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RESEARCH ARTICLE

Effects of Macroeconomic Resilience and State Fragility on the Death Toll from Natural Disasters

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ABSTRACT

This study analyzes the effects of macroeconomic resilience (as a proxy for economic capacity) and state fragility (as a proxy for state capacity) on the death toll from natural disasters in 31 countries over the period 2007–2020 using pooled regression. This study indicated that the increase in macroeconomic resilience affects the number of deaths caused by natural disasters negatively and the increase in state fragility positively. The econometric estimation results also showed that the increases in openness, size of the government, and gross domestic product per capita used as control variables decrease the number of deaths caused by natural disasters, whereas the increases in population density and carbon emissions increase the number of deaths caused by natural disasters.

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Natural disasters, either small or large, have been a factor affecting humanity and the natural environment in every period of history. Natural disasters are sudden and extreme events that cause serious damage that threatens human health and safety, the welfare of societies, and physical wealth. The frequency of natural disasters and the destruction caused by natural disasters continue to increase on a global scale. The number of natural disasters increased more than 2 times in the following 50 years compared with the beginning of the 1960s, and accordingly, the economic losses caused by natural disasters increased approximately 7 times (Raschky, 2008). In the past two decades (2001–2020), annual averages of 347 natural disasters have occurred worldwide. During this period, an average of 61.5 thousand people died each year because of natural disasters, and 194 million people were injured, were left homeless, or suffered economic losses. Moreover, during this period, the economic losses caused by natural disasters are estimated to be approximately 154 billion US dollars (CRED/EM-DAT, 2022). Many scholars attributed this increase in natural disaster-related losses to increases in economic production and population levels in vulnerable areas and global climate change (Kousky, 2014; Dell et al., 2014; Estrada et al., 2015; Bouwer, 2019; Botzen et al., 2019). A recent report by the Intergovernmental Panel on Climate Change (IPCC, 2022) predicted that the frequency of natural disasters and the losses caused by natural disasters will continue to increase in the future period.

Natural disasters are considered sudden shocks associated with natural (physical) processes (Raschky, 2008). Some researchers extended this perspective by analyzing the anthropogenic origins of natural disasters (Ribot, 2014; Kelman, 2020). According to their analysis, natural disasters are the result of the interaction between natural hazards and social factors. Furthermore, natural disasters are normalized shocks for some societies instead of unexpected shocks. Whether they occur in the form of sudden or normalized shocks, the devastating effects of natural disasters on economies and societies are inevitable. Reducing natural disaster-related losses and making societies more prepared and resistant to natural disasters are currently the primary political goals. Achieving these goals is only possible if the causes of natural disaster vulnerability and the resilience of societies are well-known and the socioeconomic and institutional factors, as well as the physical factors, are identified.

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There is a relatively new but expanding literature investigating the possible effects of natural disasters and the factors that determine these effects. Most of these studies have attempted to estimate the direct and indirect economic effects of natural disasters using different definitions, models, and empirical approaches. The existing literature draws attention to the role of many socioeconomic and institutional factors in addition to country-specific climatic and topographic factors as the main determinant of the direct and indirect effects of natural disasters, and they include the variables that define these factors in their empirical models.

Meanwhile, academic studies provide rich empirical evidence that economic and institutional capacities affect vulnerability or resilience and that increases in these capacities will reduce natural disaster-related losses, including deaths. However, the same studies are far from making a comprehensive measurement/evaluation of economic and institutional capacities. When assessing economic capacity, studies often refer to economic development as defined by the gross domestic product (GDP; e.g., Kahn, 2005; Anbarci et al., 2005; Toya & Skidmore, 2007; Keefer et al., 2011), income inequality (e.g., Kahn, 2005; Anbarci et al., 2005), financial development (Toya & Skidmore, 2007; Padli et al., 2010), openness (e.g., Toya & Skidmore, 2007; Raschky & Schwindt, 2016), investment climate (e.g., Raschky, 2008), and foreign aid or donations (Raschky & Schwindt, 2016; Costa, 2012), including one or more of the variables as a proxy in their research models. Similarly, when examining the role of institutional capacity, research frequently focuses on democracy (e.g.,Raschky & Schwindt, 2016; Keefer et al., 2011), corruption (e.g., Escaleras et al., 2007), government effectiveness and political stability (e.g., Raschky, 2008; Raschky & Schwindt, 2016), size of the government (e.g., Toya & Skidmore, 2007), or ethnic fractionalization (e.g., Kahn, 2005) as a proxy in their models.

