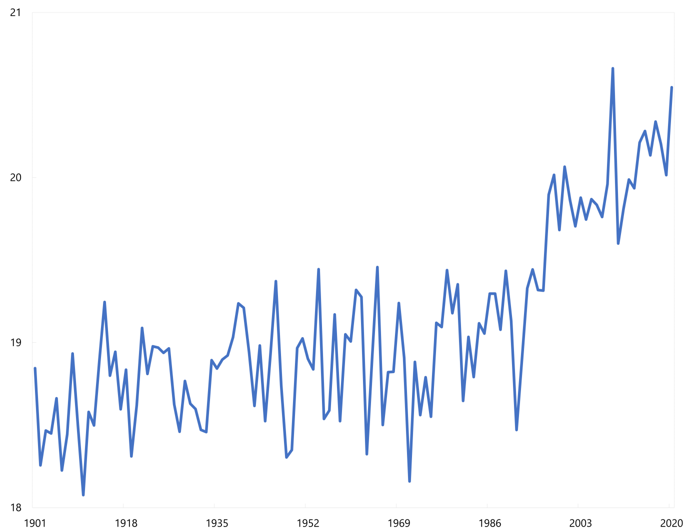
To construct our climate shock variables, we primarily rely on precipitation and temperature data. This data covers a long-time span, dating back to the beginning of the 20th century for most of the countries in our sample. Our analysis shows that climate conditions in the region are worsening, especially over the past two decades, albeit with large heterogeneities across countries.

Rainfall has become more variable (see Figure A1 in the Appendix), and climate disasters such as droughts and floods have become more frequent, putting lives and livelihoods at risk. Figure 3 documents the increasing trend in temperature for most of the ME&CA countries, suggesting that climate change is having a significant impact on the region.[8]

Climate conditions are considered in our empirical setting in two ways. First, we condition the response of inflation on the level of the climate factor using a dummy variable (i.e. above/below the median value of precipitation/temperature). Second, as a robustness check, climate shocks are also identified using a modified version of Hausmann et al. (2005)'s algorithm. The methodology classifies an episode of high temperature/precipitation growth as a shock if it satisfies the following two conditions: (i) the growth rate of climate variable in the years following the episode must exceed the

[8]Based on a panel of 183 countries over the period 1970-2018, Kabundi et al. (2022) show that droughts tend to have the highest overall positive impact on inflation, reflecting rising food prices.

Figure 3: Temperature in ME&CA: 1900-2023



Notes: The figure depicts the annual temperatures in ME&CA over the past century. Annual temperatures have increased by about 1.5 degree celsius, on average, in ME&CA over the past three decades. This is more than double the global increase of 0.7 degree celsius, which already significantly surpasses precedents from any comparable period during the last 10,000 years (Duenwald et al., 2022; Marcott et al., 2013)

growth rate in the preceding years, and (ii) the shock must be positive at the start of the episode. More technically, the following variables are computed as:

For every K-year window, the average growth rate of yearly climate variable is computed as:

$$\bar{g}_{c,t}^{clim} = \frac{1}{K}\sum_{j=t}^{t+K}[\frac{Clim_{c,j} - Clim_{c,j-1}}{Clim_{c,j-1}}] \tag{1}$$

Then, for every date t, the difference between the average growth rate and average growth rate in the four years starting in t, is defined as:

$$Dg_{c,t}^{clim} = g_{c,t}^{clim} - \bar{g}_{c,t}^{clim} \tag{2}$$

A climate shock is identified when the following conditions are satisfied: (a) $g_{c,t}^{clim} \geq g_{c,t}^{clim,50th}$ (the growth rate is higher than the 50th percentile of the growth distribution); (b) $Dg_{c,t}^{clim} \geq Dg_{c,t}^{clim,50th}$ (the climate growth acceleration is higher than 50 percentile of the distribution of climate growth accelerations); (c) $Clim_{c,j} \geq Clim_{c,0}$ (i.e. climate variable is above a certain cutoff).

2.1.3 Data: On Monetary Policy

All ME&CA countries included in the sample have some form of interbank market and report interbank rates. We use short-term interest rate data from Brandao Marques et al. (2020) for each country that represents a relatively liquid money market. The latter is considered representative of broader funding costs, after cross-checking with other short-term rates such as T-bills. From a theoretical standpoint, most central banks including those with inflation targets seek to closely align a specific short-term money market rate (known as the operating target) with their policy rate through open market operations.[9] However, in some ME&CA countries where policy rates are not market clearing or may not present arbitrage opportunities with other short-term interest rates, they may contain little or no information on short-term funding costs. Only those countries in the ME&CA region where such a rate could be identified are included in the sample. In most cases, these rates are also relatively well aligned with the respective policy rate. Several variables are employed to capture a range of relevant country characteristics that could be significant for the transmission of policy/interest rate shocks, with a particular focus on the exchange rate regime and the type of monetary policy framework.

To evaluate the effect of monetary policy on prices, we use Jordà (2005) local projections method to model the transmission mechanism and identify monetary policy shocks using a Taylor rule approach inspired by Romer and Romer (2004). We present our methodology in Section 4.

In an ideal setting, we would use central bank forecasts as in Romer and Romer (2004), however such forecasts are typically unavailable. Therefore, we make the implicit assumption that central banks and markets have access to the same information set. The monetary policy shock is represented by the residual, which is intended to capture the non-systematic and unexpected component of monetary policy actions resulting from deviations from Taylor-type rules. To account for variations in the magnitude of the shocks across countries, we standardize the residuals on a country-specific basis. For each ME&CA country c, the following equation is estimated at the quarterly frequency:

$$\Delta i_{c,t} = \alpha + \beta E \Delta y_{c,t+4|t} + \delta E \pi_{c,t+4|t} + \sum_{j=1}^{2} [\theta_j \Delta neer_{c,t-j} + \rho_j \Delta y_{c,t-j} + \mu_j i_{c,t-j}] + \varepsilon_{c,t} \qquad (3)$$

where $\Delta\pi_{c,t}$ and $\Delta y_{c,t}$ are year-over-year headline inflation and growth rate in quarter t, respectively; E_{t+4} and $E\Delta y_{t+4}$ are 4-quarter-ahead inflation and growth expectations in quarter t, respectively; $\Delta neer_{t-1}$ is the quarter-over-quarter change in the (log) nominal effective exchange rate; and i is the monetary policy rate. The monetary policy shock, denoted MP in Section IV, is the estimated error term $\varepsilon_{c,t}$.

We take into account the fact that the Taylor rule residuals may not always accurately capture monetary policy shocks, particularly when a country does not use an interest rate as its primary monetary policy tool.[10] In such cases, where central banks do not actively target a short-term interest rate and/or do not systematically adjust their policy rate in response to changes in their output/inflation forecasts, the residuals merely capture exogenous interest rate variations (cleansed from any impact of lagged variation in output, prices, and the exchange rate). These variations could indicate adjustments in other monetary policy instruments, such as reserve requirements or un-sterilized foreign exchange interventions, but also potentially reflects other exogenous factors.

[9] By buying or selling bonds, bills, and other financial instruments in the open market, a central bank can expand or contract the amount of reserves in the banking system and can ultimately influence the country's money supply. When the central bank sells such instruments it absorbs money from the system. Conversely, when it buys it injects money into the system.

[10] For countries with a peg, we use the monthly change in the policy interest rate of the reference currency (USD).

3 Theoretical Framework: Monetary Policy and the Impact of Climate Shocks

This section presents a theoretical model that explores the interaction between monetary policy, climate shocks, and their joint impact on inflation. Our main objective is providing a conceptual set-up that highlights a key, and often overlooked, mechanism for controlling inflation. We show that some certain conditions – such as unfavorable climate conditions (e.g. bad weather) that lower agricultural output – the ability for central bankers to control overall inflation can be significantly impaired.

In an economy where food constitutes a substantial size of the CPI basket, food prices substantially affect headline inflation. In a scenario of increased food prices, monetary policy implemented through instruments such as policy rates becomes less effective. As known from traditional macroeconomics textbook, changing policy rates can influence interest-sensitive components of aggregate demand, with a heightened focus on non-food prices, which often encompass a broader range of goods and services (see Figure 4).

