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The Influence of Climate Disturbances on Growth and Inflation

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Abstract

Given the multifaceted impact of climate disturbances, analyzing the effects of climate change on inflation and growth patterns presents challenges. Such disturbances can have contrasting implications for demand and supply simultaneously. The impact of climate-induced disturbances on economic growth and inflation is determined not only by the immediate effects of these events but also by the long-term damage they cause and a country's institutional and financial capacity to respond and recover. In our study, we employ the local projection method to assess the impact of climate-related catastrophes on inflation and economic growth in various countries from 1970 to 2020. Our findings indicate that inflation and GDP growth react differently to various categories of climate-related events. When we group our data by economic maturity, we find that the effects of climate events on inflation and growth depend on a country's stage of development, its present economic health, and fiscal resilience at the time of the event.

Keywords: *climate disturbances, Inflation, economic growth.*

INTRODUCTION

With its intricate and evolving nature, climate change presents considerable challenges and uncertainties for global economic stability and financial sectors. The rise in global surface temperature by over 1.1°C since preindustrial times has intensified the occurrence and severity of meteorological disturbances. As climate change progresses, forecasts indicate a growing risk of droughts, heightened temperature extremes, and violent storms, potentially damaging ecosystems, human lives, and professions. The coming century might witness a surge in the global average temperature by up to 4°C, as suggested by studies (Solow, 2017). The effects of climate change will be felt globally; however, the severity of the effects will vary depending on a country's economic size and composition, the resilience of its institutions and infrastructure, and its capacity for climate change mitigation and adaptation.

Understanding the effects of climate change on growth and inflation dynamics is a difficult task, chiefly because climate shocks are pervasive and multifaceted. Although these disruptions are prevalent, they simultaneously impose conflicting pressures on supply and demand. The magnitude and trajectory of their impact on inflation and growth depend on the lasting economic impacts and the fiscal and institutional strength of a nation's recovery efforts. In this study, the local projection (LP) technique, as conceptualised by Murphy (2018), is implemented. to gauge the effects of climate shocks. We quantify these shocks using a binary metric marking the incidence of a climate-related disaster or a ratio of fatalities from such events concerning the yearly

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population. This methodology aids our examination of their implications on inflation and economic growth across a comprehensive panel of 173 nations from 1970 to 2020. Moreover, we delve into the potential non-linear consequences of significant climate events on inflation and real GDP growth, focusing on two facets: (i) the current stage of an economy's business cycle and (ii) the magnitude of public debt, serving as a barometer of fiscal leeway when a climatic disaster strikes.

Analyzing data from 173 countries from 1970 to 2020, our study underscores that inflation and growth rates exhibit significant reactions to climatic catastrophes. However, the direction and extent of these responses differ. While extreme temperature variations correlate with decreased inflation, phenomena such as droughts and storms typically result in an uptick. A deeper examination, mainly focusing on varying inflation metrics, reveals that the impact of meteorological shocks on core and food inflation demonstrates marked disparities in scale and trend across different country classifications. Regarding economic growth, an initial downward trend is evident across all categories of climate disturbances. Nevertheless, this trend's magnitude and form show divergence in the long-term perspective. Segmenting the dataset based on income levels, a discernible variance emerges, highlighting distinct implications of climate disruptions on inflation and growth between advanced and developing economies.

In sum, our investigations indicate that the effects of climate-related catastrophes on inflation and growth are non-linear, influenced by the prevailing economic status and available fiscal buffer when these shocks occur. These climate-induced adversities can elicit diverse and, at times, counteracting impacts on inflation and growth via several mechanisms. These mechanisms encompass: (i) either boosting or curtailing agricultural yields, thereby affecting food prices; (ii) hampering economic progression and diminishing labour productivity; (iii) eroding wealth and earnings, subsequently altering consumption and investment behaviours; and (iv) impacting transportation infrastructures, leading to shifts in distribution costs. Additionally, the dynamics of these conduits differ markedly based on a country's economic advancement and its range of economic sectors (Psacharopoulos,1984).