However, disaster-related deaths depend on the disaster risk preparedness of the system as a whole and its capacity to absorb this shock during a disaster; thus, making a complete assessment of the vulnerability capacity of the system is more realistic. This study aims to investigate the role of macroeconomic resilience and state capacity in reducing disaster-related deaths by focusing on disaster-related deaths, which are one of the direct effects of natural disasters. However, in contrast to previous studies, this study uses indices that comprehensively evaluate capacity in its research model. In this context, this research aims to make an original contribution to the literature, albeit modestly, with its results. This study analyzes the effects of macroeconomic resilience (as a proxy for economic capacity) and state fragility (as a proxy for state capacity) on the death toll from natural disasters using data from 31 countries over the period 2007–2020 and using pooled regression. Empirical research evidence clearly shows that the macroeconomic resilience of countries reduces deaths caused by natural disasters and that state fragility increases deaths caused by natural disasters. The results of the research indicate that natural disaster risk should be reduced with a holistic policy set to reduce disaster-related deaths.

The remainder of this paper is organized as follows: Section 2 introduces the effects of natural disasters and the determinants of natural disaster-related deaths in a conceptual framework. Section 3 reviews the empirical literature and the results of related research analyzing the determinants of natural disaster-related deaths. Section 4 presents the empirical methodology and research findings of the models estimated in this study. Section 5 discusses the research findings and concludes the study.

Conceptual Framework: Determinants of Death Toll from Natural Disasters

The effects of natural disasters in any country have a perfect and directly proportional relationship with the disaster risk of that country. The Sendai Framework for Disaster Risk Reduction 2015–2030, adopted by the United Nations General Assembly, defines disaster risk as a function of hazard/disasters, exposure, vulnerability, and capacity. A hazard is a process, phenomenon, and human activity that can cause human, physical, environmental, and social losses. Natural disasters occur when natural hazards turn into actual results. The IPCC (2012) defines disasters as severe alterations in the normal functioning of a community or society because of hazardous physical events interacting with vulnerable social conditions, leading to widespread adverse human, material, economic, or environmental effects that require immediate emergency response to satisfy critical human needs and that may require external support to ensure recovery. The Center for Research on the Epidemiology of Disasters (CRED), affiliated with the Catholic University of Louvain in Brussels, Belgium, defines a natural disaster as an unforeseen and unexpected event that affects local capacity, causes high levels of damage, destruction, and human suffering, and requires national or international assistance. CRED divides natural hazards into six groups, namely, geophysical, meteorological, hydrological, climatological, biological, and extraterrestrial. Moreover, to consider any natural hazard as a natural disaster, at least one of the following situations must have occurred: (1) at least 10 people must have died from the natural hazard, (2) at least 100 people must have been affected, (3) an international call for help has been issued, or (4) a state of emergency has been declared.

In the context of disaster risk, exposure is the current state of people, infrastructure, housing, production capacities, and other tangible assets in vulnerable areas. Vulnerability is the condition determined by physical, social, economic, and environmental processes that increase the vulnerability of individuals, communities, assets, or systems to the effects of hazards. Capacity as a disaster risk refers to the combination of attributes and resources possessed by an organization, community, or society to manage and reduce disaster risk and strengthen disaster resilience (Noy & Yonson, 2018).

Natural disasters are destructive events that cause the loss of human life and physical wealth and the increase in welfare and development problems. To evaluate the losses caused by natural disasters, the effects of natural disasters must be calculated accurately and completely (Cochrane, 2004). In this context, researchers propose many typologies to evaluate the effects of natural disasters. The effects of natural disasters can be classified as short-term, medium-term, and long-term effects according to their duration. The long-term effects of disasters can persist for up to 5 years (Cavallo & Noy, 2011). According to how they can be measured, the effects of natural disasters can be divided into tangible and intangible effects. Tangible effects are those that can be measured in monetary terms. By contrast, intangible effects are situations that cannot be expressed in monetary terms, such as stress, fear, discomfort, or pain that occur due to a natural disaster (Paul, 2021).

