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Nature Made the State: Exploring the Effect of Disasters on Centralization

Sung Min Han[1], Min Tang[2], and Jinhai Yu[3]

Abstract

This study explores the institutional consequences of natural disasters on the distribution of authority between national and subnational governments. Specifically, it examines how disasters influence fiscal and administrative centralization and how this effect varies with their geographic distribution. We argue that natural disasters act as external shocks that increase institutional centralization and the centralizing effect of disasters is more pronounced when they occur farther from the capital or are widely dispersed. Using data from 84 countries (1962–2018), we find support for both the centralizing impact of disasters and the moderating effect of geographic distribution. Results also reveal variations in the effects across different types of disasters, dimensions of centralization, and time lags reflecting cumulative

[1]Hankuk University of Foreign Studies, Seoul, South Korea
[2]Shanghai University of Finance and Economics, Shanghai, China
[3]University of Connecticut, Hartford, CT, USA

Corresponding Authors:
Sung Min Han, Department of Political Science and Diplomacy, Hankuk University of Foreign Studies, 107 Imun-ro, Seoul 02450, South Korea.
Email: sungmhan@hufs.ac.kr

Min Tang, School of Public Administration and Policy, Shanghai University of Finance and Economics, Phoenix 627, 511 Wuchuan Rd, Shanghai 200434, China.
Email: tang.min@mail.shufe.edu.cn

Jinhai Yu, School of Public Policy, University of Connecticut, 10 prospect street, Hartford, CT 06103, USA.
Email: jinhai.yu@uconn.edu

Data Availability Statement included at the end of the article

impacts. Overall, the findings suggest that, contrary to the global trend of decentralization, natural disasters drive national and subnational units toward greater centralization, highlighting the adaptive capacity of modern states in response to environmental shocks.

Keywords
natural disasters, centralization, decentralization, fiscal centralization, administrative centralization

Introduction

Although human beings no longer live entirely at the mercy of nature, major disasters, such as the 2004 Indian Ocean tsunami, 2005 Hurricane Katrina in the U.S., and the 2008 Sichuan Earthquake in China, serve as stark reminders that our political lives are still significantly shaped by the physical environment where we inhabit. Natural disasters not only compel governments to make swift resource allocations and temporary managerial adjustments, but they can also lead to profound political outcomes, including the formation of the states (Wu et al., 2016), transition to self-government (Belloc et al., 2016), shifts in the level of democracy (Gingerich & Vogler, 2021), change in political stability (Ash & Obradovich, 2020; Brancati, 2007), and the dynamics of interstate rivalry and wars (Ember & Ember, 1992; Lee et al., 2022). In this study, we investigate how natural disasters influence a key institution of the modern states, the allocation of authority between the national government and its subnational units (hereafter referred to as *centralization*). Specifically, we ask: Do disasters drive the states to centralize power in the hands of the national government, or do they lead to greater autonomy for subnational governments? Furthermore, how does the geographic distribution of disasters shape their effect on centralization?

We answer these questions by focusing on two non-political dimensions of centralization: fiscal and administrative centralization (*institutional centralization*, for short). Drawing on insights from the literature, we generally expect natural disasters to increase the level of institutional centralization. Natural disasters make institutional centralization the preferred choice for the national government because effective disaster responses require resources and coordination that surpass the fiscal, logistical, and administrative capacities of subnational governments. Moreover, the disincentives of subnational governments in disaster preparation, which arise from information asymmetry between national and subnational governments and externalities associated with disasters, further drive institutional centralization. The centralizing effect of disasters, however, is not homogeneous but can vary with

two geographic features of disasters: the distance of disasters from the capital city and the extent of their dispersion within a country. We hypothesize that the centralizing effect of disasters is stronger when they occur farther from the capital or are widely dispersed. Conversely, this effect is weaker when disasters occur near the capital or are concentrated in a few regions.

To empirically test our propositions, we conduct a panel data analysis using data from 84 countries spanning the years 1962–2018. Our findings first reveal that disaster frequency is negatively associated with both fiscal and administrative decentralization, indicating a general centralizing effect of disasters. Results from interactive models consistently indicate that the centralizing effect is more pronounced when disasters occur farther from the capital city or exhibit higher geographic dispersion. When the distance of disasters from the capital city is short enough, or the geographical dispersion of disasters is small enough, their effect on centralization is not statistically significant. Additional analyses indicate that natural disasters have a less pronounced impact on political centralization compared to fiscal and administrative centralization. Furthermore, highly exogenous disasters (e.g., earthquakes, storms, and volcanic eruptions) exert a stronger centralizing effect than disasters more likely influenced by human activity (e.g., floods and droughts). Finally, models that use longer lag periods to capture cumulative effects yield more pronounced results than those with shorter lag periods.

This study makes three contributions to the existing literature. First, it is the first cross-national study to examine the impact of natural disasters on institutional centralization. While scholars have identified numerous factors influencing centralization and decentralization, the role of physical environments has received limited attention. Second, this study advances our understanding of the relationship between disasters and centralization. Prior research has recommended either centralization or decentralization as preferred disaster policies (Altamimi et al., 2022; Ainuddin et al., 2013; Cho, 2014; Bae et al., 2018; Goodspeed, 2015; Lohse & Robledo, 2013; Rumbach, 2016; Wildasin, 2006; 2008; 2011). These normative prescriptions, however, do not necessarily align with actual institutional changes. Additionally, some scholars have explored the impact of decentralization on the *consequences* of disasters, such as the death toll (Escaleras & Register, 2012; Miao et al., 2020). This study reverses the causal direction by examining how exogenous features of disasters influence institutional centralization. Finally, this study offers a more nuanced understanding of how different disaster characteristics affect centralization. Our findings on the heterogeneous effects of disasters highlight the importance of considering their geographic distribution. Failing to do so may lead to underestimating the centralizing impact of disasters.

Previous Studies on the Disaster-Centralization Nexus

In this study, we focus on two institutional aspects of centralization, fiscal and administrative. These two institutional dimensions involve the allocation of legal authority between national and subnational governments in non-political affairs. We exclude the political dimension of centralization because political centralization often entails broad shifts in authority or fundamental changes in the political landscape, which are unlikely to be immediately or directly influenced by the specific demands of disasters. Even if disasters impact the political structure of the states, such changes would likely unfold over a much longer time frame than fiscal or administrative changes, exceeding the temporal scope of this study. Moreover, the changes in political and non-political centralization may differ significantly in power dynamics. While the national government largely has direct control over fiscal and administrative centralization, political centralization often entails fundamental institutional or even constitutional changes, in which the national government may itself be influenced. Therefore, focusing on fiscal and administrative centralization allows for a more logically cohesive analysis of the institutional effects of natural disasters.

Determinants of Decentralization and Centralization

Scholars have explored a wide range of factors influencing decentralization. Among the most frequently included is the territorial size of countries. The consistent positive relationship between country size and decentralization may stem from the challenges of satisfying a more diverse population, which is often associated with larger territorial size (Oates, 1972; Panizza, 1999). To more directly capture societal preference heterogeneity, various studies have analyzed the effects of factors such as *ethnic and cultural diversity* (Arzaghi & Henderson, 2005; Shair-Rosenfield et al., 2021), *income inequality* (Sacchi & Salotti, 2014), and the *demographic structure* of the population (Pickard, 2020). Most studies consider the economic and political factors behind decentralization. Research shows that richer and more democratic countries are more likely to be decentralized compared to poorer and authoritarian ones (Shair-Rosenfield et al., 2021; Treisman, 2006). This may be because subnational governments in wealthier and more democratic countries are generally better equipped to manage local affairs with minimal intervention from the national government. Additionally, decentralization has been linked to the *sources* of economic development, such as dependence on natural resources (Sambanis & Milanovic, 2014).

Apart from country size, the influence of a country's physical environment has received insufficient attention in the empirical literature. Since the territorial size of most countries has remained relatively stable in recent decades,

it is unlikely to explain changes in decentralization or centralization over time. Among potential environmental factors, *natural disasters* should be a "natural," if not the most important, candidate. Because disasters strike different regions within a country, governments responding to these crises must inevitably consider the allocation of resources, responsibilities, and authority between national and subnational levels.