The data-driven outcomes highlighted in this research should be perceived as a minimal assessment of the consequences of meteorological calamities in the context of escalating climate change. These insights carry significant connotations for economic strategies. Foremost, they predict a landscape where inflation and growth trajectories are prone to heightened fluctuations, inducing ripple effects across the entire economic spectrum.

Secondly, the diverse reactions of inflation and growth to climate disturbances suggest a widening disparity in the inflation rates and income growth felt by various societal subsets within a nation. Families with consumption patterns leaning heavily on goods and services facing heightened inflation and dwindling incomes after natural disasters will be more affected. In contrast, those households with consumption less anchored to such volatile goods and whose income remains insulated during these shocks will face fewer consequences. From our perspective, these findings highlight distinct demographic tendencies, inherent structural disparities, and the diminished fiscal and institutional agility of developing countries to confront and navigate the challenges of climatic disruptions. Projecting forward, policymakers must weigh how the pivot towards environmentally friendly energy solutions, central to addressing climate change, will influence inflation and growth dynamics.

This paper proceeds in the following manner. Section II delves into a review of pertinent literature. Section III outlines the data employed for our empirical exploration. In Section IV, we elucidate the critical aspects of our econometric approach. Section V brings forward our empirical findings, complemented by a range of robustness validations. Section VI culminates with concluding observations and their implications for policy formulation.

A BRIEF OVERVIEW OF THE LITERATURE

This paper synthesizes various facets of literature concerning inflation, growth, and climate change. Firstly, numerous determinants of inflation have been identified, which encompass policy inclinations (Gerring, 2005), macroeconomic trends like income levels, trade openness, financial integration, and fiscal imbalances, among others (Grossman, 1989). Factors like labour market structures (Birdsall, 1993), currency regimes (Garnaut, 2023;), and various institutional and political attributes (such as in Finighan,2023) also play a crucial role.

Furthermore, many studies explore the connection between central bank independence and inflation rates. Rooted in foundational papers such as those by Dension (1962) and David and Loewy, (1995), this literature suggests that greater autonomy of central banks often aligns with more stable and lower inflation rates. However, it is worth noting that this association is not always consistently demonstrated. For instance, research by Loecker (2020) highlight certain discrepancies or nuances in the relationship's statistical validity.

The variation in economic growth across nations and temporally is influenced by various cultural, demographic, economic, financial, institutional, political, and societal factors. Both neoclassical and endogenous growth theories attribute these discrepancies primarily to the accrual of physical and human capital and technological progress (as posited by Solow, 2017). Through cross-country examinations, numerous studies, including those by Jamison (1994) and Lucas (1998) illustrate that variances in income growth rates correlate systematically with quantifiable factors. These factors encompass initial GDP per capita, human capital metrics such as educational achievements and health status, public and private investments, degrees of global openness, and terms-of-trade fluctuations. They also highlight the role played by geography, institutional frameworks, and political environments. Complementary research aligns with these findings, even when adopting distinct samples and approaches, as evidenced in works like Rubin (2002).

The intersection between the economic consequences of climate change and financial implications has given rise to a rapidly expanding field of research. Early foundational works, notably by Spengler (1964), employed aggregate damage functions to elucidate the relationship between climate variables and economic outcomes. While delineating the macroeconomic outcomes stemming from annual climate variations remains an intricate empirical endeavour.

ECONOMETRIC METHODOLOGY

In our study, we employ the Local Projection (LP) method to ascertain the repercussions of climate shocks on inflation and economic expansion, from which we derive impulse response functions (IRFs) within a panel context. Contrary to recursively utilizing the initially estimated coefficients, this methodology evaluates a series of regressions involving the dependent variable offset by multiple periods. Consequently, the LP approach avoids confining the shape of IRFs, making it less prone to potential inaccuracies when juxtaposed with traditional VAR models (refer to Solow, 2017). Given its efficacy in evaluating nonlinear dynamic reactions, the LP method has gained traction in contemporary research, particularly when scrutinizing the impacts of monetary and fiscal policy shocks (evident in works by Romer, 2019). Our foundational model is outlined as follows:

$$yt+k,i - yt-1,i = \alpha i + rt + \beta kCSi,t + \theta Xi,t + \varepsilon i,t1)$$

In the given equation:

- \(y \) represents consumer price inflation or economic growth. To lessen the impact of extreme values, this measure is winsorized at both the 5th and 95th percentiles.