However, the typology most adopted in previous articles is the binary distinction of the effects of natural disasters as direct (primary) and indirect (secondary; Kousky, 2014). The direct effects of natural disasters are the result of an unexpected natural hazard due to physical contact with people and/or property. Direct effects are nonmarket effects that occur almost simultaneously with a natural disaster. Examples of direct effects include loss of life or destruction of buildings, crops, and infrastructure. By contrast, indirect or secondary effects are the effects that are triggered not by the natural disaster itself but by its consequences (Hallegatte & Przylusk, 2010). Indirect or secondary effects may occur much later than the natural event and may persist for a long time. Examples of indirect effects include declines in the flows of goods and services, including weakened economic performance, losses in infrastructure, income, the environment, and tax revenues, and deaths and injuries following the event. Furthermore, indirect effects include multiplier effects resulting from decreases in demand and supply in the economy (Cavallo & Noy, 2011; Kousky, 2014). Meanwhile, estimating the magnitude of indirect effects compared with that of direct effects is relatively difficult.

Among the components of disaster risk, vulnerability and capacity are forces that oppositely affect risk. Most researchers argue that vulnerability and capacity are determined by common factors and are the most critical determinants of natural disaster-related loss and damage (Noy & Yonson, 2018). Although capacity is defined by the IPCC as "adaptive capacity," it is regarded as "coping capacity" by the United Nations International Strategy for Disaster Reduction (UNISDR, 2009). A realistic capacity assessment includes both definitions. Another concept related to capacity is disaster resilience. Resilience is the capacity to withstand adverse situations in general. The concept first emerged in the physical sciences and was later defined by Holling (1973) as a system's capability to absorb changes and persist amidst these changes in the context of ecological changes. In the context of natural disasters, resistance is defined by UNISDR (2009) as *"the ability of a system, community or society exposed to hazards to resist, absorb, accommodate to and recover from the effects of a hazard in a timely and efficient manner, including through the preservation and restoration of its essential basic structures and functions."* A country's disaster resilience also provides a clear idea of that country's disaster vulnerability and capacity (Topal, 2022).

The natural disaster vulnerability, capacity, or resilience of countries is not at the same level. Despite facing similar natural disasters, some countries suffer more losses (i.e., deaths, damages, and economic losses) than other countries. Undoubtedly, among these losses, death is the most dramatic result of natural disasters as it is an irreversible loss. Natural disaster-related deaths/fatalities can be defined as deaths that occur as a result of the direct and/or indirect exposure of people to an extreme event. UNISDR (2009) defines disaster-related deaths as *"the number of people who die during or immediately after a disaster as a direct result of a hazardous event."* Natural disaster-related deaths are divided into direct and indirect deaths. Direct disaster-related deaths are deaths experienced during natural disasters and are generally reflected in reports. Deaths due to post-disaster injuries, communicable diseases, and inadequate medical intervention are defined as indirect natural disaster-related deaths and may not be fully reflected in reports (Paul, 2021).

Many previous studies have investigated the determinants of natural disaster-related losses and tried to explain the reasons for the differences between countries. Researchers generally classify the determinants of natural disaster-related losses into three groups, namely, (1) physical, (2) socioeconomic, and (3) institutional characteristics of countries. Topographical features, such as the size of the country (area), geographical location, and density of sloping lands, come first among the physical conditions that affect the number of natural disaster-related deaths. Different types of topographical features create different types of vulnerabilities, and the frequency of disaster exposure is determined by these topographic features (Kahn, 2005; Jaramillo, 2007). For example, small island states are more vulnerable to meteorological disasters, such as storms, tsunamis, and hurricanes (Raddatz, 2009; Coffman & Noy, 2010). Landslides and floods occur frequently in countries with steep lands, whereas forest fires occur frequently in countries with large forest cover. The physical characteristics of countries also determine the severity and magnitude of disasters. The effects of topographical features on natural disaster-related losses may vary according to the size of the country. For example, direct losses, such as deaths, may be relatively high in countries with large areas because the area exposed to disasters is larger. Meanwhile, the share of economic losses in capital may be limited as the capacity of large countries to absorb shocks is relatively high (Cavallo & Noy, 2011).

Because there are differences in scale and scope between natural disasters, the effects of disasters also vary according to the type of disaster. Concerning deaths, natural disasters can be divided into “predictable” and “unpredictable” natural disasters. People can be more prepared for predictable natural disasters, such as storms and floods. By contrast, preparedness for unpredictable natural disasters, such as earthquakes, may be weaker, and deaths from such natural disasters may be higher (Neumayer et al., 2014). The areas affected by natural disasters and the duration of impact also affect natural disaster-related deaths. The wider the impact area and the longer the duration of the disaster, the greater the losses are. For example, climatic disasters, such as drought, are generally multinational or regional-scale events, whereas geological disasters, such as earthquakes, have a more local character. An earthquake lasts only a few minutes, whereas a flood can last up to 3 months (Klomp & Valckx, 2014).