Natural Disasters and Fiscal Federalism

While there is no direct empirical research on the effect of natural disasters on decentralization, some studies have proposed policies regarding the relationship between national and subnational governments. Most notably, the fiscal federalism literature theorized an optimal model of the policymaking authority allocation. In this model, decentralization is preferable for *ex-ante* disaster avoidance policies (e.g., land-use planning, zoning, and infrastructure investments), while centralization is preferable for *ex-post* disaster response policies (e.g., intergovernmental fiscal transfers) (Buzzacchi & Turati, 2009; Goodspeed, 2015; Lohse & Robledo, 2013; Wildasin, 2006, 2008, 2011). This distinction arises because subnational governments, being closer to the population, possess more localized information and are better positioned to address disaster prevention needs. In contrast, after disasters, national governments can pool risks across regions to achieve efficiency gains and internalize the external costs through fiscal or non-fiscal mandates (Buzzacchi & Turati, 2009; Goodspeed, 2015; Lohse & Robledo, 2013; Wildasin, 2008).

This literature, however, also points out that the optimal model could not be sustained, and decentralization can lead to lower-than-optimal disaster avoidance because it is incompatible with two incentives of subnational governments. First, information asymmetry between national and subnational governments can create moral hazard problems (Goodspeed, 2015; Wildasin, 2008, 2011). Information asymmetry refers to a situation in which one party has better or more information than the other (Akerlof, 1970; Miller, 2005). In this context, subnational governments are assumed to know more about disasters and their local impacts than the national government. If the national government is expected to intervene in ex-post disaster responses, subnational governments may rationally underinvest in disaster avoidance, even if they have the authority to act. Second, externalities could disincentivize subnational governments from preparing for disasters (Goodspeed, 2015; Wildasin, 2008, 2011). For one thing, disasters, especially major ones, can affect multiple jurisdictions, and thus, a subnational government that is well prepared for its own disasters can still be negatively affected by disasters from other places. For another, the benefits of any one subnational government's preparation efforts may spill over to neighboring regions. Consequently, a rational subnational government would be discouraged from preparing for

major natural disasters, which are uncertain to occur and beyond their own capacity to handle (Fox & Van Weelden, 2015). As a result, the fiscal federalism literature recommends centralization as the second-best solution for both ex-ante and ex-post disaster policies (Goodspeed, 2015; Wildasin, 2008, 2011).[1]

This body of literature leaves room for positive and empirical research, such as the present study. It remains unknown, in practice, whether natural disasters indeed centralize or decentralize the states. In this study, we draw on insights from the literature of fiscal federalism to develop our hypotheses regarding the effect of disasters on institutional centralization, especially the moderating effect of important geographic features of disasters. However, we go beyond theoretical propositions by empirically examining how disasters influence changes in institutional centralization.

Hypothesizing the Effect of Natural Disasters on Centralization

In this section, we first hypothesize the effect of natural disasters on institutional centralization and then develop arguments for the heterogeneous effects of disasters as shaped by the features of geographic distribution. To focus on the exogenous aspects of disasters, we specifically consider the moderating effect of two characteristics that are theoretically relevant to the centralizing effects of disasters: the distance of disasters from the capital city and the geographic dispersion of disasters within a country.

Disaster Frequency and Institutional Centralization

Disaster avoidance and responses often require more resources than what subnational governments can provide, fiscally, logistically, and administratively, necessitating centralization by national governments. To begin with, the fiscal costs of disasters frequently exceed the fiscal capacity of local governments and call for national intervention (Arias, 2013; Garfias & Sellars, 2021). Fiscal centralization is crucial for national governments to support local disaster preparedness and response. For disaster avoidance, research shows that fiscal centralization, compared to decentralization, is more effective for investments in public infrastructure like dams and flood control facilities (Gennaioli & Rainer, 2007; Paik & Vechbanyongratana, 2019). For disaster response, fiscal centralization helps national governments build capacity to assist subnational governments by improving efficiencies in public finances, such as revenue collection, expenditure allocation, and borrowing capabilities—capacities that local governments often lack when disasters strike (Afonso et al., 2024; Arias, 2013; Goodspeed, 2015).

While it is widely recognized that disaster costs often exceed the fiscal capacity of local governments, it cannot be assumed that national governments always have adequate fiscal resources readily available for disaster response. For national governments, frequent disasters can impose significant fiscal stress, necessitating broad institutional reforms toward centralization to strengthen their fiscal capacity and prepare for future disasters (Afonso et al., 2024; Arias, 2013). The literature suggests that fiscal centralization is positively related to state capacity (Cantoni et al., 2024; Dincecco & Katz, 2016; Hanson & Sigman, 2021). In this sense, fiscal centralization becomes an important step to enhance the overall ability of governments to respond to disaster-prone countries. A notable example is the 1755 Lisbon earthquake, which placed immense fiscal strain on Portugal's central government and led to the centralization of revenue collection through the creation of the Royal Treasury, pioneering fiscal centralization movements in Europe (Pereira, 2007).

Managing disasters requires more than fiscal resources; national governments may centralize non-fiscal policymaking to effectively mobilize logistical or human resources. Policy, management, and organizational centralization are essential for coordinated disaster response. The logistical and personnel demands of disasters can exceed the capacities of local governments. Crisis management, both during and after disasters, relies on policy centralization at the national level. Centralized decision-making is a cornerstone of crisis management (Dynes, 1970; Hermann, 1963; May et al., 2008). Furthermore, strong executive leadership by national governments is key to improving emergency management and disaster response (Farazmand, 2007; Waugh & Streib, 2006). As t' Hart et al. (1993, p. 16) note, "the need for concerted and hierarchically coordinated administrative action forms an integral part of the official legal-administrative definition of disaster." Despite the need for flexibility in responding to local conditions, centralized management helps national governments coordinate *ex-ante* disaster planning and *ex-post* responses across regions (Gerber & Robinson, 2009). Empirical observations support this centralization trend, as seen in Japan's disaster management platforms (Ishiwatari, 2021), China's flood control systems (Oh et al., 2024), and Nepal's post-disaster reconstruction efforts (Manandhar et al., 2022).

Beyond policy and management, disasters may also lead national governments to establish agencies to centralize organizational functions. The growth of the US Federal Emergency Management Agency (FEMA) as a federal arm for nationwide disaster management is a notable example of disasters' centralizing effect (Mushkatel & Weschler, 1985). Similarly, studies have shown that traditional disaster management has fostered institutional centralization in China (Liu & Christensen, 2022; Shen, 2009). For example, China has long established river basin commissions to govern flood control in

the Yangtze and Yellow River regions to address the negative externalities of disasters (Shen, 2009). In Turkey, the need for disaster management collaboration has driven reforms toward a more centralized management system (Hermansson, 2016). These cases suggest that policy centralization in disaster responses can have far-reaching consequences, resulting in a "centralization cascade," where "centralizing one element of the decision-making process leads to greater centralization throughout the system" (Raudla et al., 2015).

Nevertheless, the need for institutional centralization does not imply that subnational governments will never engage in disaster preparedness or contribute to disaster responses. Given various advantages that local governments have, national governments may delegate certain authorities to subnational governments for disaster preparation. In fact, some studies highlight the advantages of decentralization in managing disasters (Ainuddin et al., 2013; Garschagen, 2016; Rumbach, 2016; Skidmore & Toya, 2013). However, according to the fiscal federalism literature, the expectation is that decentralization is unlikely to result in efficient disaster policies due to inherent disincentives faced by subnational governments, thus making centralization the more likely net effect of natural disasters (Goodspeed, 2015; Wildasin, 2008, 2011). First, the information asymmetry between national and subnational governments can lead to moral hazard problems, such as underinvestment in disaster avoidance. Second, externalities associated with disasters entail that the benefits of their efforts often spill over to neighboring jurisdictions, and they remain vulnerable to disasters originating outside their own region.

These two incentive problems tend to drive the national government to centralize government institutions. As these problems become more pronounced, subnational governments' involvement in disaster policy would decrease, thus necessitating greater centralization by national governments. Before exploring how the centralizing impact of disasters varies with these two incentive problems, as driven by key geographic features of disasters, we state our main hypothesis:

> *Hypothesis 1: An increased frequency of disasters is associated with higher levels of institutional centralization, both fiscally and administratively.*

Moderating Effect of Disaster Distance and Dispersion

The extent to which disasters drive institutional centralization depends on the severity of two incentive problems: information asymmetry between the national and subnational governments and the extent of disaster externalities. We use two geographic features of disasters to proxy these problems: the distance of disasters from the capital city (disaster distance) and the degree of their geographic spread (disaster dispersion). Disaster distance can reflect the

degree of information asymmetry between the national and subnational governments. Disaster dispersion can capture disaster-related externalities.