- \(αi \) and \(rt \) act as fixed effects for country and time, respectively. Their inclusion ensures that cross-country differences and global shocks are taken into account.

- \ (βk \) illustrates the compounded response of inflation or growth for each year, \(k \), following a climate shock.

- \ (CSi, t \) signifies the climate shock variable. This can be a binary value or a measure scaled by the number of deaths relative to population. It is crucial to note that this shock is treated as an unpredictable external event, implying it is not forecasted or linked with prior economic shifts.

- The substantial climate events scrutinized in this study are viewed as country-specific shocks for two primary rationales: the nature of the shock itself might be extensive, or due to economic ties (be it through trade or integrated markets), a localized shock might disseminate, affecting the entire nation.

- Finally, \ (Xi, t \) encompasses a range of control variables. This includes two preceding lags of climate shocks, the relevant dependent variable's lags, and two lags of the output gap derived using the HP filter.

This formulation provides a structured way to discern how economic factors respond to climatic shocks while accounting for inherent differences between countries over time.

This analysis uses three distinct inflation measures: headline Consumer Price Index (CPI), core CPI, and food prices. Alongside this, real GDP growth is also taken into account. For the focal variable, \ (CSi, t \), the study incorporates three distinct climate shock types: droughts, extreme temperatures, and storms.

The aforementioned equation is deduced utilizing the Ordinary Least Squares (OLS) technique. The Spatial Correlation Consistent (SCC) standard errors, as suggested by Holmberg (2006), are employed to account for the potential spatial correlation.

Post-estimation, the Impulse Response Functions (IRFs) are derived by mapping out the computed \ (βk \) for the timeline \ (k = 0,1, …,5 \). These are showcased with confidence bands spanning both 90% and 68%. These confidence intervals span five years and are deduced from the standard errors associated with the \ (βk \) coefficients.

As highlighted by Sims and Zha (1999), it is worth noting that the standard pointwise bands, which are frequently used, ought to be complemented with metrics that indicate the uncertainty of shape. As a result, in delineating the probable shape, bands reflecting a 68% posterior probability—or a shock equating to one standard deviation—offer a more accurate representation of the genuine likelihood.

EMPIRICAL RESULTS

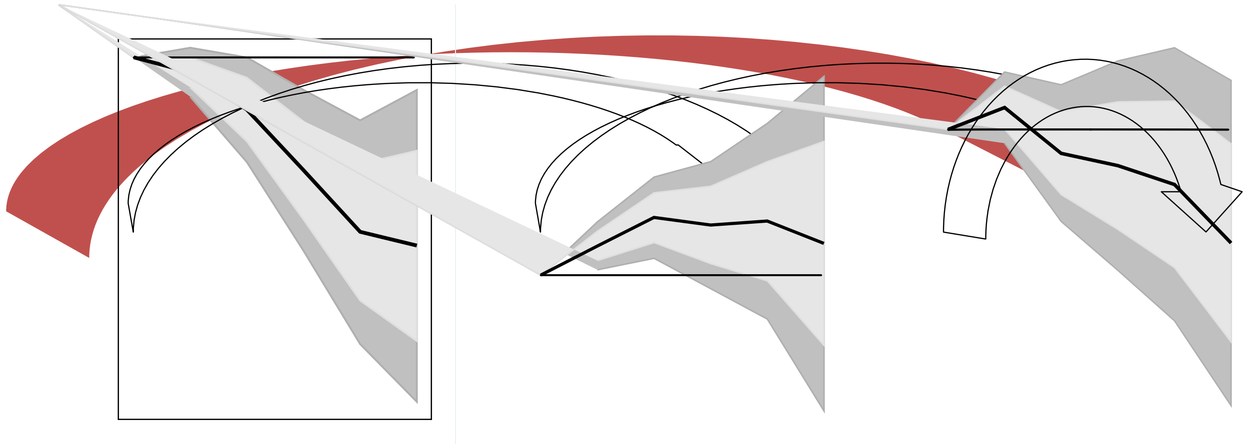
Climate Shocks and Inflation

The cornerstone of our investigative study hinges on examining the influence of climate disturbances on inflation across a vast sample of 173 nations, spanning the timeframe of 1970-2020. Figure 1 depicts the Impulse Response Functions (IRFs) of headline inflation to three categories of climate-induced natural calamities, flanked by 90 percent confidence bands.