There is a direct relationship between the severity and magnitude of natural disasters and deaths caused by natural disasters (Anbarci et al., 2005; Escaleras et al., 2007; Neumayer & Plümber, 2007). People are more unprepared and vulnerable to natural disasters with high severity and power. Meanwhile, natural disaster experience can have a positive effect on preparedness because it is, in a way, the process of learning preparedness for rational actors. In countries with a high number and frequency of natural disasters, people and politicians may better discover appropriate ways to prepare for natural disasters and take better measures to reduce vulnerability (Yamamura, 2012). Although this experiential learning process is often more evident at the policy level (Keefer et al., 2011), it may be limited at the individual level (Gaiha et al., 2015).

Climate change has been the subject of intense debate in recent years. Climate change is a process that changes the frequency, intensity, spatial extent, duration, and/or moment of the occurrence of an extreme weather event (Kousky, 2014). There is a strong consensus that human activities, particularly the burning of fossil fuels, have drastically altered the Earth’s climate. Climate change due to global warming makes people more vulnerable and increases deaths from some types of natural disasters. Climate change is unlikely to affect the frequency of some types of natural disasters, such as geophysical disasters. However, there is strong scenario evidence that global climate change is making storms, droughts, and floods more common and severe (e.g., IPCC, 2007). Climate-related natural disasters have serious adverse effects on well-being, particularly in underdeveloped and developing countries (Klomp & Valckx, 2014). Air pollution causing global climate change is also strongly linked to natural disasters (Thomas & López, 2015). In particular, increases in carbon emissions are predicted to increase the number of storms further in the coming years (Anderson & Bausch, 2006; Hyunh & Hoang, 2022).

In the literature, economic development (GDP per capita), income inequality, human capital, openness, financial development, and ethnic fractionalization are often emphasized as socioeconomic determinants of the number of natural disaster-related deaths. Notably, in societies with a more developed, egalitarian, and educated population, high social capital, and homogeneous population, disaster-related deaths will be less (among others, e.g., Kahn, 2005; Anbarci et al., 2005; Toya & Skidmore, 2007; Raschky, 2008; Yamamura, 2012). Relatively few studies on investment climate (Raschky, 2008), unemployment rates (Zhou et al., 2014), urbanization (Rubin, 2014), population, population growth rate, and population density (Skidmore & Toya, 2013; Zhou et al., 2014), or the dependent and immigrant population (Yamamura, 2010) draw attention to the role of socioeconomic factors in natural disaster-related deaths.

Developing countries are more vulnerable to natural disasters (Klomp & Valckx, 2014; Khan et al., 2019). According to one study, only 11% of people living in developing countries are exposed to natural disasters; however, these countries also account for more than half of the total deaths recorded (UNDP, 2004). Developing countries do not have the economic and institutional capabilities to withstand major natural disaster shocks (Loayza et al., 2012; Noy, 2009) and spend only a small part of their national income on disaster preparedness (Keefer et al., 2011). Some policy interventions to mitigate natural disasters are rare in these countries, particularly in land use planning, building codes, and engineering practices (Cavallo & Noy, 2011). The main reason for this is that the ruling elite and citizens have a lower motivation to invest in disaster preparedness compared with developed countries (Kahn 2005; Toya & Skidmore, 2007). Thus, vulnerability can be reduced by investing in higher per capita income and more human and institutional development (Hallegatte et al., 2020).

Natural disaster vulnerability results from exposure, as well as the inequalities in access to resources, skills, and opportunities and the systematically greater disadvantage of certain groups of people (Neumayer & Plümber, 2007). Inequality and poverty are major drivers of people's vulnerability to natural disasters. At the microscale, poor people are less able to cope with and recover from the effects of natural disasters. Poor individuals do not have sufficient resources to reduce risks or cope with problems. At the macroscale, inequality and poverty hinder the development of institutional capacities (democracy and state capacity; Hallegatte et al., 2020). More unequal societies also cannot take collective action to implement preventive and mitigation measures (Cavallo & Noy, 2011). In these countries, the poor are often left to fend for themselves, whereas the rich can insure themselves against disasters (Anbarci et al., 2005). Countries with a high level of human development are well-equipped for natural disaster preparedness, post-disaster mitigation, and natural disaster-related loss reduction strategies (Padli et al., 2018). In addition to health and income, education is one of the main indicators of human development. The educated population has more knowledge and sufficient resources to invest in risk reduction measures, such as safe construction practices or making settlement decisions in safe places (Toya & Skidmore, 2007; Kousky, 2014).