3.1 Monetary Policy framework

We begin by examining how monetary policy operates when there are no unexpected climate events. Afterward, we introduce negative climate shocks and analyze their impact on the relationship between monetary policy and inflation.

In this benchmark model, we use a simple Taylor rule that offers guidance on how nominal policy interest rates could be adjusted in response to divergence of actual inflation rates from target levels, and output from its potential. We define the Taylor rule as follows:

$$i = \eta + \phi\bar{y} + \beta(\pi - \pi^*)$$

where:

- i denotes the nominal interest rate set by the central bank,
- η is a constant term that represents the equilibrium or neutral real interest rate,
- $\bar{y}$ is the output gap, which measures the deviation of actual output from its potential level,
- ϕ is the policy response coefficient to changes in the output gap, indicating the intensity of the central bank's reaction to economic activity,
- π stands for actual inflation rate,
- π^* is the target inflation rate, set by the central bank as an operational guide for its monetary policy, and
- β is the policy response coefficient to inflation, showing how the central bank changes the its nominal interest rate in response to deviations of inflation from its target.

Although Taylor rule does not include every detail that a central bank might consider, this approach is still useful for understanding the main ideas behind standard monetary policy decisions. (Brancaccio and Fontana, 2013).[11]

In addition to the Taylor rule, we consider the Phillips curve which illustrates the relationship between inflation and the output gap. In its simplest form, the Phillips curve we use is expressed as:

$$\pi = \pi^* + \alpha \bar{y}$$

where the parameter α represents the sensitivity of inflation to changes in the output gap. This sensitivity reflects the strength of "demand-pull" inflation, which occurs when demand for goods and services in an economy outstrips supply, leading to rising prices. The larger the α, the stronger the inflationary pressure for a given output gap.[12]

Integrating the Taylor rule with the Phillips curve gives:

$$i = \eta + \phi \left(\frac{1}{\alpha}(\pi - \pi^*) \right) + \beta(\pi - \pi^*)$$

This equation reflects how the nominal interest rate (i) set by the central bank responds to changes in the inflation rate (π) and the deviation of the inflation rate from its target ($\pi - \pi^*$). The parameters η, ϕ, β, α, and π^* have the same interpretations as described earlier. The sensitivity of changes in inflation to monetary policy is given by:

$$\frac{\partial i}{\partial \pi} = \phi \left(\frac{1}{\alpha} \right) + \beta$$

This implies that an increase in the inflation rate leads to an increase in the nominal interest rate, given the positive values of ϕ, β, and α.

If we are in the world without climate shocks, the sacrifice ratio which captures the trade-off between reducing inflation and the associated loss of output can be defined as follows:

$$SR_{NoCS} = \frac{\bar{y}}{\bar{\pi}}$$

To understand this equation, we revisit the Phillips curve model. The variable $\bar{\pi}$ represents the gap between the actual inflation rate (π) and the inflation target (π^*). It can be expressed as:

$$\bar{\pi} = \pi - \pi^*$$

Similarly, $\bar{y}$ represents the output gap, which indicates the deviation of actual output from potential output. In this framework, the Phillips curve can be rearranged to solve for the output gap:

$$\bar{y} = \frac{1}{\alpha}(\bar{\pi})$$

The sacrifice ratio reflects the absolute magnitude of output that needs to be sacrificed (negative $\bar{y}$)

[11] In our model, for tractability reasons, we only use a simple version of the Phillips Curve. A more elaborate model would have included other factors that make up the marginal cost, such as import prices, oil prices, etc. Without loss of generality, our model focuses on the relationship between the output gap and inflation.

[12] The Phillips curve is an essential tool for understanding how fluctuations in an economy's output relative to its potential level can influence inflation dynamics. Its basic premise reflects the trade-off central banks often face between stabilizing inflation and stabilizing output around its potential level (Ari et al., 2023)

to achieve a unit reduction in the inflation gap (positive $\bar{\pi}$), scaled by the sensitivity of inflation to changes in the output gap, denoted by α.

By substituting $\bar{y}$ and $\bar{\pi}$ into the definition of the sacrifice ratio, we find:

$$SR_{NoCS} = \frac{\bar{y}}{\bar{\pi}} = \frac{\frac{1}{\alpha}\bar{\pi}}{\bar{\pi}} = \frac{1}{\alpha}$$

Hence, the sacrifice ratio simplifies to $\frac{1}{\alpha}$, highlighting that the ratio is solely determined by the sensitivity parameter α (i.e. sensitivity of inflation to changes in the output gap).

This indicates that a higher value of α corresponds to a smaller sacrifice ratio, implying that the central bank can achieve a given reduction in the inflation gap with relatively less output loss. Conversely, a lower value of α implies a larger sacrifice ratio, indicating a greater output cost associated with reducing the inflation gap.

Understanding the sacrifice ratio is crucial for policymakers as they strive to find a balance between price and output stability. It helps quantify the potential costs and trade-offs involved in implementing contractionary monetary policy to achieve lower inflation.

3.2 Inclusion of Climate Shocks

We now incorporate climate shocks into the model (s). A negative climate shock increases food prices and subsequently inflation and a positive climate does the opposite. This modifies the Phillips curve as follows:

$$\pi = \pi^* + (\alpha - s)\bar{y}$$

A negative climate shock decreases the sensitivity of inflation to changes in the output gap. Consequently, for a given output gap, we assume for tractability that the impact of "demand-pull" inflation is more subdued compared to a scenario without the shock. Considering these shocks, the Taylor rule becomes:

$$i = \eta + \phi\frac{(\pi - \pi^*)}{\alpha - s} + \beta(\pi - \pi^*)$$

The sacrifice ratio under negative climate shocks is:

$$SR_{CS} = \frac{1}{\alpha - s}$$

Proposition 1: When negative climate shocks increase food prices (high s), monetary policy becomes less effective in controlling inflation.

Proof: The sacrifice ratio increases with negative climate shocks as the denominator of its formula, $\alpha - s$, shrinks. This indicates that the output costs of reducing inflation are higher.[13]

[13]While the transmission mechanism of monetary policy is not necessarily hindered by climate shocks, the effectiveness, as we have previously defined, would likely be impacted. Central banks may find it more difficult to achieve overall price stability. In some sense, our definition can be seen as an accounting one: when climate shocks are positive, the food component of the CPI is likely to be under control. Therefore, for the same policy interest rate change, prices are likely to be more moderate.

Proposition 2: When negative climate shocks push food prices up, the central bank can only achieve its inflation target with higher interest rates.

Proof: In the absence of climate shocks, the Taylor rule given the Philips curve is:

$$i = \eta + \phi \bar{y} + \beta \left(\frac{\bar{y}}{SR_{NoCS}} \right)$$

With climate shocks, the modified Taylor rule is:

$$i = \eta + \phi \bar{y} + \beta \left(\frac{\bar{y}}{SR_{CS}} \right)$$

With negative climate shocks, the central bank's interest rate under the modified Taylor rule is higher than under the original rule. Therefore, in the context of supply shocks modeled as a reduced sensitivity to "demand-pull" factors, the rising volatility of food prices is likely to weaken the effectiveness of monetary policy, requiring central banks to raise policy rates even more compared to scenarios without such shocks.

Figure 4: Interaction between changes in climate conditions, monetary policy, food and non-food prices.