Our results reveal a noteworthy yet varied response in headline inflation based on the type and intensity of climate disruptions, predominantly when determined by the binary indicator denoting the occurrence of a substantial weather-related catastrophe within a specific year. For instance, surges in extreme temperatures seem to drive down inflation rates. In contrast, phenomena such as droughts and storms elevate inflation levels.

Digging deeper into the effects of temperature spikes, our findings indicate a pronounced decline in headline inflation beneath its starting position, both within the initial year and persistently over an extended timeframe. This dip is most profound around the 4-year mark post the temperature-related disruption.

Figure 1. Baseline Impact of Climate Shocks on Headline Inflation: Global Sample

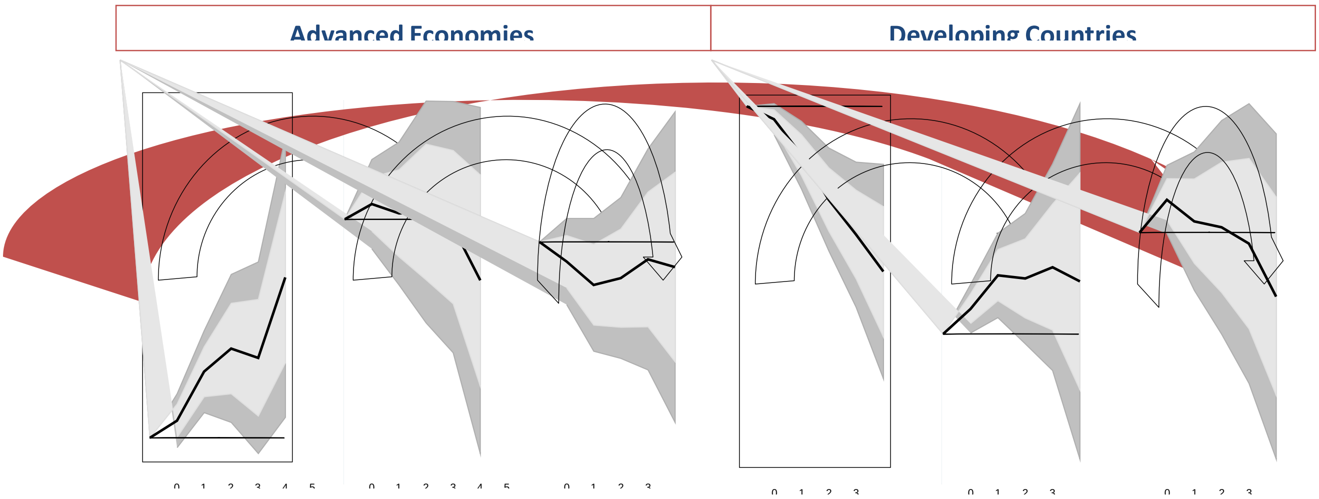


Note: The visuals illustrate the Impulse Response Functions (IRFs) derived using the LP method. On the x-axis, the timeline is mapped in years. Notably, 't=0' signifies the year immediately before the onset of the climate shock, whereas 't=1' marks the inaugural year post the climate perturbation.

After the temperature shock, headline inflation drops by 3.5 percentage points compared to its expected trajectory without the shock. In contrast, a drought shock causes an immediate uptick in headline inflation, persisting in the long run, resulting in an elevation of approximately 1.5 percentage points from what would have been without the shock. Storms exhibit a unique pattern: There is an initial rise in inflation by roughly 0.2 percentage points in the first-year post-shock, but this eventually recedes, leading to a decrease of about 1 percentage point in the long run. For a detailed breakdown, refer to Table A2 in the Appendix, which lists coefficient estimates, standard errors, and essential diagnostic statistics correlating with the IRFs illustrated in Figure 1.

