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Is growth at risk from natural disasters? Evidence from quantile local projections

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Over the past three decades, natural disasters have become increasingly frequent and intense, posing significant risks to economic activity, particularly in developing countries. This paper investigates the impact of natural disasters on economic growth, focusing on the 10th percentile of GDP growth to capture the worst recessions experienced by countries. Using the Quantile Local Projections (QLP) method on a panel of developing countries, we explore whether these disaster shocks worsen economic downturns and delay recoveries. Our findings reveal that natural disasters tend to exacerbate severe economic contractions in developing countries, causing a lasting decrease in the lower tail of GDP growth distribution. This effect is especially pronounced in the agricultural and industrial sectors, with the services sector showing a less persistent response. Moreover, high-income developing countries and those with better political institutions better counteract the adverse effects of natural disasters and exhibit greater resilience when output is extremely low.

This paper examines the economic impact of natural disasters on developing countries, mainly focusing on whether these events increase the risk of experiencing severe recessions. Over the last three decades, there has been a surge in the frequency and severity of natural disasters and their significant economic costs, as evidenced by recent events like the 2022 floods in Pakistan and the 2023 earthquakes in Turkey and Syria. Despite extensive research, macroeconomic literature remains divided on the effects of natural disasters on economic growth, with studies reporting varying impacts.

The literature underscores this debate, presenting studies with diverse findings. Skidmore and Toya (2002) suggest that disasters can enhance economic growth by fostering human capital accumulation and technology adoption. In contrast, Noy (2009) shows that developing economies suffer more significant output declines due to their limited

ability to implement counter-cyclical policies and other structural weaknesses. Loayza et al. (2012) and Fomby et al. (2013) find that the impact of natural disasters varies across economic sectors and disaster types, with developing countries being more vulnerable. Recent studies by Atsalakis et al. (2021) and Ginn (2022) explore natural disasters' non-linear and state-dependent effects, shedding light on the complex relationship between natural disaster intensity and economic activity.

Given these mixed findings, this paper seeks to address a crucial question: **Do natural disasters worsen severe recessions in developing countries?**

We employ the Quantile Local Projections (QLP) method, focusing on the 10th percentile of GDP growth distribution, capturing the worst economic downturns. This approach is inspired by the Growth-at-Risk models and is particularly suitable for analyzing the heterogeneous effects of disasters across different economic states.

The study focuses on developing countries due to their heightened vulnerability, low resilience, and poor institutional quality, as noted by Noy (2009) and Kabundi et al. (2022). Accordingly, developing countries struggle to implement counter-cyclical policies in disaster aftermath, facing issues like limited insurance coverage and insufficient aid mechanisms, which worsen the adverse effects. Moreover, high corruption levels tend to contribute to higher fatalities from natural disasters, particularly in developing economies, highlighting their vulnerability due to poor institutional quality and inadequate health and risk management systems. Consequently, it is crucial to carry out this study on developing countries.

Our findings indicate that natural disasters lead to significant and persistent declines in the 10th percentile of economic growth, mainly affecting the agricultural and industrial sectors. The services sector shows a less persistent negative impact, likely due to increased post-disaster demand. Additionally, higher income developing countries and those with better political institutions demonstrate greater resilience.

The paper contributes to the literature by moving beyond traditional average effect estimations and focusing on the tail-risk framework using the QLP method. This novel approach provides a deeper understanding of the dynamics of natural disasters' impact on severe economic downturns in developing countries, emphasizing the importance of resilience-building measures and effective institutions.

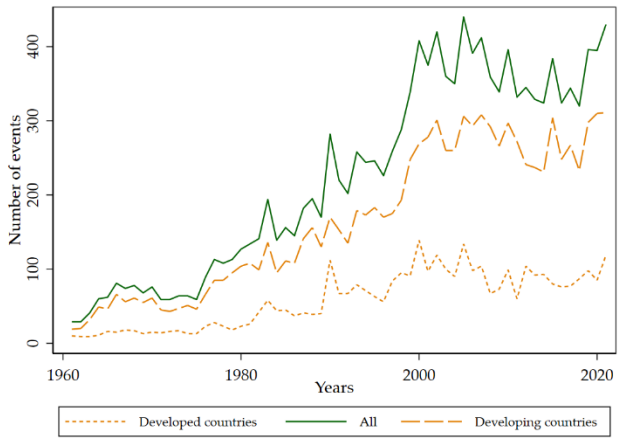
Some facts

Global climate is changing, making directly related natural disasters more frequent and intense. For instance, global warming does not directly cause earthquakes (Buis, 2019), but it is likely to increase the intensity and frequency of droughts, floods, and storms, along with the vulnerability of countries (Field, 2012).