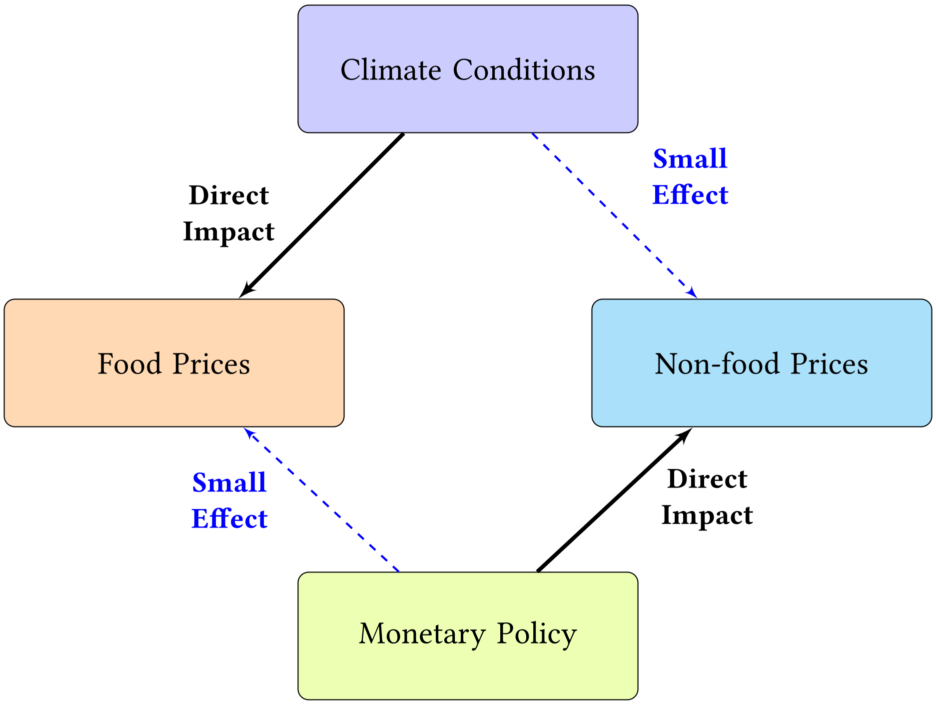


Figure 4 intuitively presents how we tackle the key identification problem we face when analyzing the monetary policy pass-through to inflation. The key objective of our empirical framework is to assess the impact of monetary policy shocks on inflation that varies depending on climate conditions. In periods of unexpected high climate stress, monetary policy shocks have a smaller impact on overall inflation because climate conditions (i.e., supply shocks) can be difficult to manage and food price inflation may be very high. This is because food prices are more sensitive to climate shocks (i.e. direct impact) than other prices, and a large increase in food prices can offset the effects of monetary policy on other prices.

4 Empirical Framework

We follow the general method proposed by Jordà (2005) by estimating impulse response functions (IRFs) from local projections (LPs). The LP framework employed in our study is adaptable to a panel data structure and does not restrict the shape of the impulse response functions, making it less vulnerable to misspecification. Other contributions, including Auerbach and Gorodnichenko (2013), Jordà and Taylor (2016), Ramey and Zubairy (2018), and Born et al. (2020) have also used LP in their analysis, however, their focus is mainly on the impact of fiscal policy surprises on economic activity, while our paper concentrates on the effects of monetary policy shocks. Our baseline specification for various horizons ($h = 0, \ldots, 12$) in quarters is given by:

$$\pi_{i,t+h} - \pi_{i,t-1} = \alpha^j_{i,h} + \gamma^j_{t,h} + \beta_h MP^j_{i,t} + \delta^j_i X_{i,t} + \epsilon_{i,t+h}, \tag{4}$$

where $\pi_{i,t+h}$ denotes the change in inflation for country i at horizon h in quarters; $MP_{i,t}$ represents the monetary policy shock for country i in quarter t; $X_{i,t}$ is a vector containing control variables that may affect inflation such as lagged inflation and global shocks (i.e. supply chain constraints, uncertainty, commodity prices). The baseline specification also includes fixed effects for each country $(\alpha_{i,h})$ and time $(\gamma_{t,h})$ to control for unobserved, time invariant heterogeneity in countries' risks and common shocks (e.g. increase in risk-aversion), respectively. The impulse responses are constructed based on the estimated β_h coefficients at each horizon and the respective confidence bands are based on the estimated standard errors.

One advantage of the LP method in estimating the effects of monetary policy shocks on inflation is its flexibility in dealing with non-linearities and state dependency (Ramey and Zubairy, 2018). Hence, our analysis goes beyond the benchmark regression presented in Equation (4) and explores additional specifications that condition the response of inflation to monetary policy surprises based on specific scenarios. These scenarios include (i) monetary policy surprises during episodes of *high climate stress*, characterized for instance by low precipitation levels, and (ii) monetary policy surprises when a country is experiencing a *positive climate shock*, defined for example by strong rainfall.

Our main strategy is thus to run panel regressions, including country and quarter fixed effects, where we ask: Once the monetary policy shock hits, how does the path of inflation in an environment with climate constraints (e.g., limited rainfall) deviate from scenarios with more favorable climate conditions? Our baseline state-dependent specification is as follows:

$$\begin{aligned}\pi_{i,t+h} - \pi_{i,t-1} = S^j_{i,t-1}[\alpha^j_{i,h} + \gamma^j_{t,h} + \beta_h MP^j_{i,t} + \delta^j_i X_{i,t}] \\ + (1 - S^j_{i,t-1})[\alpha^j_{i,h} + \gamma^j_{t,h} + \beta_h MP^j_{i,t} + \delta^j_i X_{i,t}] + \epsilon_{i,t+h}\end{aligned} \tag{5}$$

where $\pi_{i,t+h} - \pi_{i,t-1}$ represents the change in inflation between time t and time $t + h$, $S_{i,t-1,j}$ is the state-dependent variable that takes on a value of 1 or 0 depending on the state being considered, and $X_{i,t}$ is a vector of control variables.

In scenario (i), the state-dependent variable $S^j_{i,t-1}$ takes value of 1 if the country is experiencing high climate stress, characterized by low precipitation levels. We measure this through a precipitation threshold variable, which is an indicator variable that takes on a value of 1 if the precipitation level falls below the 25th percentile of the historical distribution of precipitation levels.

In scenario (ii), the state-dependent variable $S^j_{i,t-1}$ takes value of 0 if the country is experiencing a positive climate shock, characterized by strong rainfall. We measure this through a rainfall threshold variable, which is an indicator variable that takes on a value of 1 if the rainfall level exceeds the median value or the 75th percentile of the historical distribution of rainfall levels.

On the other hand, positive climate shocks (such as an increase in rainfall) can lead to lower inflation. This is because positive climate shocks can increase production and demand, which can put downward pressure on prices. Additionally, the non-food price component of inflation, which is generally more responsive to monetary policy shocks, can be affected more rapidly to positive climate shocks. This is because non-food prices are less sensitive to climate shocks than food prices.By distinguishing between periods of high climate stress and positive climate shocks, we are able to identify potential non-linearities in the relationship between monetary policy shocks and inflation. This means that the impact of monetary policy shocks on inflation may not be the same in all contexts. For example, monetary policy shocks may have a lower impact on inflation in periods of high climate stress than in periods of positive climate shocks.

5 Results

5.1 Monetary Policy Pass-through

We begin by estimating regression specification (4) for h = 12. Table 1 presents our results for aggregate inflation. This base regression incorporates country-specific fixed effects coupled with an extensive set of controls at both the country and global levels. The negative coefficient associated with the monetary policy shock variable implies that an unanticipated monetary policy tightening (standardized at +100 bps) corresponds to a subsequent decline in headline inflation over the ensuing three-year period.

In terms of magnitude, the influence of a monetary policy shock is comparably minor, though it remains statistically significant. For instance, within the regressions that include country fixed effects, a +100 bps tightening — an unusually large measure by historical standards — suggests that the rate of inflation decreases by 0.6 percentage points over the next two years. These modest estimated coefficients align with findings reported in the literature concerning monetary policy transmission in developing and emerging markets (Brandao Marques et al., 2020). Figure 5 traces out the IRF associated with the LP coefficient estimates.

Table 2 and Figure 6 present analogous estimates of the baseline regression incorporating country fixed effects, with food inflation being the dependent variable. Upon assessing the coefficients associated with monetary policy shocks, it clearly appears that the outcomes diverge significantly from the baseline regressions for headline inflation. Intriguingly, albeit predictably, the coefficients corresponding to monetary policy shocks are small in absolute terms and not statistically discernible, given their overlapping confidence intervals.