A prominent incentive problem associated with decentralization as identified in the fiscal federalism literature, moral hazards, concerns information asymmetry between national and subnational governments. The degree of information asymmetry can increase with the distance between a country's capital city and disaster location. Previous studies frequently use geographic distance as a proxy for information asymmetry, including research on the locational choices of multi-national corporations' headquarters (Huang et al., 2017; Kalnins & Lafontaine, 2013; Zhao et al., 2005), the effect of proximity to headquarters on investment (Giroud, 2013), the public firms' implementation of state policies (Yang et al., 2023), and compliance of local governments to national policies of environmental protection (Zhu & Wang, 2024). Information asymmetry is expected to increase with distance due to geographic barriers that hinder communication, monitoring, or coordination.

As the distance between the disaster location and the capital city increases, the associated information asymmetry grows, resulting in more opportunistic behaviors by subnational governments and a higher demand for centralization by the national government. The literature suggests that increased information asymmetry fosters opportunistic behaviors, such as moral hazard and adverse selection, which often necessitate centralized government intervention for income redistribution or regulation (Bordignon et al., 2001; Breuillé & Gary-Bobo, 2007). Similarly, longer geographic distances can make it more difficult for the national government to gather accurate information and effectively reward or penalize subnational governments' disaster responses. Thus, the national government is more motivated to increase its fiscal authority over the subnational governments to better address the financial and material needs caused by disasters.

Disaster distance can also amplify the centralizing effect of disasters in the administrative dimension. As the distance increases, the costs of resource mobilization and monitoring local governments' opportunist behaviors in disaster preparation increase (Gooris & Peeters, 2014; Handley & Benton, 2013). When disaster-prone areas are located far from the capital, a stronger presence of national agencies and personnel is required to enforce disaster-related orders and policies from the political center, conditions that administrative centralization can facilitate. For instance, Italy's government established a centralized agency to respond to emergencies caused by the violent Storm Vaia in 2018, which mainly affected the remote territories (Riccardi et al., 2022). In contrast, when disasters occur close to the capital, the national government can often manage the response directly without significant changes to the authority structure between national and subnational governments.

Another incentive problem of subnational governments identified in the literature, externalities, critically varies with disaster dispersion. If all disasters cluster within a single region, there is little need for a sweeping, nationwide institutional centralization. In contrast, if disasters are dispersed across multiple jurisdictions, the problem of externalities worsens, calling for centralization as a solution. In this case, individual regional government confronts both greater positive and negative externalities. For one thing, the benefits of its efforts in disaster preparation are more likely to be enjoyed by other regions without reciprocal compensation. For another, it becomes more vulnerable to the negative impacts of disasters originating from other regions.

The degree of externalities is considered a critical parameter of fiscal centralization in the literature. A common solution to inter-jurisdictional externalities is centralizing across regions to internalize the costs (Ellingsen, 1998; Lockwood, 1999). Most notably, Oates' Decentralization Theorem states that the costs of decentralization in the degree of spillover must be balanced against the costs of centralization in policy uniformity (Oates, 1972). As spillover effects increase, the balance shifts from decentralization to centralization (Besley & Coate, 2003; Lockwood, 2002; Oates, 1972). Applying this logic to the effect of disasters, we can expect that as externalities increase with greater disaster dispersion, subnational governments further underinvest in disaster avoidance. This makes decentralization less desirable and leads to greater centralization.

Geographic dispersion can also amplify the effect of disasters on administrative centralization. When disasters are widely dispersed within a country, two consequences are likely. First, more central agencies and staff are needed to oversee disaster-related infrastructure building and maintenance nationwide. Second, widespread disasters become truly national crises, necessitating centralized administration for effective crisis management at the national level. When most regions are likely to be impacted by disasters, greater authority for the national government in local policy affairs is required to coordinate multiple governments and policy areas, a task beyond the capacity of any single subnational government. National governments need to elevate administrative centralization to absorb the coordination costs and overcome potential centrifugal tendencies. Conversely, when past disasters consistently cluster in a few regions, local governments in those regions have a stronger incentive to prepare for disasters. First, the high likelihood of reoccurring disasters in the same areas validates the utility of preparation efforts. Second, a clustering pattern of disasters means that regional governments are less likely to endure the negative externalities of uncertain disasters from other regions, allowing them to focus resources on mitigating risks within their own jurisdiction. In such a case, dedicating resources and staff to these regions is usually sufficient for disaster preparedness.

In sum, the two hypotheses regarding the moderating effect of geographical features of disaster are as follows:

Hypothesis 2: With a longer distance of disaster locations to the capital city, there is a greater positive effect of disaster frequency on institutional centralization.
Hypothesis 3: With a wider dispersion of disasters within a country, there is a greater positive effect of disaster frequency on institutional centralization.

Data, Measurement, and Empirical Strategy

Institutional Centralization

We choose indicators from the Regional Authority Index (RAI) (Hooghe et al., 2016) to measure institutional centralization. Since RAI measures regional authority, a higher RAI value indicates a lower level of centralization (higher decentralization). RAI ranks the institutional authority of a regional government in two "domains:" the extent to which it has authority over people in the region (self-rule) and over the country as a whole (shared rule). Each domain includes five "dimensions." The domain of self-rule evaluates the extent to which a regional government enjoys autonomous administration ("institutional depth"), the range of policies for which it is responsible ("policy autonomy"), the autonomy it has regarding taxation ("fiscal autonomy") and borrowing ("borrow autonomy"), and the presence of an independent legislature and executive ("representation"). The domain of shared rule evaluates the extent to which a regional government co-determines national legislation ("law-making"), the national policy (executive control), the distribution of national tax revenues ("fiscal control"), subnational and national borrowing constraints ("borrowing control"), and constitutional change ("constitutional reform"). RAI is estimated for each tier of government in a country and can be aggregated to a higher-level region weighted by population share of lower-level regions. When aggregated to the country level, it is interpreted as a measure of decentralization (Hooghe et al., 2016, p. 19).[2]

RAI is an institutional measure of decentralization. We choose an institutional measurement primarily because this study centers on the institutional allocation of authority between national and subnational governments. RAI conceptualizes institutional decentralization as a continuous variable. Among institutional measures of decentralization/centralization, RAI has several advantages for the purpose of this study. First, it provides a clear conceptualization. The definition of "regional authority" is built on a well-argued theory of multilevel governance that focuses on the legal authority of regional governments at all tiers below the national government (Hooghe et al., 2016).

Second, on balance, RAI has the broadest coverage of countries and years (Harguindéguy et al., 2021), enabling a comprehensive comparative analysis. Our main analysis includes 84 countries from 1962 to 2018 due to the data availability for control variables. Third, most important to this study, Hooghe et al. (2016) purposely conceptualize RAI in a way corresponding to a widely accepted three-dimensional typology of decentralization (i.e., fiscal, administrative, and political) and include items for each of the three aspects of decentralization in the composite index. This approach enables us to analyze two aspects of institutional centralization (i.e., fiscal and administrative) within a cohesive conceptual framework. Specifically, fiscal decentralization includes "fiscal autonomy," "borrow autonomy," "fiscal control," and "borrow control." We sum the scores of these four items to obtain the measurement of fiscal decentralization. Administrative decentralization includes "institutional depth," "policy autonomy," and "executive control." We sum these three items to obtain the measurement of administrative decentralization. Appendix 1 provides summary statistics for these two variables, along with others used in this study.

Figure 1 presents variation over time in the average level of decentralization across different dimensions, along with the aggregate index. It shows that the overall level of decentralization experienced a sharp drop during the 1960s. Since the middle of the 1970s, there has been a significant increase in decentralization, although with fluctuations. This indicates that the change of

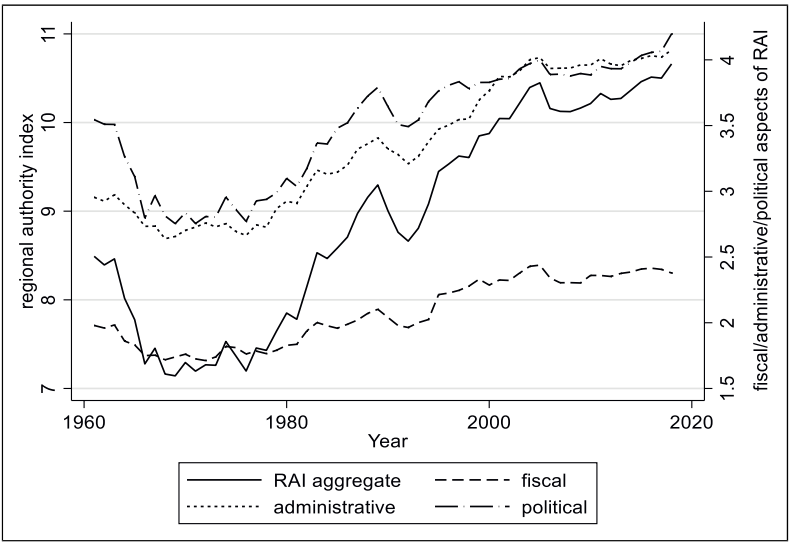

Figure 1. Trends in decentralization over years. *Note*: The data are sourced from the Regional Authority Index.

decentralization can be substantial without a constitutional makeover. Both fiscal and administrative centralization also show changes over time. Generally, since 1980, there has been a steady increase in the authority of subnational governments, indicating decentralization on a global scale.