Figure 1 below shows a sharp increase in the number of natural disasters since the beginning of the 21st century. This acceleration is more pronounced for developing countries, while the evolution of the number of disasters seems to remain stable for developed countries.

Our analysis only focuses on earthquakes, droughts, floods, and storms for various reasons. In fact, these disasters represent 85% of all natural disasters between 1961 and 2021.

Figure 1. Number of natural disasters. 1961-2021.



9% of these events are earthquakes, 5.5% are droughts, 40% are floods, and 31% are storms. Additionally, these disasters are omnipresent in both developed and developing countries, with a predominance of storms in developed countries and floods in developing ones. Plus, these disasters are the costliest in terms of human damage in both types of countries.

On the other hand, the preponderance of these disasters can be attributed to climate change (IPCC, 2013, 2014; IMF, 2017). In fact, rising global temperatures and changing weather patterns tend to increase the frequency and intensity of natural disasters, such as hurricanes and floods (Buis, 2019). Moreover, developing countries tend to be more affected by these changes as they are often located in more vulnerable geographic regions.

Determinants of natural disasters: hazards vs vulnerability

The determinants of natural disasters are influenced by their social and economic impacts, transforming a climate shock into a natural disaster when it significantly affects society and the economy. The extent of these impacts depends on a country's *vulnerability* and the nature and intensity of the *hazard*.

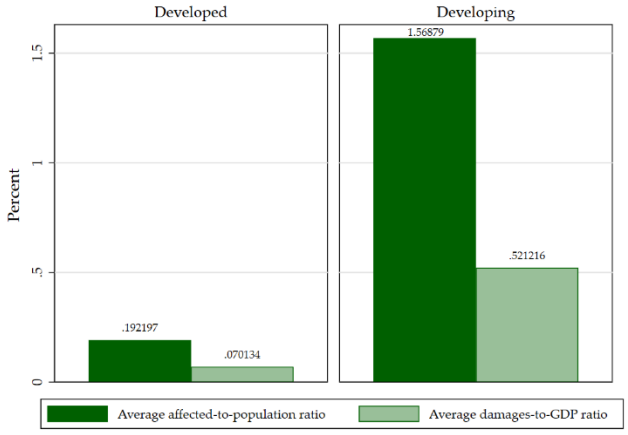
Vulnerability is influenced by factors such as infrastructure quality, urban population concentration, and the effectiveness of early prevention systems. Hazards become disasters when they result in loss of life and damage to livelihoods and infrastructure. While papers such as Noy (2009) and Kabundi et al. (2022) focus on countries' structural vulnerabilities to explain extreme economic losses from disasters, Schumacher and Strobl (2011) find a non-linear relationship between economic losses and stages of economic development, crucially driven by a country's exposure to different hazard stages. Therefore, the interplay between vulnerability and hazards is critical in determining the extent of a natural disaster's impact. While vulnerability factors shape a country's susceptibility, the nature and stage of hazards significantly influence the outcomes. Understanding this dynamic is essential for developing effective risk reduction and mitigation strategies.

Advanced economies have improved their resilience and reduced vulnerability through counter-cyclical fiscal and monetary measures. In contrast, developing countries have seen increased vulnerability due to population growth (Perrow, 2011) and low-quality institutions, leading to higher average populations affected by natural disasters.

Coronese et al. (2019) show that extreme damages from natural disasters are increasing, with a notable shift towards more severe damages over time. While developed countries bear higher levels of material costs (according to data collected from the EM-DAT not reported here), developing countries experience greater monetized damages relative to GDP (see figure 2 below), underscoring their significant vulnerability. This disparity is attributed to developing

countries' limited capacity to adopt proactive measures to reduce vulnerability. Additionally, these countries tend to be poorer, hotter, and more exposed to natural disasters, making them more susceptible to the adverse effects of climate change and natural disasters.

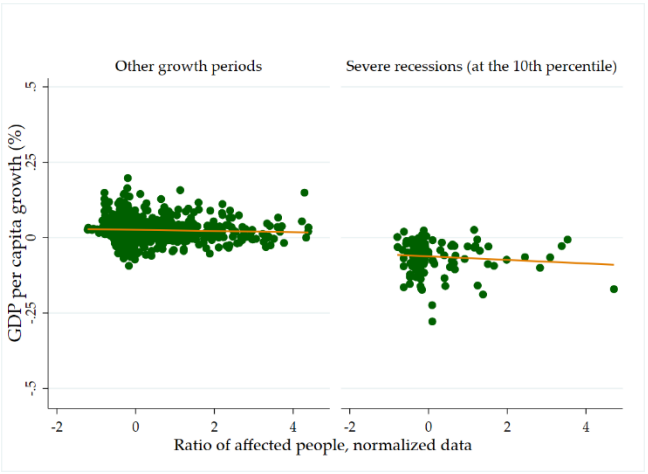
Figure 2. Average affected-to-population and damages-to-GDP. 1961-2021.