In nutshell, the disparity observed between food and headline inflation highlights the distinct dynamics governing food prices, which may not necessarily echo the broader contours of aggregate inflation. The muted impact of monetary policy shifts on food inflation, as indicated by the relatively negligible coefficients, further emphasizes these unique dynamics. Despite controlling for an extensive set of variables, the absence of statistical significance could be explained by several factors. These include the inherent volatility characteristic of food prices and their susceptibility to a large set of non-monetary influences, such as climatic conditions, agricultural yields, and fluctuations in global commodity markets. Furthermore, the modest absolute value associated with the coefficients of monetary policy shocks hints at the restrained efficacy of conventional monetary policy instruments in mitigating food inflation.

5.2 Robustness Checks

We present the robustness of our findings for both headline and food inflation through a series of tests and alternative specifications. Figures 7, 8, and 9 provide an overview of these exercises, where each impulse response function (IRF) represents a different specification.

In Figure 7, we start by presenting our baseline results with varying lags. This analysis allows us to assess the sensitivity of our findings to different lag lengths. Despite the variations in lag specifications, the results remain consistent and stable (panels (a) and (b)). Then, we investigate the validity of our results by conducting regressions with different sets of controls or parameters, as suggested by Jordà (2005) (panels (c) and (d)). Remarkably, the results remain robust across all of these specifications, providing further support for the stability of our findings. The same set of robustness checks is conducted for food inflation as the dependent variable in Figure 8. The obtained results closely resemble the outcomes of the baseline analysis presented in Figure 6.

In conducting a robustness check to our initial findings, we focus on assessing the response of headline inflation and food inflation to alternative monetary policy shocks. In particular, for countries where Taylor rule residuals were missing, notably the Gulf Cooperation Council (GCC), we substituted the absent policy rates of GCC countries with the U.S. Federal Funds rate. The results depicted in Figure 9 remain consistent with the baseline estimations: headline inflation consistently registers a decline following a monetary policy shock, in accordance with the pattern observed in the baseline analysis, while the observed impact on food inflation remains statistically non-significant. The same exercise is conducted using the Shadow rate in Figure A3 in the Appendix, and the results shows strong consistency with baseline findings.

To bolster the strength of our analysis, we employ an even more stringent test in Figure 10. Here, we examine the impact of climate shocks on food inflation. From our theoretical model, we expect the main climate explanatory variable (i.e. strong precipitation) to exhibit a statistically significant and negative effect on prices. Our findings indicate that a positive climate shock leads indeed to a substantial decline in food inflation by approximately 5 percentage points after a 2-year period. Inasmuch as our empirical model is linear, the exact opposite effect holds with respect to unfavorable climate conditions. This is consistent with Kabundi et al. (2022), who document that droughts and floods have a dampening impact on food inflation.

5.3 Monetary Policy and Climate Shocks

To gauge the significance of climate shocks and monetary policy transmission, we subsequently focus on more granular levels of heterogeneity, specifically emphasizing climate exposure and risks for country-specific water scarcity. Our approach starts with the expansion of the baseline specification to accommodate heterogeneous effects of climate shocks at the country level, and we display results for various specifications of regression (5). For conciseness, we exclusively present tables pertaining to headline inflation.

Figure 11 shows local projection estimates for regression (5), detailing inflation dynamics under both high and low precipitation regimes. We retain time-varying fixed effects to maintain the principal coefficient on monetary policy while incorporating country fixed effects in all specifications. The coefficient associated with the monetary policy shock variable is always negative and highly significant across all specifications for the regime correlated with a positive climate shock. Examining the coefficient within a context of water scarcity (i.e., low rainfall), we observe that ME&CA countries more severely impacted by negative climate shocks exhibit diminished sensitivity to monetary policy shocks. We implement a similar exercise using temperature instead of rainfall in Figure 12, which yields similar results, despite the fact that the decline in inflation under a low-temperature regime is relatively more significant compared to that under high rainfall. By doing so, we show that our result on the importance of climate shocks is robust to alternative definition of climate conditions. Figure A4 and A5 in the Appendix replicates the same exercise for rainfall and temperature using the algorithm of Hausmann et al. (2005) to define the levels of climate conditions. The findings are also consistent with the previous figures: unfavorable climate conditions hinders the monetary policy pass-through to headline inflation.

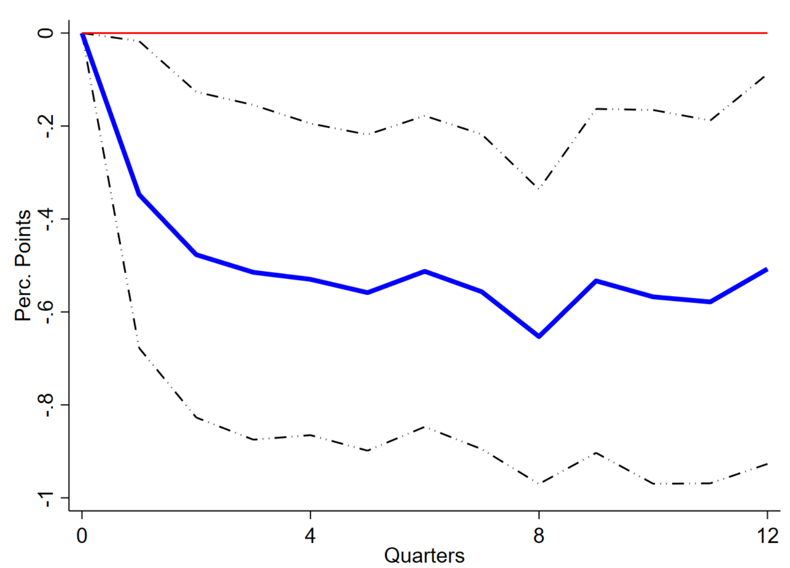
6 Main tables and figures

Table 1: Local projection: IV estimation results - Baseline model (i) - Headline inflation

Food inflation	Quarter 1	Quarter 2	Quarter 4	Quarter 6	Quarter 8	Quarter 10	Quarter 12
Δ MP Shocks	-0.35*	-0.48**	-0.53***	-0.51**	-0.65***	-0.57**	-0.51**
	(0.20)	(0.21)	(0.20)	(0.20)	(0.19)	(0.24)	(0.25)
R^2	0.246	0.271	0.293	0.300	0.287	0.257	0.244
F-statistic	3.38	4.11	6.78	9.46	8.29	3.69	4.93
Observations	974	956	924	892	860	828	796

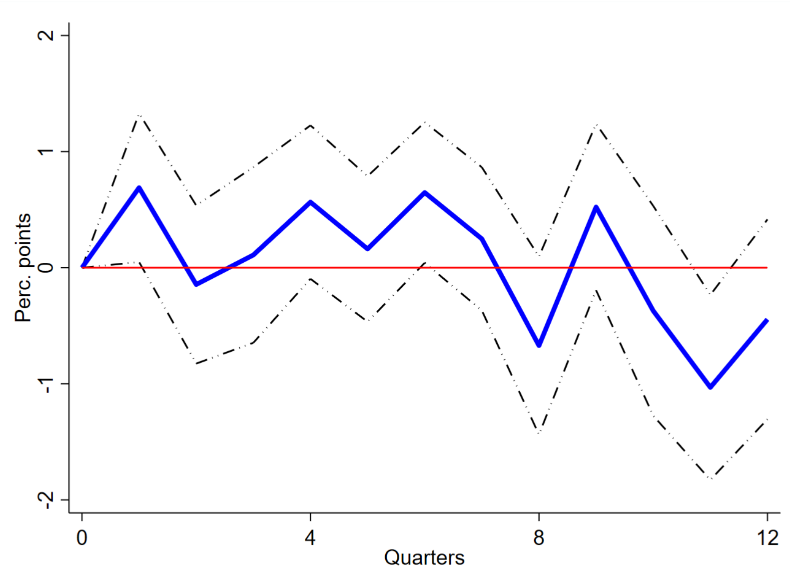
Notes: *, ** and *** indicate statistical significance at the 10%, 5% and 1% levels, respectively. Stock and Watson robust standard errors in parentheses. The percentage change rate of headline inflation is regressed on monetary policy shocks and country and global controls. Country fixed effects are also included.

Figure 5: Response of Headline inflation to a monetary policy shock



Notes: The figure shows the responses (in percentage points) of Headline inflation – relative to their initial value in year 0 – to a normalized +100 b.p. increase monetary policy shock. The dashed lines represent 90% Stock and Watson robust confidence bands.