While there is a general trend of power devolution worldwide, different countries exhibit distinct patterns of over-time change of decentralization. The level of decentralization can change rapidly in some countries, while in others, it increases incrementally. Some countries even have experienced centralization, against the global trend. To illustrate this, the four graphs in Figure 2 demonstrate how decentralization patterns have varied across different countries. For example, while fiscal decentralization of Spain has risen sharply during the period of this study, Sweden has experienced a decrease in fiscal decentralization over the same period. And, while the level of administrative decentralization in Portugal has risen steadily, it stays at the same level with large fluctuation in Pakistan. The varying patterns over time require that cross-national estimation models should carefully account for time trends across countries.

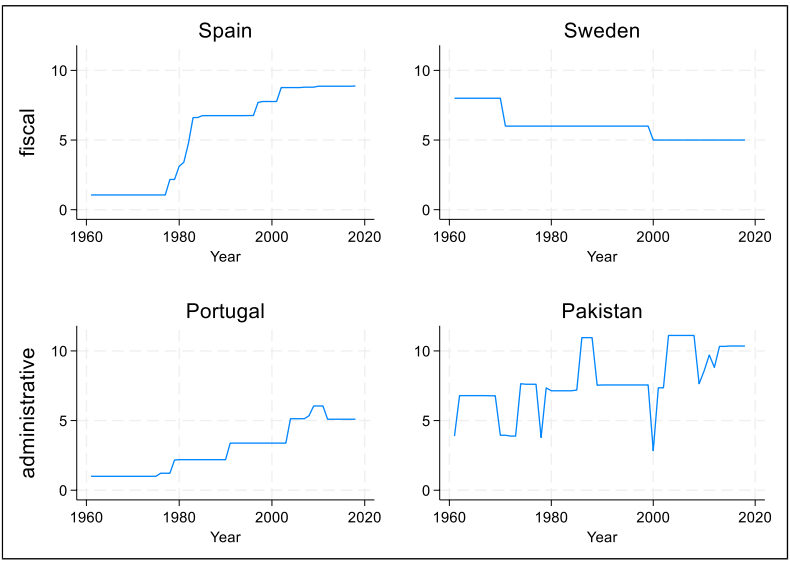

Figure 2. Country-specific patterns of over-time change of decentralization. *Note*: The data are sourced from the Regional Authority Index.

Natural Disasters

We select five types of natural disasters to study their effects on decentralization: earthquakes, storms, volcanic eruptions, floods, and droughts. This choice is primarily driven by information availability regarding the geographic locations of disasters. The data sources of these five disasters, as reported in Appendix 2, provide the longitude and latitude coordinates of the disaster center or contain information that allows us to obtain the coordinates. This enables us to measure the distance from the capital city and geographic dispersion. Although other types of disasters are omitted, the five selected types account for most disasters. For instance, in the Emergency Events Database (EM-DAT), the most comprehensive dataset of major disasters in the world, these five types of disasters account for 78% of the total number of cases. EM-DAT, however, does not contain sufficient geographic location information needed for our analysis. Moreover, compared to the omitted disasters (e.g., wildfires, insect infestations, and epidemics), the five selected types are less likely to be influenced by human actions. Focusing on more exogenous types mitigates endogeneity in the relationship between disasters and centralization.

We include only "major" disasters that could have significant social-economic consequences. Appendixes 2-1 provides a detailed explanation of how we identify major disasters from various data sources. Unlike all disasters, the information on major disasters is relatively easy to retrieve. Years without records in the databases are highly likely to have experienced no major disasters. Therefore, we coded country-year cases with no major disasters as zero. Disasters are usually rare events. Moreover, the effect of disasters on centralization, including the average effect of disaster frequency and the moderating effect of disaster distribution, is unlikely to occur on an annual basis. When policymakers make decisions regarding centralization in response to the shocks from disasters, they will likely refer to their country's historical record and consider the long-term patterns of disasters, including their frequencies and distributions. We therefore calculate the averages for the number of disasters, distance from the capital city, and geographic dispersion over the previous one to ten years (backward moving averages; Appendixes 2-2).

Disaster Frequency. After converting the map data of disaster information into country-year panel data, we obtain the raw count of each type of natural disaster separately. Figure 3 displays the average number of disasters between 1962 and 2018. The five graphs in Figure 3 show the frequencies of all disasters over time. For both earthquakes and storms, the yearly average number remained relatively stable until the late 1980s and has increased significantly since then. The frequency of major volcanic eruptions fluctuates

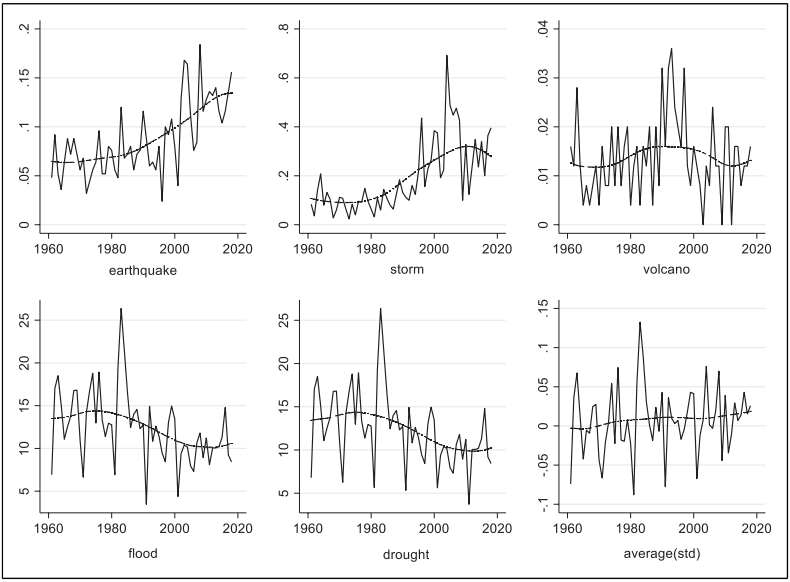

Figure 3. Number of natural disasters over time. *Note*: The average measure of disasters (right-bottom graph) is calculated based on five types of major disasters: earthquakes, storms, volcanic eruptions, floods, and droughts.

annually without a clear trend over time. The number of floods and droughts has slightly decreased since the 1980s. There is also considerable variation in frequencies across different disaster types. Major volcanic eruptions occur the least frequently, while major earthquakes and storms are less rare but still infrequent. In contrast, the two precipitation-related disasters, floods and droughts, are much more frequent.

Because disasters are generally rare, we aggregate five types of disasters into a single index for our main analysis, consistent with previous studies (Belloc et al., 2016; Miao et al., 2018; Quiroz Flores & Smith, 2013). To ensure that the count of more frequent types of disasters does not overwhelm that of others, we first standardize the count measure within each type and then obtain the aggregate measure of *disaster frequency* by taking the average standardized scores of all five types of disasters for each country-year. Finally, we calculate moving averages for the previous one to ten years.[3] The last graph in Figure 3 plots this aggregate measure over the study period of 1962–2018.

Disaster Distance and Dispersion. We measure *disaster distance* by calculating the distance between disaster centers and capital cities using their latitude and longitude coordinates with the Haversine formula (Sinnott, 1984). The

Haversine formula calculates the shortest distance between two points on the surface of a sphere, such as the Earth, using their latitude and longitude while accounting for its curvature. The technical details of the calculation of disaster distance are provided in Appendixes 2-3. By scaling the distance by the number of disasters and weighting it by the country's area perimeter, we account for variations in both country size and disaster frequency. This approach ensures that the measurement is not disproportionately influenced by larger countries or those experiencing more frequent disasters, but rather reflects the relative impact of disaster locations on a country's governance structure. To calculate backward moving averages, we apply the same procedure used for disaster frequency.