Breaking down our entire dataset into income tiers—specifically, advanced and developing economies—yields intriguing insights into the varying impacts of climate shocks on headline inflation, as illustrated in Figure 2. Advanced economies display a consistent upward trend in headline inflation following temperature shocks, starkly contrasting with the declining trend observed in developing nations. Concerning drought shocks, both segments experience an initial surge in headline inflation; however, while this surge is transient in advanced economies, it endures in developing ones. Similarly, storm-induced shocks precipitate a decrease in headline inflation for advanced nations but an increase for their developing counterparts—although these effects are not long-lived for either group. These disparities could be attributed to inherent structural and demographic contrasts between the two categories and a potentially diminished fiscal and institutional resilience among developing countries to adapt and cushion the repercussions of these climatic upheavals.

Figure 2. Effects of Climate Disruptions on Inflation Trends: An Analysis by Economic Status



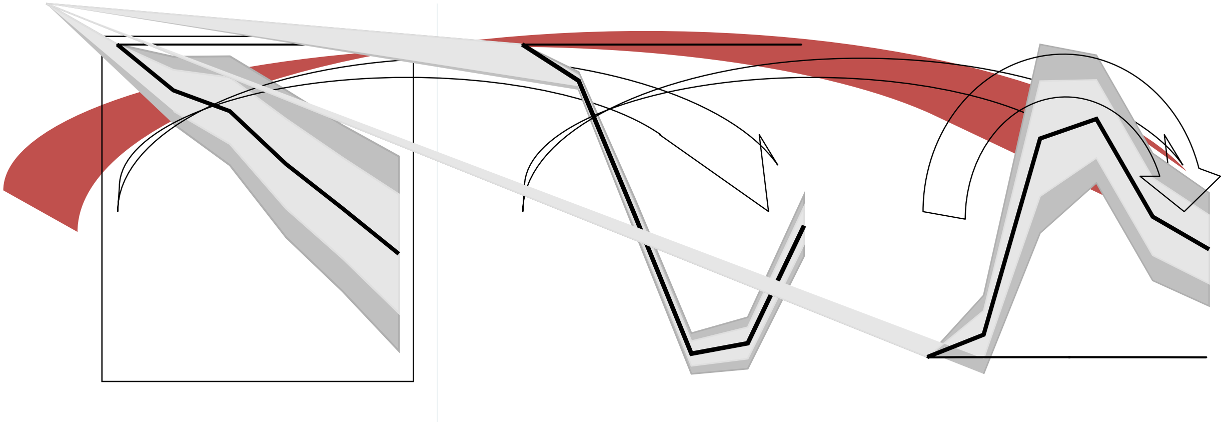
Note: The displayed charts utilize the LP method to depict IRFs. The x-axis represents years, with t=0 marking the year before a climate shock and t=1 indicating the initial year of impact. The prominent black line traces the reaction to a climate event, while the dark and light grey regions signify the 90-percent and 68-percent confidence intervals, respectively. These intervals are calculated using standard errors clustered by country.

Climate Shocks and Growth

Figure 3 displays the IRFs of real GDP growth against three specific weather-related natural calamities, complete with 90 percent confidence intervals. Our observations indicate that the initial response in growth to these climate perturbations is consistently downwards. However, the degree and course of these reactions vary over an extended period. For instance, after a temperature disturbance, there is a sustained decline in real GDP growth. Five years post-disturbance, the growth rate is reduced by approximately 1.5 percentage points compared to a scenario without the disturbance. On the other hand, both droughts and storms elicit a sharper decline in growth in the year immediately after the disturbance. Yet, the depth and continuity of this decline waver in the ensuing years. Appendix Table A3 provides a comprehensive breakdown of the coefficients, their related standard errors, and other pertinent statistical diagnostics underpinning these IRFs.