Figure 6: Response of Food inflation to a monetary policy shock



Notes: The figure shows the responses (in percentage points) of Food inflation – relative to their initial value in year 0 – to a normalized +100 b.p. increase monetary policy shock. The dashed lines represent 90% Stock and Watson robust confidence bands.

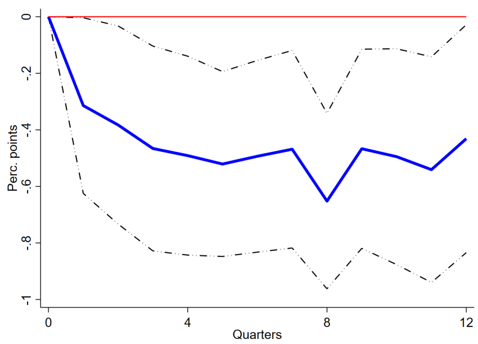
Table 2: Local projection: IV estimation results - Baseline model (ii) - Food inflation

Headline inflation	Quarter 1	Quarter 2	Quarter 4	Quarter 6	Quarter 8	Quarter 10	Quarter 12
Δ MP Shocks	0.69*	-0.14	0.57	0.65*	-0.67	-0.37	-0.44
	(0.39)	(0.41)	(0.40)	(0.37)	(0.47)	(0.55)	(0.52)
R^2	0.375	0.366	0.337	0.463	0.368	0.490	0.349
F	18.49	13.12	11.92	18.91	12.51	23.55	8.57
Observations	461	443	411	379	347	315	283

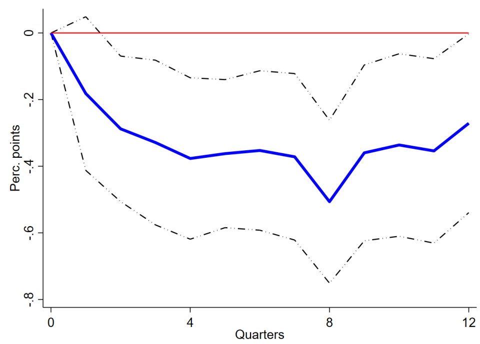
Notes: *, ** and *** indicate statistical significance at the 10%, 5% and 1% levels, respectively. Stock and Watson robust standard errors in parentheses. The percentage change rate of headline inflation is regressed on monetary policy shocks and country and global controls. Country fixed effects are also included.

Figure 7: Response of Headline inflation to monetary policy shock - Sensitivity

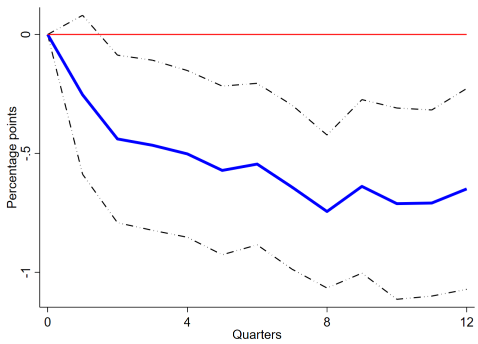
(a) One lag



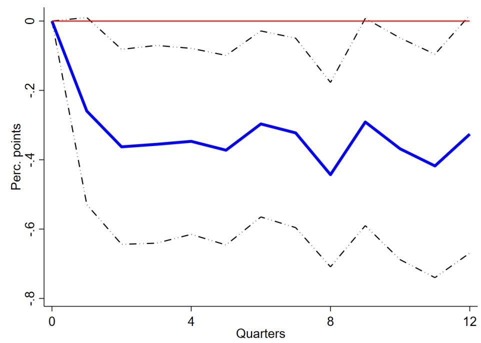
(b) 3 lags



(c) No controls



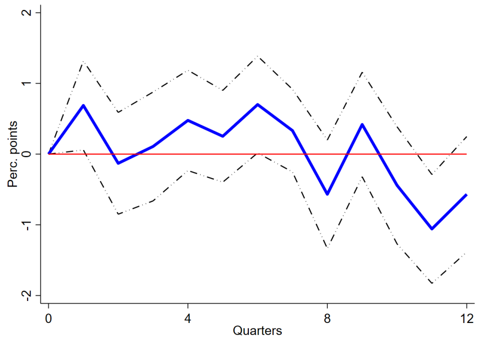
(d) More parameters



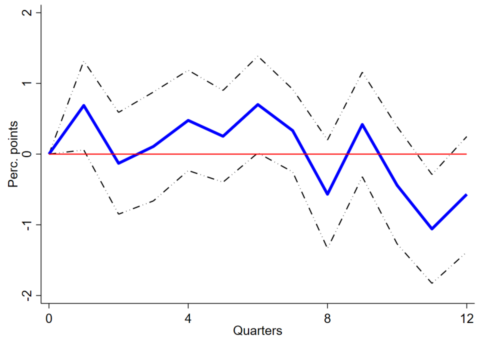
Notes: The figures show the responses (in percentage points) of Headline inflation – relative to its initial value in year 0 – to a normalized +100 b.p. monetary policy shock. The dashed lines represent 90% Stock and Watson robust confidence bands.

Figure 8: Response of Food inflation to monetary policy shock - Sensitivity

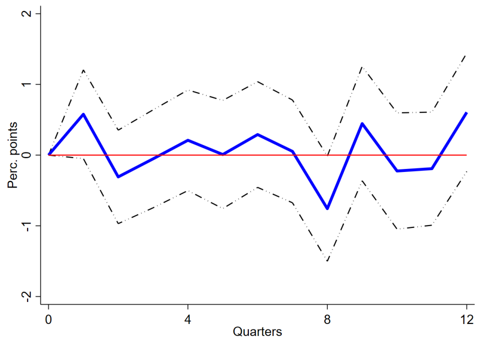
(a) One lag



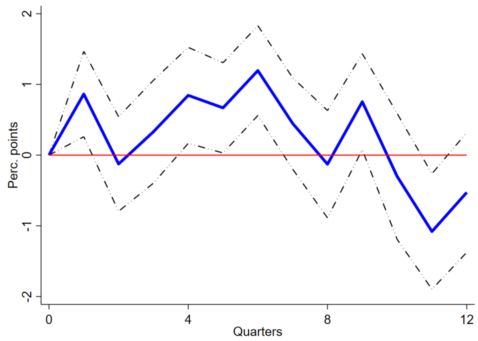
(b) 3 lags



(c) No controls



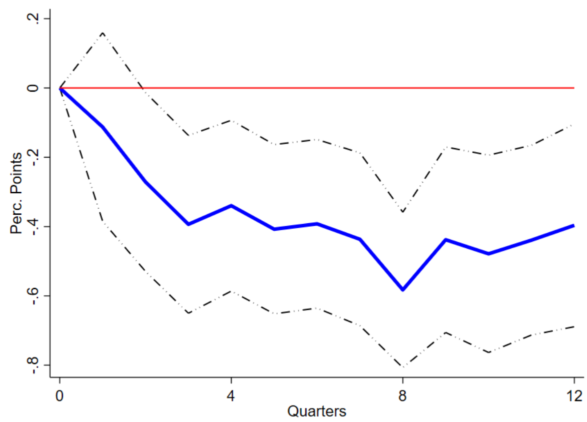
(d) More parameters



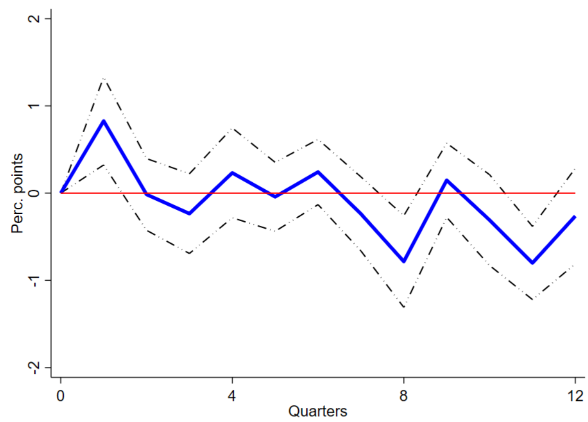
Notes: The figures show the responses (in percentage points) of Food inflation – relative to its initial value in year 0 – to a normalized +100 b.p. monetary policy shock. The dashed lines represent 90% Stock and Watson robust confidence bands.