We calculate *disaster dispersion* based on the sum of squared distance between each disaster location and the centroid of all disasters within a country. The technical details of the calculation of disaster dispersion are provided in Appendixes 2-4. As in the calculation of disaster distance, we weight dispersion by the number of disasters and country's perimeter and obtain backward moving averages. In particular, the inclusion of perimeter in the calculation rules out the possibility that dispersion is larger simply because a country is larger in territory size. The variable disaster dispersion captures how far one disaster is away from another and, collectively, how spread all disasters are within a country. A small value means that disasters cluster around a small area, while a large value indicates that disasters are spread across multiple localities. The correlation between country area size and disaster distance is 0.021; the correlation between country area size and disaster dispersion is 0.016. Moreover, both measures of disaster distance and dispersion are centered for a more straightforward interpretation of analytical findings.

Figure 4 presents two world maps depicting the distribution of the standardized aggregate measure of five types of disasters, using the year 2015 as the reference. The first map presents the ten-year (2005–2014) moving-average standardized disaster frequency. Darker colors indicate a higher frequency of disasters. Not surprisingly, countries with a larger area size, such as the US, China, Russia, Brazil, and India, have more disasters. Some relatively smaller countries (e.g., Chile, Italy, and Japan), however, are also often susceptible to disasters. The second map plots the center locations of all major disasters during the same ten years. It shows that disasters cluster in a few localities in some countries (e.g., Canada and Sudan) but are spread out in others (e.g., China and Egypt). Additionally, in some countries, most disasters occur far away from the capital city (e.g., Russia and France), while in other countries, many disasters are relatively close to the capital city (e.g., Iran and Spain).

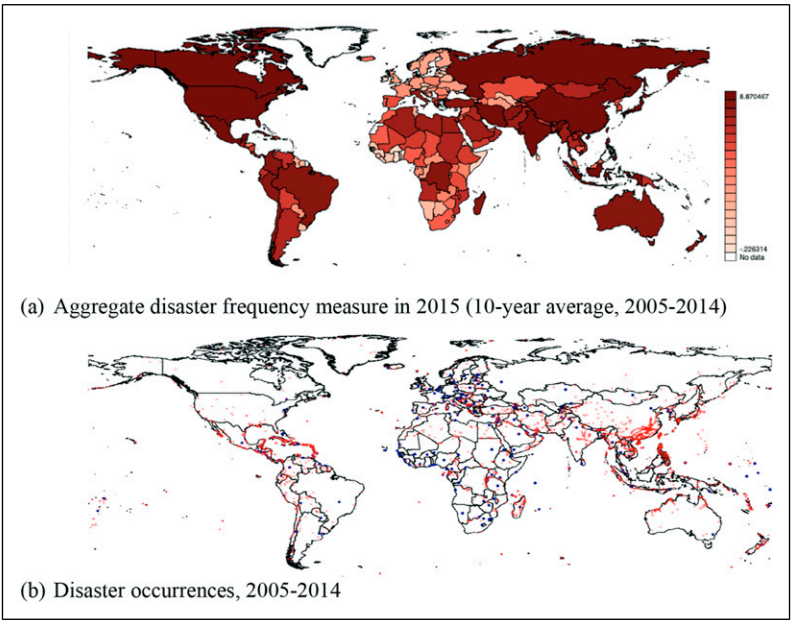

Figure 4. Natural disaster distribution in 2015 (10-year average, 2005–2014). (a) Aggregate disaster frequency measure in 2015 (10-year average, 2005-2014) (b) Disaster occurrences, 2005-2014. *Note*: Measures in both graphs include five types of major disasters: earthquakes, storms, volcanic eruptions, floods, and droughts.

Econometric Model

We use a two-way fixed effects model to estimate the effects of the frequency and geographic distribution of natural disasters. In the following model, the dependent variable $Y_{i,t}$ is an indicator of decentralization in country i in year t. $N_{i,t}$ is *disaster frequency*. $G_{i,t}$ indicates the two geographic attributes of disasters, including *disaster distance* and *disaster dispersion*. The next term shows the two-way interaction between $N_{i,t}$ and $G_{i,t}$. $X_{i,t}$ is a vector of control variables. λ_t is year fixed effects term to account for the effects of factors that drive the global trend of decentralization; γ_i is country fixed effects that absorb time-invariant, unobserved factors within countries. Given that the level of institutional decentralization exhibits differing over-time patterns across countries, as illustrated in Figure 2, we include a term, $\sigma_i * t$, to control for the country-specific time trend (Fouirnaies & Mutlu-Eren, 2015; Jacobson et al., 2005). $\varepsilon_{i,t}$ is the error term.

$$Y_{i,t} = \beta_1 N_{i,t} + \beta_2 G_{i,t} + \beta_3 N_{i,t} G_{i,t} + \beta_4 X_{i,t} + \lambda_t + \gamma_i + \sigma_i * t + \varepsilon_{i,t}$$

The full list of control variables in $X_{i,t}$, includes population size, GDP per capita (measured by World Development Indicators of the World Bank, WDI), the level of democracy (Polity score from the Polity V dataset), ethnic fragmentation (the Historical Index of Ethnic Fractionalization), income inequality (the Standardized World Income Inequality Database) (Solt, 2020), the share of the population over age 65 (WDI), and resource rent (per capita income from petroleum, coal, natural gas, and metals production, V-Dem).

One critical issue of this study is the causality between disasters and centralization. Disasters often occur because of an interaction between human behavior and natural events (Chmutina & von Meding, 2019). In this study, we employ three strategies to attenuate this concern. First, we omit the most human-sensitive disasters, such as wildfires and pandemics, which may arise from decentralized governance. Wildfires, for instance, can be caused by decentralized governance in which local government has shirked its responsibility to tighten regulation on the use of fire in forest parks. Second, we focus on the physical aspects of natural disasters, namely frequency and distributional traits. Physical disaster traits are more exogenous than social outcomes of disasters, such as loss of life and wealth. Finally, we lag our disaster variables (i.e., disaster frequency, distance, and dispersion) and study centralization changes with fixed effects models.

Estimation Results

Average Effect of Disaster Frequency on Centralization

We first only consider the average effect of disaster frequency on centralization in two dimensions, without including disaster distance and dispersion in the analysis. We proceed with two versions of control variables: one with a short list (population size, GDP per capita, and the level of democracy) that most studies include and another with a full list (adding ethnic fragmentation, income inequality, share of the population over age 65, and resource rent). The analyses using the shortlist best match with the temporal and geographical coverage of the dependent variables and thus retain most cases in the sample. And these three variables are most commonly used in existing studies. Some of the control variables included in the full list contain a significantly smaller sample. We use linear interpolation by year to input missing values for the three variables that account for most of the missing data (ethnic fragmentation, income inequality, and the resource rent). Both sets of analyses yield findings with the same pattern. We present the results of analyses using the short list of control variables in the main text (Figure 5) and the results with a full list in Appendix 3.

Figure 5 reports the coefficients of disaster frequency as measured by backward moving averages.[4] Two patterns are evident in Figure 5. First,

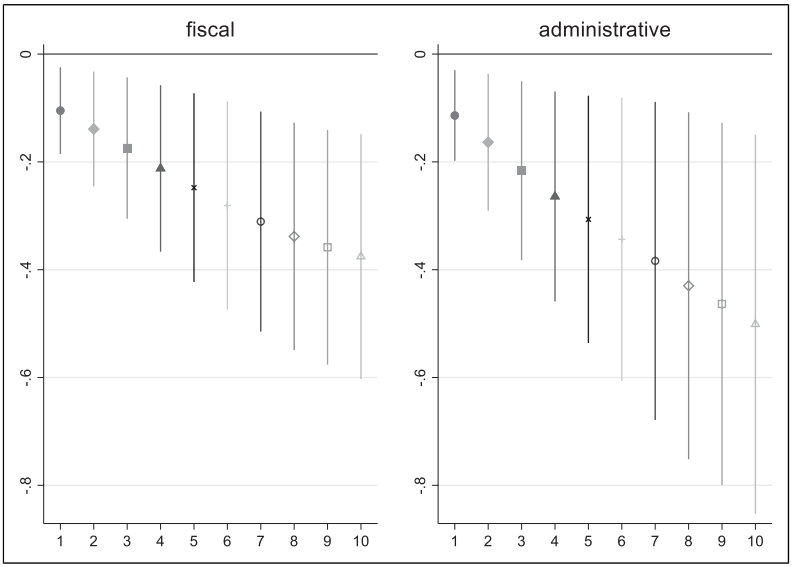

Figure 5. Average effect of disaster frequency on decentralization. *Note*: The *Y*-axis is the regression coefficient of disaster frequency. Each coefficient plot on the *X*-axis is for a model that measures disaster frequency at different lag terms (moving averages for previous 1–10 years). Spikes represent 95% confidence intervals, with robust standard errors clustered by country.

regardless of the number of years considered for measuring disaster frequency, it is consistently and significantly associated with decreases in both fiscal and administrative decentralization, indicating its centralizing effect on government institutions. This finding supports our key hypothesis (*Hypothesis 1*). Second, there is a cumulative effect of disasters over time. With a longer period for measuring disaster count, its effect becomes greater. For fiscal decentralization, while the effect of the yearly count of disasters (one-year lag) is −0.10, the effect of the ten-year moving average count of disaster is −0.38, about four times the yearly effect. For administrative centralization, the yearly effect is −0.11, and the ten-year count effect is −0.50 about five times the yearly effect. This pattern indicates while a few disasters in recent years might have a limited effect on institutional centralization, accumulation of more disasters over time can lead to more substantive changes. In the retrospective thinking of the national governments, the longer they look back in history, the greater weight they give to natural disasters when adjusting the level of centralization.