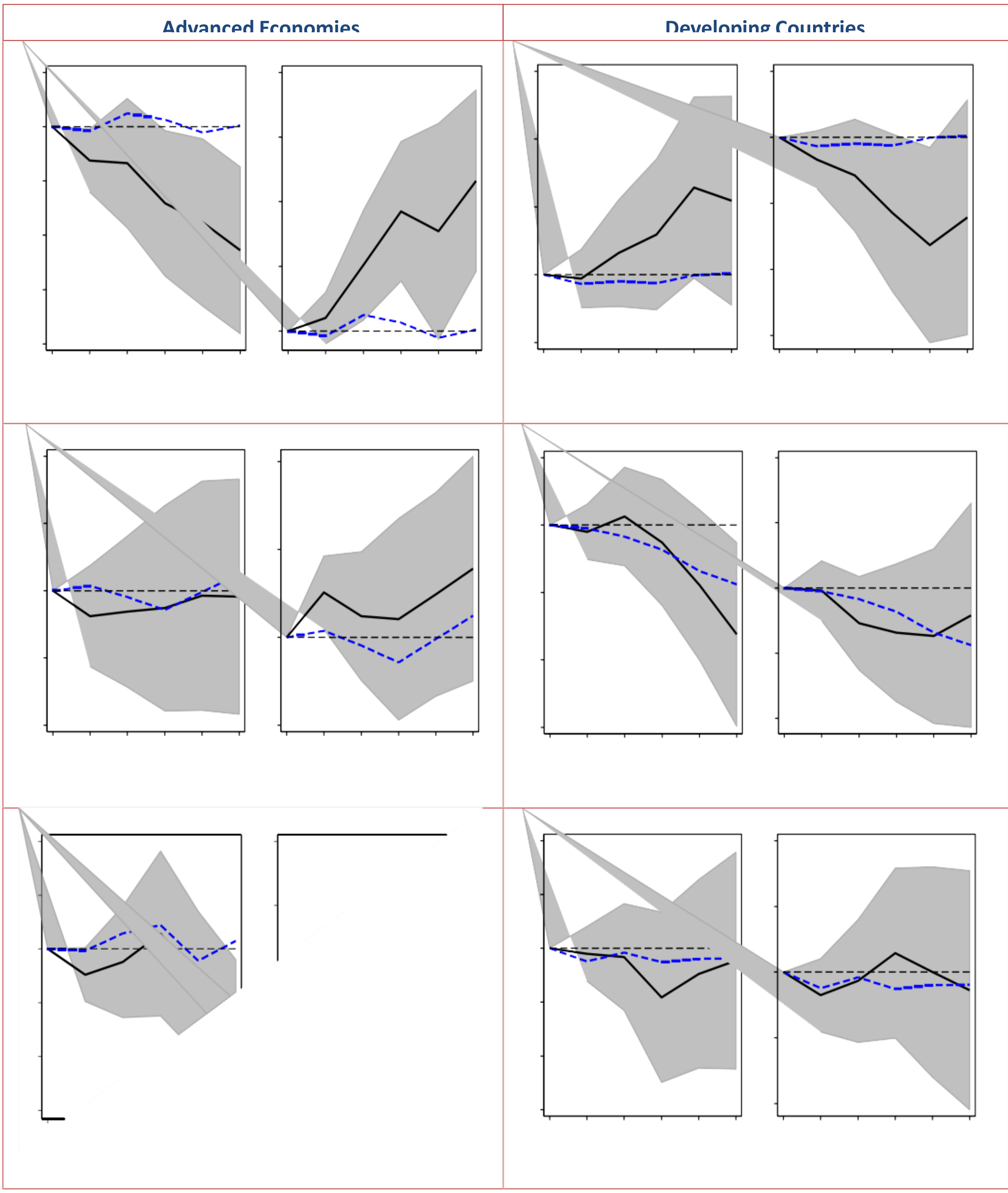
To better understand how climate shocks affect growth, we categorized the countries into income brackets—advanced economies and developing nations—and showcased these IRFs in Figure 4. This classification highlights a pronounced difference in how climate disturbances influence real GDP growth in nations with distinct economic standings. Whereas developing countries experience a marked and enduring downturn in economic growth following weather-induced calamities, advanced economies remain largely unaffected.