Figure 9: Response of headline and food inflation to - Alternative monetary policy shock

(a) Headline Inflation

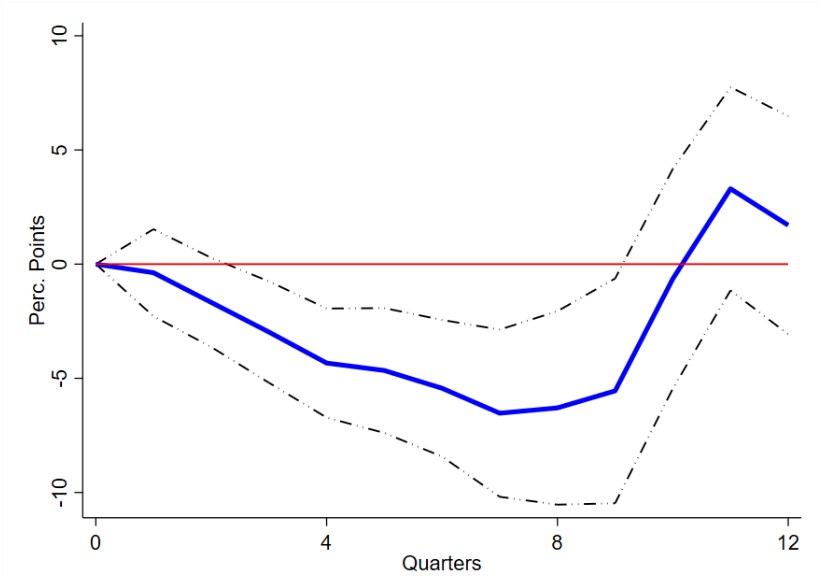


(b) Food inflation



Notes: The figures show the responses (in percentage points) of headline and food inflation to a normalized +100 b.p. increase in monetary policy shock. The dashed lines represent 90% Stock and Watson robust confidence bands.

Figure 10: Response of Food inflation to a rainfall shock

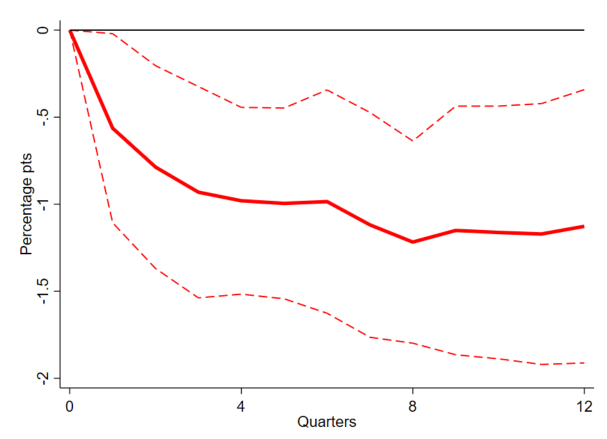


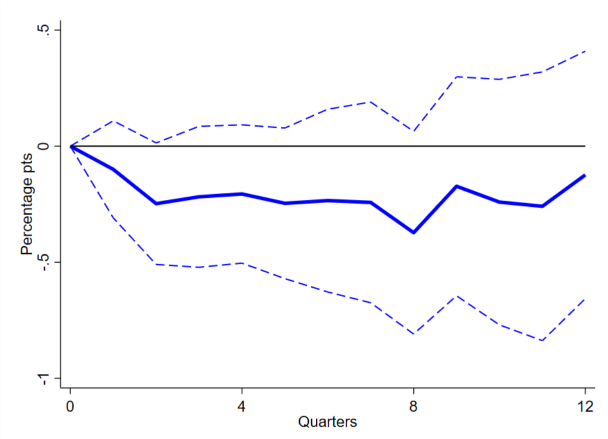
Notes: The figure shows the responses (in percentage points) of Headline inflation – relative to their initial value in year 0 – to a normalized +100 b.p. increase in rainfall. The dashed lines represent 90% Stock and Watson robust confidence bands.

Figure 11: Response of headline inflation to a monetary policy shock

(a) High rainfall

(b) Low rainfall

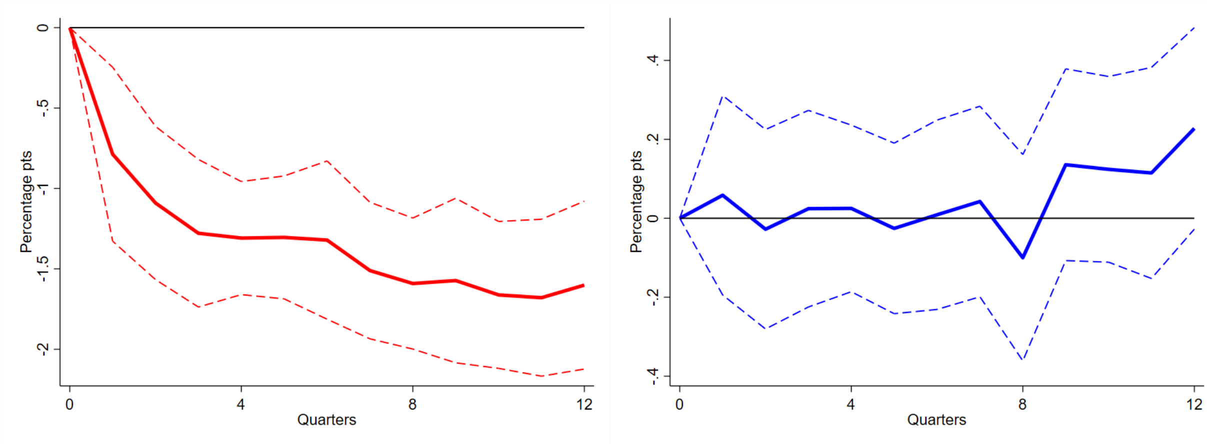




Notes: The figures show the responses (in percentage points) of headline inflation to a normalized +100 b.p. increase in monetary policy shock. The dashed lines represent 90% Stock and Watson robust confidence bands.

Figure 12: Response of headline inflation to a monetary policy shock

(a) Low temperature (b) High temperature



Notes: The figures show the responses (in percentage points) of headline inflation to a normalized +100 b.p. increase in monetary policy shock. The dashed lines represent 90% Stock and Watson robust confidence bands.

7 Conclusion

This paper contributes to the understanding of the effects of climate shocks on inflation in the ME&CA region. Our empirical analysis provides valuable insights into the persistent influence of climate shocks in influencing food price inflation. Notably, we find that an unexpected 100 basis points monetary policy tightening, associated with a positive climate shock, leads to a significant 1 percentage point reduction in inflation in the short run. These findings have significant implications for central banks, particularly in economies where food plays a crucial role in the CPI. In essence, positive climate shocks afford central banks greater flexibility in managing inflationary pressures through adjustments to policy rates.

Our study shows the limited pass-through effect of monetary policy on food prices within the ME&CA region, highlighting the challenges faced by policymakers in influencing food price dynamics. Negative climate shocks further compound these challenges, shed lights on the critical importance of effective climate policies, such as sustainable agriculture practices and robust water management initiatives.

In conclusion, our findings underscore the limitations of relying solely on monetary policy to control inflation, particularly in countries where food prices have a substantial weight in the CPI. While tightening policy rates is necessary, it may not always be sufficient to effectively lower inflation and could potentially trigger a severe recession. Therefore, policymakers need to carefully consider the trade-offs between inflation and output when formulating monetary policy decisions. Furthermore, it is crucial for policymakers to explore supplementary strategies, such as climate policies, to enhance their ability to manage inflation dynamics. These insights hold significant relevance not only for the ME&CA region but also for other areas where climate-related supply shocks exert a notable influence on inflation (Baptista et al., 2022).