Natural disasters and low-growth periods

Our data show that during periods of low economic growth, disaster impacts are more severe, with human costs averaging 1.7% compared to 1.1% at other times. As the proportion of affected people increases, there is a sharp decline in GDP growth in these countries, indicating a negative relationship (see Figure 3). Overall, there is a minor negative correlation (-5%) between GDP per capita growth and disaster human costs. However, this correlation worsens significantly (-10%) during severe economic downturns, illustrating a heightened vulnerability to disasters in times of low growth.

Figure 3. Natural disasters cost based on economic activity.



Materials and methods

The study draws on disaster data from the Emergency Disasters Database (EM-DAT) covering 1970 to 2021. We measure natural disaster intensity based on fatalities and the proportion of affected people relative to the population, following Fomby et al.'s (2013) methodology. Annual indexes for moderate and severe disasters are then created, which are crucial for understanding their impact on the lower end of economic growth.

Using Quantile Local Projections (QLP) on a panel of 51 developing countries, the study focuses on the 10th percentile of GDP growth. We use this method to examine how natural disaster shocks during severe economic downturns exacerbate economic contractions and delay recovery.

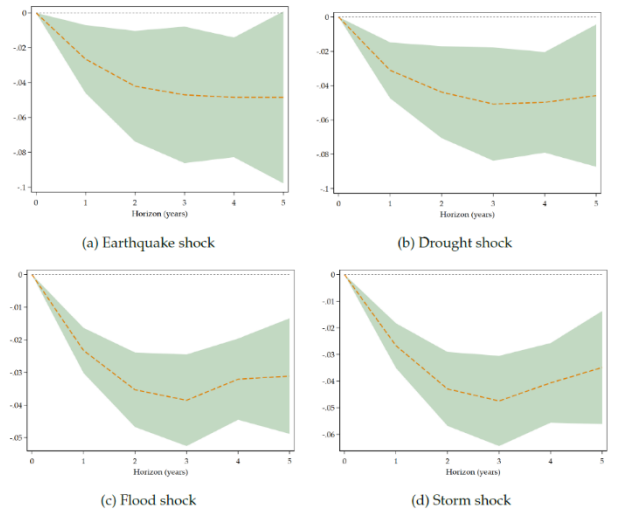
Key takeaways

For moderate disasters, our QLP analysis shows that while these events cause immediate disruptions, the long-term effects are less pronounced compared to severe disasters.

Moderate floods, for instance, might even have some positive outcomes by providing sufficient water for multiple cropping seasons, which can boost agricultural productivity.

However, the quantile impulse response functions (QIRFs) indicate that the impact of moderate natural disasters tends to fade after a few years, suggesting a quicker economic recovery and a return to pre-disaster growth levels.

Figure 4. Natural disasters, responses at 10-th percentile of real GDP per capita growth.



Notes: Figures show the predictive effects on growth of a 1-SD $DS^{dis}_{i,k,t}$ shock based on a LP series of quantile regressions. Shaded areas denote the 95% confidence interval.

In contrast, severe natural disasters have a more pronounced and lasting negative impact on economic growth. Severe earthquakes, floods, droughts, and storms significantly worsen extreme recessions, with QIRFs showing persistent negative effects on the 10th percentile of GDP growth. Earthquakes, in particular, cause extensive human and material damage, leading to prolonged economic downturns. Additionally, severe floods cause profound economic decline by devastating capital and crops. These considerations emphasize the critical need for policymakers to integrate disaster risk management into economic planning to mitigate such adverse effects on vulnerable economies.

Heterogeneity across production sectors

Aiming to refine our analysis, we also explore the effects of natural disasters on the 10th percentile of sectoral production growth, focusing on agricultural, industrial, and services sectors. The findings reveal that natural disasters have a significantly high negative impact on agricultural and industrial sectors, with persistent risks to growth. In contrast, the services sector shows a lesser and more quickly reversing negative impact, likely due to increased demand for services in disaster aftermaths.