Heterogeneous Effect of Disasters by Distance

Using the same model specifications as those in Figure 5, we add disaster distance and its interaction term with disaster frequency in the analysis. Figure 6 presents coefficient plots for the interactive term between disaster frequency and distance across all models that use different lag terms.[5] It consistently shows that the coefficient of the interaction term is negative, meaning that with longer distance from the capital city there is greater negative effect of disasters on both fiscal and administrative decentralization. Moreover, models that use longer time lag in calculating moving averages yield a greater moderating effect of disaster distance. The coefficient is not statistically significant when disaster variables are measured over a short time period. For fiscal decentralization, the coefficient of the interaction becomes significant when disaster frequency and distance are measured using a backward moving average with a time lag of five years or longer. For administrative decentralization, the coefficient becomes significant when the two variables are measured using a seven-year or longer time lag backward moving average. Given the low frequency of major disasters in a single year, it

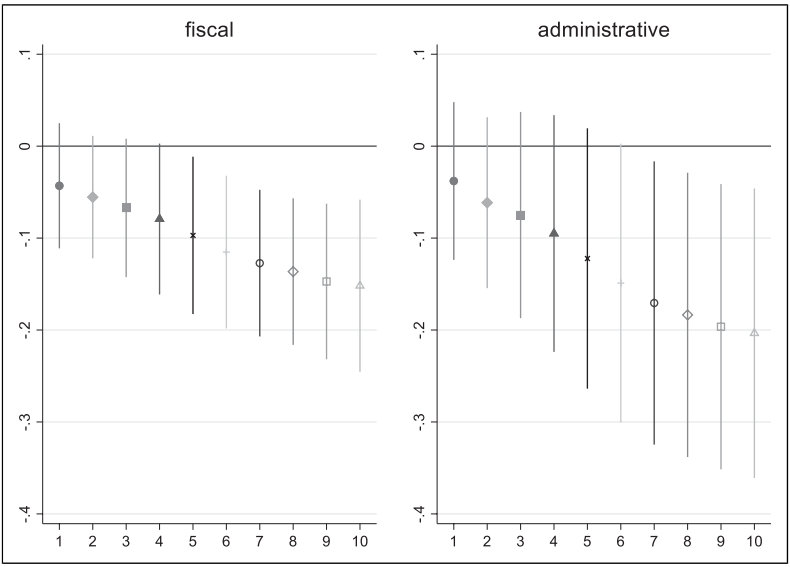

Figure 6. Moderating effect of disaster distance. *Note*: The *Y*-axis is the regression coefficient of the interaction term between disaster frequency and distance. Each coefficient plot on the *X*-axis is for a model that measures disaster frequency and distance at different lag terms (moving averages for previous 1–10 years). Spikes represent 95% confidence intervals, with robust standard errors clustered by country.

does take time for disasters to take a certain geographical pattern and for the national government to make decisions of institutional changes.

To give a more meaningful interpretation of the interactive effect, in Figure 7, we plot the marginal effect of disaster frequency on fiscal and administrative decentralization at all levels of disaster distance based on a ten-year moving average measure (Models 4 and 8 in Appendix 5). Marginal effect plots can reveal different effects of disaster frequency at different values of distributional traits, as discussed in the theoretical section. The two graphs in Figure 7 show a strong moderating effect of disaster distance on the relationship between disaster frequency and decentralization. First, when the value of disaster distance is small enough (i.e., disasters are close to the capital city), the effect of disasters on both fiscal and administrative decentralization are not statistically significant, although negative. Second, as disaster distance increases, the effect of disasters on decentralization substantially decreases, indicating a stronger centralizing effect. That is, when disasters occur at places far enough away from where the national government is located, they tend to increase the level of centralization. This finding supports our hypothesis regarding the moderating effect of disaster distance (*Hypothesis 2*). Omitting

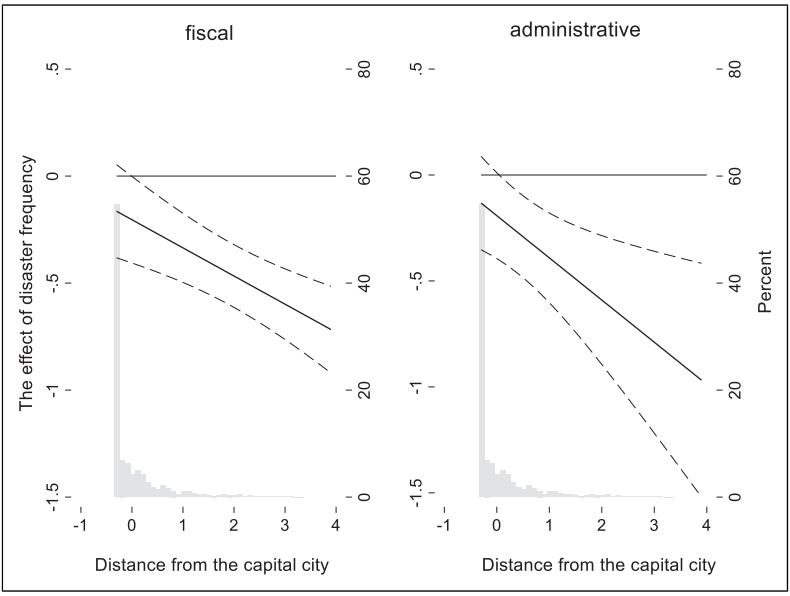

Figure 7. Marginal effect of disaster frequency on decentralization at all values of disaster distance. *Note*: The *Y*-axis is the effect of disaster frequency on decentralization. The *X*-axis is disaster distance from the capital city. Marginal effects are calculated based on Models 4 and 8 in Appendix 5. Dashed lines are 95% confidence intervals, with robust standard errors clustered by country.

the moderating effect of the geographic location of disasters can lead to an underestimation of the effect of disaster frequency on centralization.

Heterogeneous Effect of Disasters by Dispersion

With the same model specification as before, we replace disaster distance with disaster dispersion as the moderating variable to show the heterogeneous effect of disasters on centralization/decentralization. Figure 8 shows coefficient plots for the interaction term between disaster frequency and dispersion across all models, incorporating different lag terms, including yearly measures and backward-moving averages for the past two to ten years. It consistently shows that the coefficient of the interaction term is negative, meaning that with larger dispersion, there is a greater negative effect of disasters on both fiscal and administrative decentralization. The coefficient of the interaction term, however, is not statistically significant when disaster frequency and dispersion are measured over a short time period. For both fiscal and administrative decentralization, the coefficient of the interaction term becomes significant when disaster variables are measured as a seven-year or longer time lag