Looking ahead, there are several initiatives that policymakers should consider implementing to address the issue of food inflation. These initiatives encompass various measures, including but not limited to increasing investment in agriculture, supporting small-scale farmers, encouraging private sector investment in the agricultural sector, promoting research and development activities aimed at enhancing agricultural productivity, and facilitating the availability of high-yield, drought-resistant crop varieties. Additionally, policymakers should explore the utilization of resources such as the IMF's RSF or similar facilities, where applicable. Overall, fostering domestic production will play a pivotal role in reducing food inflation in countries where food prices significantly impact the CPI basket. By implementing these recommendations, policymakers can effectively mitigate the impact of climate shocks on inflation dynamics and achieve sustainable economic growth.

References

Ari, A., Garcia-Macia, D., and Mishra, S. (2023). Has the phillips curve become steeper? *IMF Working Paper No 2023/100*.

Arouri, M., Nguyen, C., and Youssef, A. B. (2015). Natural disasters, household welfare, and resilience: evidence from rural vietnam. *World development*, 70:59–77.

Auerbach, A. J. and Gorodnichenko, Y. (2013). Output spillovers from fiscal policy. *American Economic Review*, 103(3):141–146.

Baptista, D. M. S., Farid, M. M., Fayad, D., Kemoe, L., Lanci, L. S., Mitra, M. P., Muehlschlegel, T. S., Okou, C., Spray, J. A., Tuitoek, K., et al. (2022). Climate change and chronic food insecurity in sub-saharan africa.

Barrett, P. (2022). How food and energy are driving the global inflation surge. *IMF. Sept*, 12.

Black, S., Parry, I., Mylonas, V., Vernon, N., and Zhunussova, K. (2023). The imf-world bank climate policy assessment tool (cpat): A model to help countries mitigate climate change. *IMF Working Paper No 2023/128*.

Born, B., Müller, G. J., and Pfeifer, J. (2020). Does austerity pay off? *Review of Economics and Statistics*, 102(2):323–338.

Brancaccio, E. and Fontana, G. (2013). 'solvency rule'versus 'taylor rule': an alternative interpretation of the relation between monetary policy and the economic crisis. *Cambridge Journal of Economics*, 37(1):17–33.

Brandao Marques, L., Gelos, R. G., Harjes, T., Sahay, R., and Xue, Y. (2020). Monetary policy transmission in emerging markets and developing economies. Technical report, International Monetary Fund.

Cantelmo, M. A., Fatouros, N., Melina, M. G., and Papageorgiou, M. C. (2022). *Monetary policy in disaster-prone developing countries*. International Monetary Fund.

Duenwald, M. C., Abdih, M. Y., Gerling, M. K., Stepanyan, V., Al-Hassan, A., Anderson, G., Baum, M. A., Saksonovs, M. S., Agoumi, L., Chen, C., et al. (2022). *Feeling the Heat: Adapting to Climate Change in the Middle East and Central Asia*. International Monetary Fund.

Espinoza, M. R. A. and Prasad, A. (2012). Monetary policy transmission in the gcc countries. *IMF Working Paper No 2012/132*.

Fuje, H., Yao, J., Choi, S. M., and Mighri, H. (2023). Fiscal impacts of climate disasters in emerging markets and developing economies.

Gollier, C. (2022). *Entre fin de mois et fin du monde: économie de nos responsabilités envers l'humanité*. Fayard.

Gopinath, G. (2022). How will the pandemic and war shape future monetary policy? In *Presentation at the Jackson Hole Economic Symposium, August*, volume 26.

Gray, M. S. T. and Karam, M. P. D. (2013). *Monetary issues in the Middle East and North Africa region: A policy implementation handbook for central bankers.* International Monetary Fund.

Guerrieri, L., Gust, C., and López-Salido, J. D. (2010). International competition and inflation: a new keynesian perspective. *American Economic Journal: Macroeconomics*, 2(4):247–280.

Hausmann, R., Pritchett, L., and Rodrik, D. (2005). Growth accelerations. *Journal of economic growth*, 10:303–329.

IMF (2022). World economic outlook. *World Economic Outlook: Gloomy and Uncertain, July.*

Jahan, S. (2012). Inflation targeting: Holding the line. *Finance & Development*, 4:72–73.

Jordà, Ò. (2005). Estimation and inference of impulse responses by local projections. *American economic review*, 95(1):161–182.

Jordà, Ò. and Taylor, A. M. (2016). The time for austerity: estimating the average treatment effect of fiscal policy. *The Economic Journal*, 126(590):219–255.

Kabundi, A., Mlachila, M., and Yao, J. (2022). How persistent are climate-related price shocks? implications for monetary policy. *IMF Working Paper 22/207.*

Kara, E. and Thakoor, V. (2023). Monetary policy design with recurrent climate shocks. *IMF Working Paper 23/243.*

Marcott, S. A., Shakun, J. D., Clark, P. U., and Mix, A. C. (2013). A reconstruction of regional and global temperature for the past 11,300 years. *science*, 339(6124):1198–1201.

Ramey, V. A. and Zubairy, S. (2018). Government spending multipliers in good times and in bad: evidence from us historical data. *Journal of political economy*, 126(2):850–901.

Romer, C. D. and Romer, D. H. (2004). A new measure of monetary shocks: Derivation and implications. *American economic review*, 94(4):1055–1084.

Salahodjaev, R. and Chepel, S. (2014). Institutional quality and inflation. *Modern Economy*, 5(03):219–223.

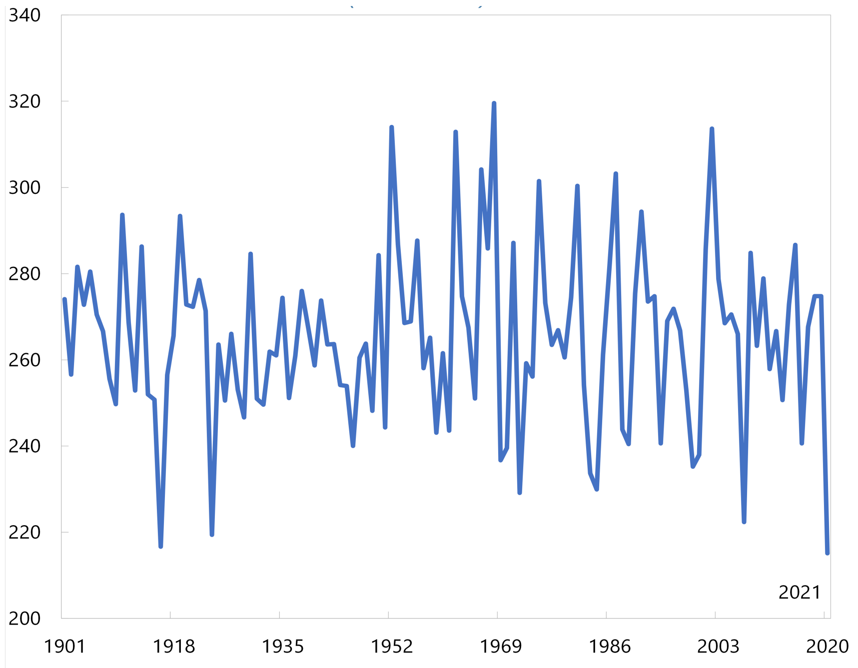
Sbordone, A. (2007). Globalization and inflation dynamics: the impact of increased competition.