Some researchers pointed out that openness can reduce natural disaster risks (Toya & Skidmore, 2007). Cuaresma et al. (2008) argued that natural disaster risk is also positively related to the scale of technology transfers between developed and developing countries. Transfers of technological knowledge from abroad can help reduce natural disaster-related deaths by increasing the productivity of capital and increasing the stock of human capital (Padli et al., 2018). A more developed financial sector can also help reduce disaster effects. Investors may also need tighter security standards, and the financial system is less likely to finance projects in risky locations (Kahn, 2005; Toya & Skidmore, 2007). Ethnic fractionalization in a society can indirectly affect natural disaster-related losses as it slows economic development by causing reduced investment and increased likelihood of conflict. Yamamura (2012) pointed out that ethnic polarization can increase natural disaster-related losses by reducing social capital. It may be more difficult in heterogeneous societies for people to take the collective action necessary to cope with unexpected events, such as natural disasters.

There is a general belief that countries with more developed institutions can prepare for and respond better to an event that may cause casualties (among others, e.g., Kahn, 2005; Anbarci et al., 2005; Toya & Skidmore, 2007; Raschky, 2008; Lin, 2015). Related studies often emphasized democracy, state capacity, and political stability in the context of institutional capacity. However, the role of countries' political regimes on natural disaster-related losses is still controversial. First, in both democratic and autocratic regimes, natural disasters threaten the sovereignty and legitimacy of governments and the welfare of citizens. For this reason, autocratic governments, such as democratic governments, want to reduce disasters to prevent natural disaster-related losses. However, some authors argued that voters and politicians are more motivated in democracies to reduce disasters (e.g., Kahn, 2005). Second, compared with autocratic regimes, democratic regimes spend more socially on their vulnerable citizens (e.g., education, health, quality food, and water) and seek to improve their natural disaster preparedness and emergency response capacity (Lin, 2015). In democracies, elected politicians tend to expand the scope of accountability and citizens' rights. Public bureaucracy works better in democracies. However, in autocratic regimes, nontransparent public bureaucracy tries to manipulate the death toll to avoid accountability and responsibility. Civil rights and freedom are broader in democracies, and free media is important. Free media is a helpful force in disaster preparedness as it reduces the problems of information gaps and asymmetric information and helps prevent corruption. Autocratic regimes can increase disaster-related deaths by investing less in disaster preparedness and restricting civil society mobilization and freedom of expression. Autocratic governments also restrict the freedom of expression and association of individuals and the freedom of the media to suppress opposition (Lin, 2015).

However, some authors argued that the difference between political regimes in terms of their role in disaster mitigation may be negligible. Keefer et al. (2011) emphasized that, in autocratic regimes, natural disaster experience is high because of the generally long duration of power; therefore, disaster preparedness can be better institutionalized. Rational choice theorists pointed out that, in democracies, voters, politicians, and public bureaucrats acting in line with their short-term interests will weaken the mitigation of the effects of disasters. Free-rider voters prioritize disaster impact reduction by increasing public spending in exchange for less tax burden. Myopic voters may encourage politicians to support recovery activities but may not sufficiently motivate them to implement disaster prevention activities. The general attitude of politicians is to hold power for a longer period rather than protect citizens from the effects of natural disasters. In contrast to voters and politicians, public bureaucrats responsible for disaster management may demand greater allocation of resources to disaster measures to avoid punishment and blame. However, in practice, myopic voter behavior in general drives more vote-seeking politicians and may make them more narrow-minded in disaster preparedness (Healy & Malhorta, 2009). Therefore, in practice, the difference between democracy and autocracy in terms of disaster preparedness may become meaningless. Some other researchers drew attention to the problem of collective action. In a society where income is unequally distributed, an agreement on how to distribute the burden of disaster preparedness among income groups may not be reached. For this reason, a consensus on reducing disasters within democratic processes may not be easily established. After all, in democracies where inequality is widespread, the rich can be better protected against natural disasters by insuring themselves, whereas the poor are left to fend for themselves (Anbarci et al., 2005).