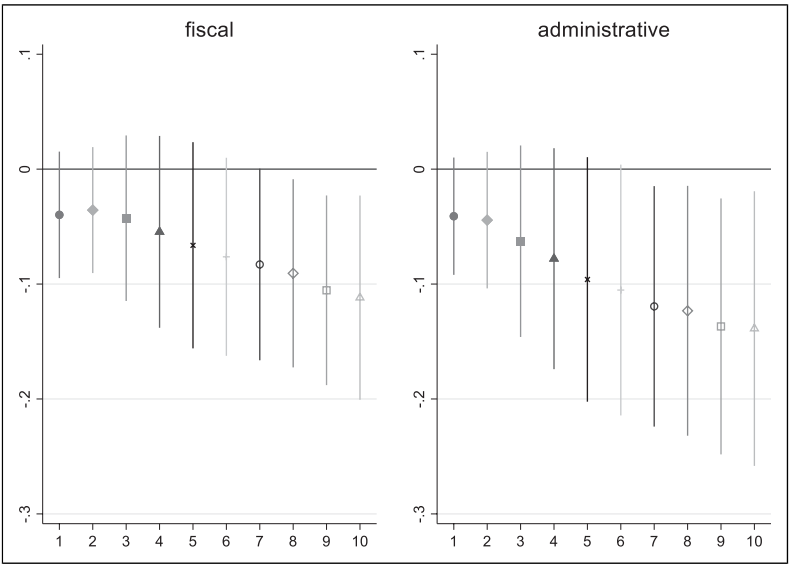

Figure 8. Moderating effect of disaster dispersion. *Note*: The *Y*-axis is the regression coefficient of the interaction term between disaster frequency and dispersion. Each coefficient plot on the *X*-axis is for a model that measures disaster frequency and dispersion at different lag terms (moving averages for previous 1–10 years). Spikes represent 95% confidence intervals, with robust standard errors clustered by country.

backward moving average. This pattern, again, is understandable given the infrequent happening of natural disasters. A long time-horizon is needed because it takes years for major disasters to establish a geographical pattern, both in distance from the capital and in dispersion.

Figure 9 plots the marginal effect of disaster frequency on two dimensions of decentralization, as measured by a ten-year moving average, based on Models 4 and 8 in Appendix 6.[6] Both graphs indicate that with a higher value of disaster dispersion, disasters' effect on decentralization decreases, indicating a stronger centralizing effect of disasters. This finding supports our hypothesis regarding the moderating effect of disaster dispersion (*Hypothesis 3*). For fiscal and administrative decentralization, the effect of disaster frequency is not statistically significant at the low-value end of dispersion (i.e., when disasters are clustered narrowly enough in regions). When dispersion increases to a certain level, the effect of disaster frequency becomes negative, indicating a centralizing effect, and is statistically significant. The size of the centralizing effect of disasters further increases with the value of dispersion. That is, in places where disasters spread more widely across localities, they are more likely to increase the centralization of governments in fiscal and administrative authority. As with disaster distance, failing to

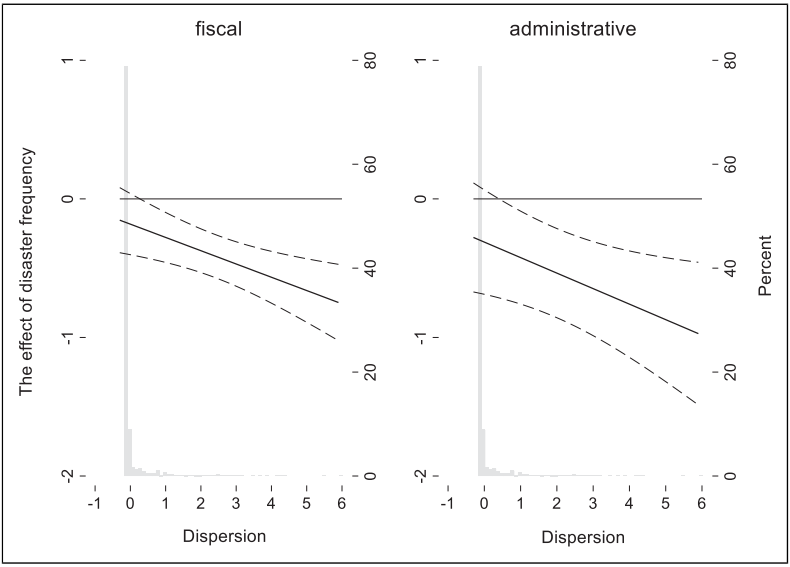

Figure 9. Marginal effect of disaster frequency on decentralization at all values of disaster dispersion. *Note*: The *Y*-axis is the effect of disaster frequency on decentralization. The *X*-axis is disaster dispersion. Marginal effects are calculated based on Models 4 and 8 in Appendix 6. Dashed lines are 95% confidence intervals, with robust standard errors clustered by country.

consider the moderating effect of disaster dispersion leads to underestimating the institutional impact of natural disasters.

Additional Analyses and Robustness Check

To further reveal the heterogeneous effects of disasters on centralization and show the robustness of our findings, we conduct several additional analyses. First, we consider political centralization that is excluded in this study. Figure 10 presents coefficients plots of regression models that use the measurement of political centralization in the RAI.[7] The results indicate that the average effect of disaster frequency on political decentralization is generally negative, indicating the centralizing effect of disasters on the political dimension as well. However, that effect is weaker compared to the effect on fiscal and administrative centralization, as indicated by a smaller number of significant coefficients among measurements of disaster using different lag terms and smaller values of those coefficients. Moreover, while dispersion can moderate the effect of disaster frequency on political decentralization when

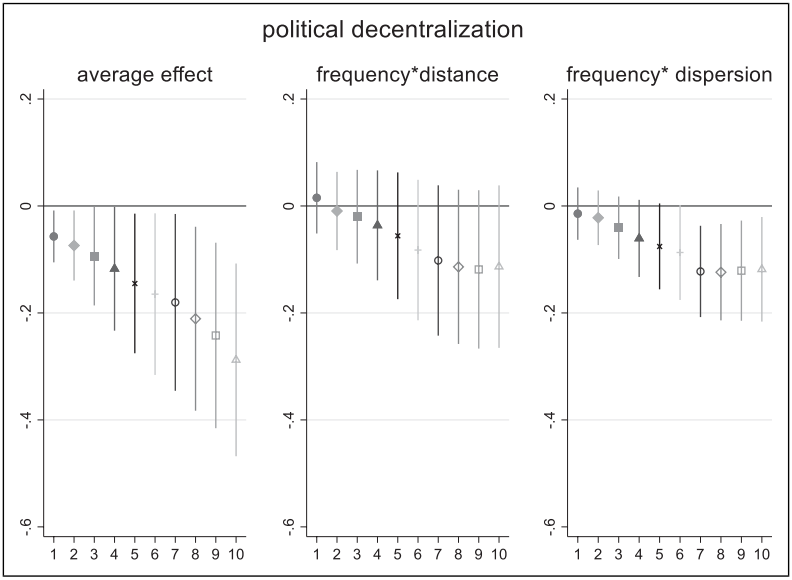

Figure 10. Coefficient plots of the effect of disasters (average effect and interactive effect with distance and dispersion) on political decentralization. *Note*: The *Y*-axis is the regression coefficient; Each coefficient plot on the *X*-axis is for a model that measures disaster variables at different lag terms (moving averages for previous 1–10 years). Spikes are 95% confidence intervals, with robust standard errors clustered by country.

measured as a seven-year moving average or a longer time lag, disaster distance does not moderate the effect of disaster frequency.

Second, we disaggregate our measurement of the key independent variable, disaster frequency, into two types. The first type includes earthquakes, storms, and volcanic eruptions. The second type includes floods and droughts. For one thing, the first type of disasters is more exogenous than the second. For another, the frequency of the first is lower than the second. Figure 11 shows regression coefficient plots for the effect of these two types of disasters on fiscal and administrative decentralization. The results show that more exogenous disasters (earthquakes, storms, and volcanic eruptions) have a greater effect on institutional centralization; those of the second type have no significant effect on fiscal centralization. The results of an additional analysis that includes wildfires in the aggregate measurement of disaster frequency indicate a centralizing effect of disaster frequency, but that effect is not statistically significant for most lag terms.[8] This could be caused by the fact that wildfires are less exogenous than the ones that are included in our main analyses, as discussed above.