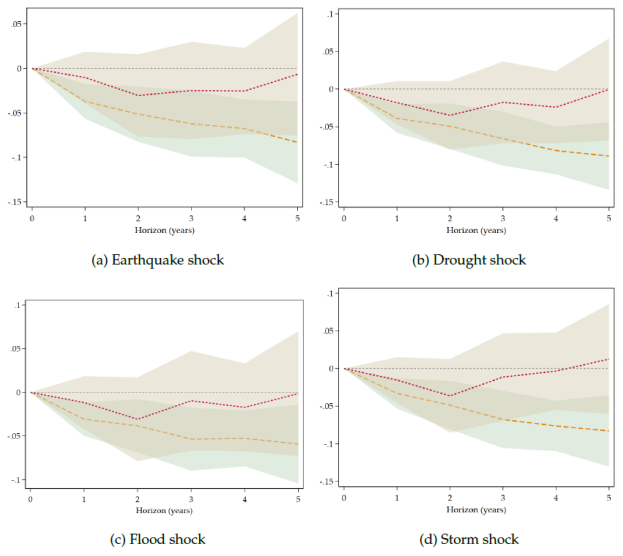
Natural disasters lead to persistent negative effects on agricultural low output, primarily due to the close interdependencies between agriculture and the industrial sector in developing countries. The industrial sector, heavily reliant on agricultural inputs, also suffers prolonged adverse effects, though these begin to reverse five years after a disaster. The services sector, however, demonstrates resilience, with a quicker recovery from negative impacts. This resilience is attributed to increased demand for disaster relief and recovery services, such as transport, communications, and insurance.

Heterogeneity across income level and institutional quality

Our paper explores the heterogeneous effects of natural disasters as well on economic growth across different income levels. For low-income countries, natural disasters tend to exacerbate severe recessions significantly, with their impact remaining highly persistent over the medium term. This persistence is attributed to the greater vulnerability of low-income countries, which often experience more extensive damage due to their smaller economies and limited capacity for effective policy response. In contrast, high-income countries show more resilience, with their diversified economies and better infrastructure enabling quicker recovery. The ability of high-income countries to implement

counter-cyclical policies further mitigates the adverse effects of natural disasters, resulting in less pronounced and shorter-lived economic downturns compared to low-income countries (see figure 5).

Figure 5. Natural disasters, the 10-th percentile of real GDP per capita growth by income level.



Notes: Figures show the predictive effects on the 10th percentile growth of a 1-SD $DS^{dis}_{i,t}$ shock based on a LP series of quantile regressions. Small dashed lines represent QIRF of high-income countries and long dashed lines represent the QIRF of low-income countries. Shaded areas denote the 95% confidence interval.

Institutional quality significantly influences how natural disasters impact economies. High-income countries with strong governance, legal frameworks, and regulatory systems manage disasters more effectively. They can effectively distribute aid, mitigating both short-term and long-term economic effects. Conversely, low-income countries with weaker institutions struggle to respond and recover efficiently, leading to more severe and prolonged economic setbacks. QLPs show that countries with robust institutions experience less severe GDP downturns after disasters, highlighting the critical role of effective governance in disaster resilience and recovery. In contrast, countries with poor institutional quality are more vulnerable to the economic impacts of natural disasters. In these countries, natural disasters lead to significant and prolonged declines in GDP growth, particularly affecting the 10th percentile. Weak institutions result in inefficient resource allocation and ineffective disaster management, exacerbating the economic damage caused. Strengthening institutional frameworks in low-income countries is crucial to enhancing resilience and improving recovery from natural disasters.

Concluding remarks

In summary, our paper provides compelling evidence of the differentiated impacts of natural disasters on low economic growth outcomes across various contexts. By employing QLP methodology, the research highlights how both moderate and severe natural disasters significantly exacerbate economic recessions, with the most profound effects observed in the 10th percentile of GDP growth.

The findings underscore the critical importance of considering income and institutional heterogeneity when assessing the economic risks posed by natural disasters. Low-income countries and those with weaker institutional frameworks face more severe and prolonged economic downturns in the aftermath of disasters. This stark contrast emphasizes the need for targeted policy interventions aimed at strengthening institutional resilience and improving disaster preparedness and response capabilities.

The study underlines the importance of integrating disaster risk management into economic planning and policymaking. Strengthening institutional quality and resilience in vulnerable regions is crucial to mitigating natural disaster impacts, safeguarding long-term economic growth, and promoting sustainable development.

Policy Implications

The policy implications of this paper emphasize the critical need for international cooperation to enhance the resilience of developing countries against natural disasters. Modernizing infrastructure and implementing comprehensive emergency response plans are essential to mitigate immediate impacts and accelerate recovery. Diversifying economic activities, particularly in agriculture and industry, can buffer economies from sector-specific shocks. Strengthening institutional quality, especially in low-income and less democratic countries, is vital for effective disaster management and long-term economic stability. Additionally, coordinating fiscal and monetary policies can further support economic stabilization and social well-being post-disaster.

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