Appendix

Table A1: Countries included in the sample

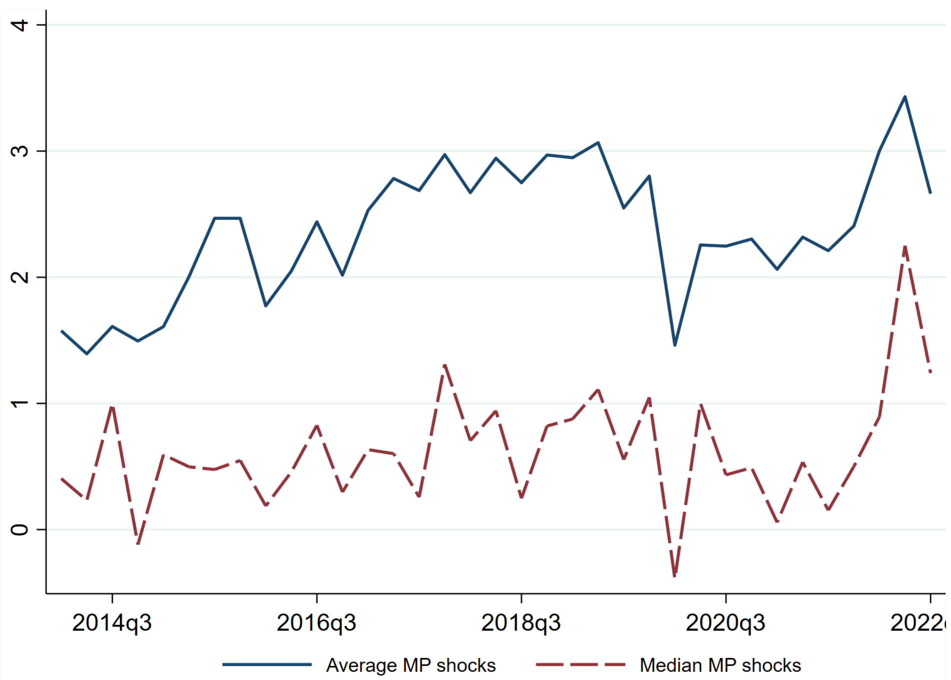
Armenia
Azerbaijan
Bahrain
Egypt
Georgia
Jordan
Kazakhstan
Qatar
Kuwait
Morocco
Oman
Pakistan
Saudi Arabia
Tajikistan
Tunisia
United Arab Emirates
Uzbekistan

Figure A1: Precipitation in ME&CA countries: 1900-2023



Notes: The figure depicts the annual precipitations in ME&CA over the past century. (Marcott et al., 2013, IMF, 2022)

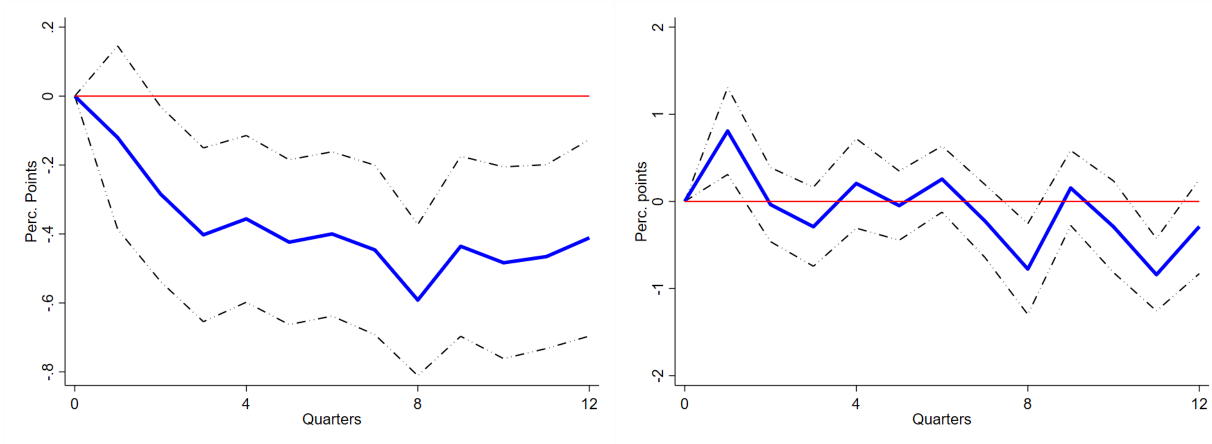
Figure A2: Monetary policy shock series



Notes: The figure depicts the average and median monetary policy shocks for our sample over the period 2014-2022.

Figure A3: Response of headline and food inflation - Shadow rate

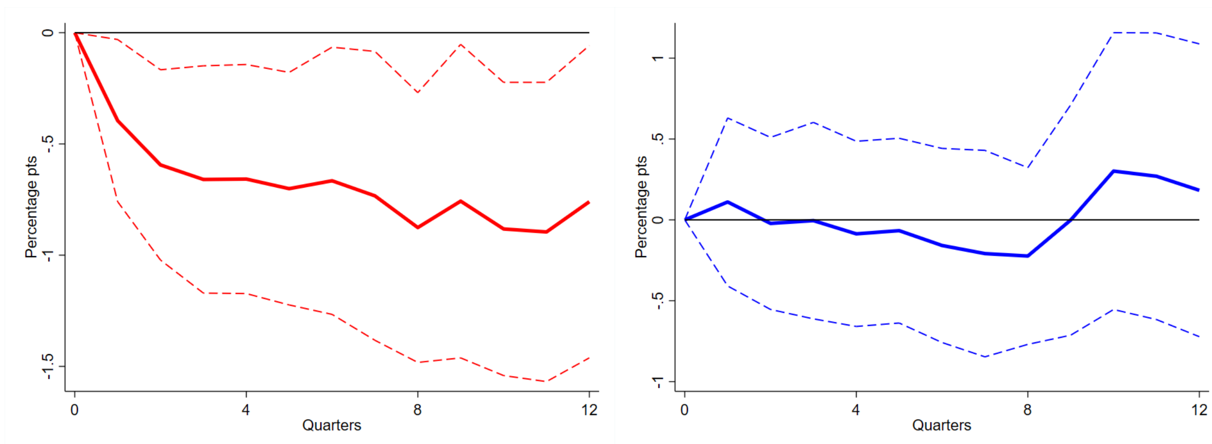
(a) Headline Inflation (b) Food inflation



Notes: The figures show the responses (in percentage points) of headline and food inflation to a normalized +100 b.p. exogenous increase in the Shadow rate. The dashed lines represent 90% Stock and Watson robust confidence bands.

Figure A4: Response of headline inflation to a monetary policy shock - Climate surges

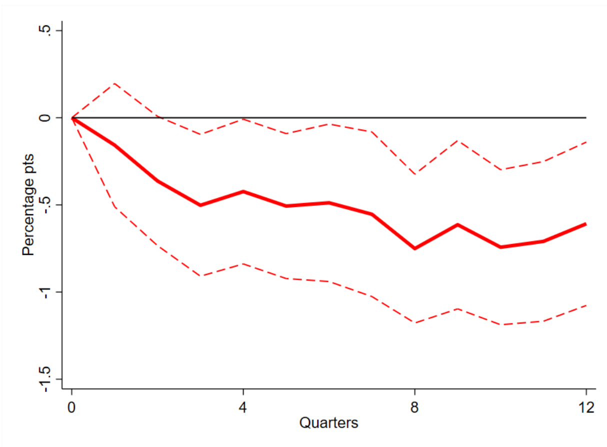
(a) High rainfall deviation (b) Low rainfall deviation



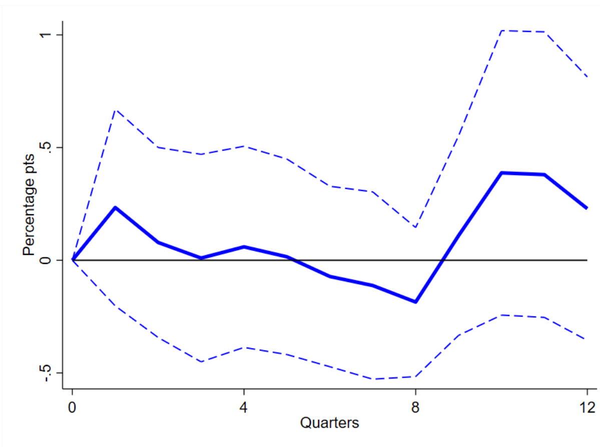
Notes: The figures show the responses (in percentage points) of headline inflation to a normalized +100 b.p. increase in monetary policy shock. The dashed lines represent 90% Stock and Watson robust confidence bands.

Figure A5: Response of headline inflation - Climate surges and alternative monetary policy shock

(a) High rainfall deviation



(b) Low rainfall deviation



Notes: The figures show the responses (in percentage points) of headline inflation to a normalized +100 b.p. increase in monetary policy shock. The dashed lines represent 90% Stock and Watson robust confidence bands.

PUBLICATIONS

The Nexus of Climate and Monetary Policy: Evidence from the Middle East and Central Asia
Working Paper No. WP/2024/090