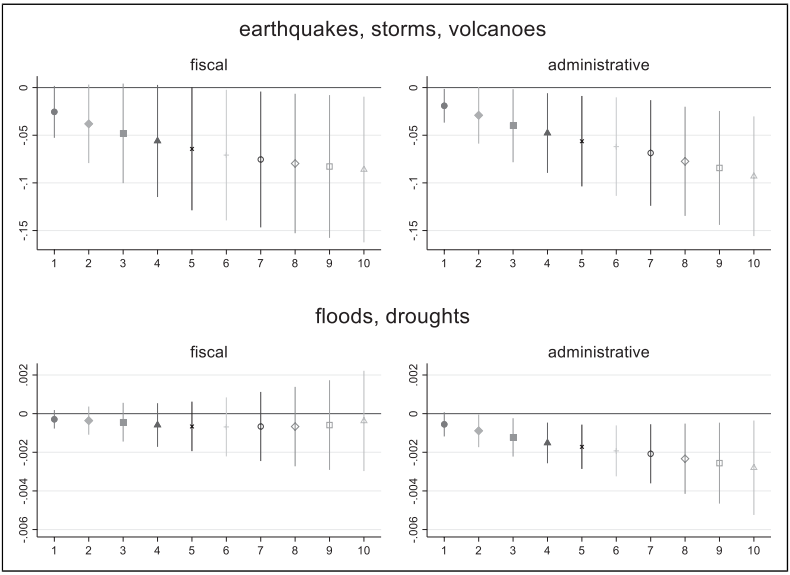

Figure 11. Effect of different types of disasters on institutional centralization. *Note*: The *Y*-axis is the regression coefficient of disaster frequency. Each coefficient plot on the *X*-axis is for a model that measures disaster frequency at different lag terms (moving averages for previous 1–10 years). Spikes represent 95% confidence intervals, with robust standard errors clustered by country.

In this study, we focus on two geographical features of disasters, their distance from the capital city and their dispersion within a country, that are closely related to our theoretical explication of the centralizing effect of disasters. These two features, however, are by no means the only geographical features that might moderate the effect of disasters. As an alternative, we analyze the moderating effect of the distance from disaster locations to the most populous city in a country in Appendix 9. The results (Appendixes 9-1 and 9-2) show that the distance to populous cities does increase the effect of disaster frequency on institutional centralization. This might be due to that subnational governments with greater population could be more likely to handle disasters than more remote governments or disagree with national government oversight. To rule out the possibility that the moderating effect of disaster distance to the capital city, which is the focus of this study, is confounded by disaster distance to the populous cities, we conduct additional analyses in which we control for the effect of the latter. The results in Appendixes 9-3 and 9-4 indicate the robustness of our main findings regarding the moderating effect of disaster distance to the capital city.

Finally, we conduct a robustness check by estimating the moderating effect of disaster distance separately for countries with different levels of economic development. It can be expected that disaster distance to the capital city is a better proxy of information asymmetry in developing countries than in developed countries. Economic development, along with enhanced managerial and monitoring capacities of the state, can make the national government less constrained by geographical distance. In the main analyses, we controlled for the effect of GDP per capita and uncovered a statistically significant moderating effect of disaster distance in our total sample. Appendix 10 further presents the results for the effect of disaster frequency on centralization for richer and poorer countries, separately. It shows that, as expected, the moderating effect of disaster distance is more evident in developing countries than in developed countries. It seems that developed countries can better overcome information asymmetry problems associated with geographical distance, although they cannot entirely avoid them.[9]

Discussion and Conclusion

In this study, we focus on an external factor influencing institutional centralization, natural disasters, and explore their average and heterogeneous effects across different aspects. The main results support our key argument regarding the average effect of natural disasters on fiscal and administrative centralization, as well as the moderating effects of two distributional attributes, disaster distance and disaster dispersion, on the relationship between disaster frequency and institutional centralization. Our analyses also reveal variations in the effects of disasters across different dimensions of

centralization, different types of disasters, and different time lags used in the measurement. We find stronger effects of disasters on fiscal and administrative centralization than on political centralization, which is expected given that political centralization is more resistant to change. We show that more exogenous disasters, such as earthquakes, storms, and volcanic eruptions, exert a stronger impact on centralization than floods and droughts, which are more influenced by human activity. This suggests that it takes more exogenous environmental shocks to drive institutional centralization. Finally, we find stronger effects of natural disasters when using longer periods to construct disaster measurements. This indicates that adopting a long-term perspective is essential for capturing the institutional impacts of disasters.

The present study serves as a basis for future exploration of the institutional effects of natural disasters. Our findings on the two heterogeneous disaster attributes, distance from capital cities and geographic dispersion, indicate the need for a more nuanced understanding of disasters. The two distributional traits we examine, however, are not exhaustive. Future theoretical and empirical work can incorporate different disaster attributes more formally in theory or explore the moderating effect of social and political factors in empirical analysis. Moreover, we in this study argue for the centralizing effect of disasters primarily based on the need for disaster preparedness and response. Scholars could explore alternative mechanisms through which disasters centralize the state. For instance, disasters might have spillover effects on state capacity or other policy areas, which in turn could influence centralization or decentralization. Future studies can also explore the effects of disasters on political centralization, an aspect excluded from this study. Disasters might not only drive the national government to change its institutional relationship with subnational governments in non-political affairs, but also subject the political authority of the national government itself to external shocks.

This study has several critical implications. First, for the decentralization literature, the robust findings of the impacts of natural disasters imply that scholars should pay greater attention to the influences of natural environments. Second, for the fiscal federalism literature, our findings suggest that the impacts of natural disasters extend beyond intergovernmental fiscal transfers within a given political system. On the global scale and over the long term, disaster shocks shape the fundamental institutional relationship between national and subnational governments. The modern states do not passively endure the consequences of disasters. Rather, they actively reflect on historical patterns of disasters and accordingly adjust institutional arrangements of centralization to mitigate potential damage from future disasters.

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Authors' Contribution

The authors made equal contributions to this research, and their names are ordered alphabetically. All are corresponding authors.

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ORCID iDs

Sung Min Han https://orcid.org/0000-0003-4284-8424
Min Tang https://orcid.org/0000-0001-5102-4983
Jinhai Yu https://orcid.org/0000-0002-8146-6093

Data Availability Statement

Replication materials can be found at Han et al. (2025), https://doi.org/10.7910/DVN/FIUZYZ.

Supplemental Material

Supplemental material for this article is available online.

Notes

1. For more details on the second best, please see Bohm, P. (2008, p. 379). Second Best. In: *The New Palgrave Dictionary of Economics.* Palgrave Macmillan, London.
2. The data and its detailed description are available at: https://www.arjanschakel.nl/index.php/regional-authority-index.

3. The formulas for calculating backward moving averages for disaster frequency, disaster distance, and disaster dispersion are reported in Appendix 2.
4. Replication data and code are available at Han et al. (2025). Appendix 3 reports the results for all the models that use lag terms from 1 to 10 years, using a full list of control variables. Appendix 4 selectively reports the regression results of the models that measure disaster frequency as yearly count and moving average of previous three, five, and ten years, using a short list of control variables (Appendixes 4-1) and a full list of control variables (Appendixes 4-2), respectively.
5. For brevity, Appendix 5 presents regression coefficients of models that measure disaster variables as one-year lag and moving average for the previous three, five, and ten years.
6. Appendix 6 presents regression coefficients of models that measure disaster variables as one-year lag and moving average for the previous three, five, and ten years.
7. For RAI, we sum "representation," "law-making," and "constitutional reform." For DPI, we sum "auton (are there autonomous regions?)," "muni (are municipal governments locally elected?)," "state (are there state/province governments locally elected?)" and "stconst (are the constituencies of the senators the states/provinces?)." Appendix 7 reports coefficient plots for analyses that use the DPI measurement (Appendixes 7-1), along with regression coefficient tables for analyses of both RAI and DPI (Appendixes 7-2 and 7-3). Both sets of analysis yield results with similar patterns.
8. Appendix 8 provides regression coefficients for Figure 11 (Appendixes 8-1), coefficient plots (Appendixes 8-2) and coefficient tables (Appendixes 8-3) of results of analyses that include wildfire in the composite measurement of disaster frequency.
9. Appendix 11 further provides a set of analyses as a robustness check of our main findings.

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Author Biographies

Sung Min Han is an associate professor in the Department of Political Science and Diplomacy at Hankuk University of Foreign Studies. His research focuses on economic inequality, political leaders, and East Asian politics. His work has been published in journals such as *Democratization, Electoral Studies*, *European Journal of Political Research*, *Political Studies,* and *Studies in Comparative International Development*.

Min Tang is currently associate professor in the School of Public Administration and Policy at Shanghai University of Finance and Economics. His research focuses on comparative democratization, political attitudes, and Chinese public opinions. His research has been published in *Political Research Quarterly, Studies in Comparative International Development*, *British Journal of Political Science*, *Political Studies*, *International Political Science Review,* and *Democratization*.

Jinhai Yu is an assistant professor in the School of Public Policy at the University of Connecticut. His research focuses on public budgeting and finance, fiscal transparency and accountability, and organizational performance. He has published in *the Journal of Public Administration Research and Theory, Public Administration Review, National Tax Journal, Public Management Review*, and other peer-reviewed journals.