Figure 3. Impact of Climate Shocks on Growth: Disaster Intensity



Note: The diagrams illustrate IRFs using the LP technique. On the x-axis, t=0 represents the year before the climate event, while t=1 marks the initial year of its effects. A solid black line highlights the reaction to a climate disturbance. The shaded regions show confidence bands: dark grey represents 90-percent confidence, while light grey indicates 68-percent confidence. These are determined using standard errors that are grouped by country.

Figure 4. Impact of Climate Shocks on Growth: Role of Fiscal Space



Note: The diagrams display IRFs derived from Equation [2]. On the x-axis, t=0 marks the year when the climate event occurred, while t=1 signifies the immediate year following its impact. A solid black line traces the reaction to a climate disturbance. The shaded areas represent confidence intervals: dark grey for 90-percent and light grey for 68-percent, determined using standard errors grouped by country. Meanwhile, a dotted blue line showcases the baseline result without conditions, sourced from Equation.

CONCLUSION

Climate change emerges as the most pressing concern of our generation. In this research, we probe the repercussions of weather-driven natural disasters on consumer price inflation and overall economic trajectory. Our analysis, which encompasses 173 countries from 1970 to 2020 and employs the LP method, highlights that inflation and growth respond in marked yet varied ways to these environmental disruptions.

Intriguingly, shifts in temperature tend to lower inflation, while droughts and storms elevate it. When we categorize our broad dataset by income, distinguishing between advanced and developing economies, we observe profound disparities. The impact of environmentally induced disasters on baseline inflation significantly diverges based on the economic status of a country. Further deepening our inquiry, we assess how these meteorological events influence specific inflation categories. It becomes evident that the effects on core and food inflation vary considerably in scope and pattern across different nations. In summary, our research underscores that the inflationary pressures exerted by environmental upheavals are influenced by the existing economic landscape and the fiscal capabilities present when these disruptions occur.

Every climate anomaly has a discernible effect on economic expansion, but the severity and persistence of these effects differ over time. Specifically, shifts in temperature consistently depress real GDP growth, whereas the economic tremors caused by droughts and storms are more erratic and short-lived. When we segment our data based on economic standing, a pronounced divergence is apparent in how climate disturbances affect GDP growth across countries at varying development phases. Developing countries face extended economic downturns due to weather-related disruptions, while advanced economies seem insulated mainly. Delving deeper into the subtle implications of these weather events on economic trajectories, it becomes clear that a nation's economic vitality and fiscal leeway are central in determining the magnitude and duration of growth disturbances following climatic upheavals. This dynamic, interestingly, exhibits variance across countries based on their economic stature.

This study's empirical findings underscore that climate-related disasters influence inflation and growth in diverse and sometimes contrasting ways. They impact various facets of the economy, including:

(i) Swinging agricultural outputs and fluctuating food prices,

(ii) Restraining economic momentum and hampering labour efficiency,

(iii) Diminishing wealth and income, which in turn curtails consumption and investment,

(iv) Interfering with transport systems and escalating distribution costs.

Moreover, these effects are not uniform; they significantly differ based on a country's economic maturity and diversity. In our estimation, these outcomes also indicate the distinct demographic profiles, economic structures, and, crucially, developing nations' limited fiscal and administrative resources to counter and cushion against the ramifications of climate adversities. Given the escalating climate change concerns, these insights are significant for shaping future economic strategies and policies.

To put it succinctly, the ripple effects of climate disturbances have multifaceted implications. Firstly, the unpredictability of climate-induced changes can amplify volatility in inflation and growth, affecting the broader economic landscape. Secondly, the nuanced reactions of inflation and growth to these disruptions can widen economic disparities within nations. Specifically, families whose livelihoods or consumption heavily rely on sectors most vulnerable to climate shocks will bear a heavier burden. Conversely, those less tethered to such sectors may remain relatively insulated. As we gaze into the horizon, decision-makers must weigh the economic repercussions of transitioning towards greener alternatives in our fight against climate change. This transition, while essential for environmental conservation, will undeniably shape inflation and growth trajectories in the future.

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