Some authors, approaching from a historical–institutional perspective, claimed that natural disaster-related losses can be prevented by strengthening state capacity (Lin, 2015). First, increasing the fiscal capacity of the state can help reduce natural disaster-related losses (Toya & Skidmore, 2007). In general, the fiscal capacity of the government or the size of the government is measured by the share of public expenditures in national income. Public expenditures allocated to natural disaster relief centers, natural disaster preparedness programs, early warning systems, and enforcement of building regulations in natural disaster-prone areas reduce the negative effects of natural disasters on society (Padli et al., 2018). Moreover, reducing natural disaster-related losses requires an advanced national population registration system and other registration systems, strong infrastructure, communication power for post-disaster evacuation and emergency aid, and extensive public services (Lin, 2015). Thus, more economic resources need to be converted into public expenditures for disaster preparedness, emergency response, and recovery services. Second, transparent and accountable public management can help reduce natural disaster-related deaths by planning disaster risk management and implementing disaster preparedness measures correctly (Hendrix, 2010). Third, good risk governance is important in reducing natural disaster-related losses. Zuo et al. (2017) emphasized the importance of risk governance to prevent or minimize natural disaster-related losses and stated that this can only be achieved through democracy, government effectiveness, economic freedom, and control of corruption. Fourth, emergency preparedness and rapid response capacity are also important within the scope of disaster risk management to reduce disaster-related deaths. A well-functioning and high-quality public bureaucracy makes disaster risk management effective by ensuring the rational allocation of resources for economic and social development (Hamm et al., 2012). The rule of law provides adequate legal and regulatory frameworks for disaster measures. By contrast, corruption is an important factor that weakens efforts to prepare for natural disasters and manage and control the problem (Escaleras et al., 2007; Alexander 2017; Padli et al., 2019). Corruption undermines the effectiveness of government at all levels (central and local), distorts resource allocation, and indirectly undermines trust and public support for governments (Zuo et al., 2017). Therefore, corruption can undermine the adoption of necessary and adequate disaster mitigation measures and the establishment of safety standards, leading to increased damage and losses from natural disasters (Escaleras et al., 2007; Escaleras & Register, 2016).

Natural hazards and deaths caused by natural hazards are inevitable. However, reducing natural disaster-related deaths is possible. As mentioned above, previous studies have placed particular emphasis on expanding the economic and institutional capacities to reduce natural disaster-related deaths. Economic vulnerability and economic resilience, interacting with exposure to natural hazards, population, and physical assets, are considered critical determinants of the resulting natural disaster damage and losses. Indeed, natural disasters are greatly influenced by economic forces; therefore, their occurrence is an economic event (Cavallo & Noy, 2011). Vulnerability and capacity/resilience are processes that oppositely operate (Noy & Yonson, 2018). If the economic resilience of a country can be increased, then the natural disaster-related deaths in that country can be reduced.

The concept of economic resilience is often used in studies on economic shocks, climate change, and institutions, apart from natural disasters. According to one definition, economic resilience is the process that improves a community's capacity to absorb the initial shock through mitigation and subsequently respond and adapt and provides a better position to reduce losses from future disasters (Rose, 2004). According to another definition, economic resilience is a set of policies that increase macroeconomic stability and market efficiency, improve governance, and expand social development (Briguglio et al., 2009). Hallegatte et al. (2020), who examined economic resilience in the context of the welfare costs of natural disasters, defined economic resilience as the economy's capability to cope, recover, and reconstruct. The author calls this capability macroeconomic resilience to natural disasters, which is considered an important parameter for predicting the overall vulnerability of the population. Microeconomic resilience can also be considered to evaluate the similar capabilities of households and firms. However, research on microeconomic resilience in the context of natural disasters is limited (e.g., Hallegatte, 2020). To evaluate economic resilience, indices and econometric estimations are mostly used in the literature. The most included economic variables in the developed indices are GDP, employment, inflation, consumption, expenditures, savings, domestic and international financial transfers, public finance, and trade (Noy & Yonson, 2018). In econometric models, per capita income, income inequality, openness, investments, literacy rate, public expenditures, financial development, foreign aid (particularly for post-disaster mitigation), and institutional quality variables are frequently used as factors reducing the effects of natural disasters (Noy, 2009; Mochizuki et al., 2014; Noy & Yonson, 2018). However, the same studies are far from making a comprehensive assessment by taking a holistic view of macroeconomic resilience.

Similar to economic resilience, state capacity can also be effective in reducing disaster-related deaths (Keefer et al., 2011; Lin, 2015). State capacity helps maintain the stability of the state and recover relatively quickly from unexpected shocks (e.g., extreme events and economic shocks), including natural disasters (Gelbard et al., 2015). Fragile states are states with weak state capacity. Fragile states are defined as *"the state that cannot adequately/reluctantly perform functions such as security, property protection, infrastructure establishment, and provision of basic public services"* (Cammack and Macleod, 2006). In these states, public services, such as justice and security, poverty reduction, economic and social development, and protection of human rights, cannot be delivered to a significant part of the population (Brown & Stewart, 2007). Fragile states are often a combination of some constraints, such as weak and non-inclusive institutions, weak governance, low state capacity, and the problem of social cohesion. The capability of fragile states to overcome difficulties is also weak. These states typically present a high risk of both political and economic instability (Gelbard et al., 2015). In fragile states where institutional power, state capacity, and social cohesion are not strong enough, the capacity of state authority and institutions to mitigate the negative effects of natural disaster shocks remains limited.

Meanwhile, there is bidirectional causality between natural disasters and state capacity. Although state capacity provides resilience to reduce the negative effects of natural disasters, natural disasters threaten state capacity (Lin, 2015). According to one view, state capacity stems from a process conditioned by internal and external threats (Kisangani & Pickering, 2013). Especially in fragile states, natural disasters, like wars, threaten the most basic functions of the state, such as security, representation, and social welfare. Natural disasters reduce the population, capital, soil fertility, physical wealth, and tax revenues in most countries. Furthermore, radical opposition to power in fragile states increases vulnerabilities by fueling conflict and violence and disrupting social cohesion. The governments of democratic, developed, and resilient countries are adequately equipped to predict natural disaster-related losses and prepare for disasters, whereas narrow-minded ruling elites in nondemocratic, underdeveloped, and fragile countries may not be able to adequately allocate resources to disaster reduction (Keefer et al., 2011).

Earlier studies often focused on the relationships between state fragility and economic development (e.g., Besley & Persson, 2011), economic performance (e.g., Chuku & Onye, 2019), human development (e.g., Stepputat et al., 2007), international security (e.g., Patrick, 2011), terrorism (e.g., Newman, 2007; Okafor & Piesse, 2018), tax effort or foreign aid (e.g., Diaz-Sanchez et al., 2022), and climate change (Hamza & Corendea, 2012). To our knowledge, there is no study in the literature that deals with the relationship between state fragility and the effects of natural disasters holistically. In general, studies have examined the effects of these factors on natural disaster-related losses by considering factors, such as democracy, corruption, political stability, government effectiveness, rules of law, civil rights and freedom, and size of the government (Mochizuki et al., 2014; Lin, 2015), as representations of state capacity.

Empirical Literature

Studies on the determinants of natural disaster-related losses in general and deaths caused by natural disasters in particular have recently started to increase. These studies generally examine relationships using panel data models. Although most of the studies focused on natural disasters in the post-1980 period, few studies (e.g., Anbarci et al., 2005; Toya & Skidmore, 2007; Keefer et al., 2011) extended the study period until the 1960s. Empirical studies often used EM-DAT data compiled by CRED. However, given that it does not report all natural disaster-related losses, EM-DAT data are subject to criticism by some authors in terms of data quality (Kousky, 2014; Bakkensen et al., 2018). Moreover, some authors emphasized that such modeling problems may have an impact on the results, drawing attention to possible endogeneity problems in empirical models (e.g., between GDP and deaths), high correlation between explanatory variables, lagged effects, inadequate control of topographical features, and disaster characteristics (Fereira et al. 2013; Kousky, 2014).

Although human casualties caused by natural disasters are related to the physical intensity of disasters, such as severity, duration, or area affected, the literature identifies some additional physical, socioeconomic, and institutional factors that affect human vulnerability resulting in death (see Table 1). In terms of physical factors, studies often draw attention to the topographic characteristics and areas of countries, the type, numbers, and severity of disasters, and global climate change. Many studies have shown that natural disaster-related deaths vary according to the geophysical characteristics of the countries and the type of disaster (Kahn, 2005; Kellenberg & Mobarak, 2008; Raschky & Schwindt, 2016; Yonson et al., 2018) and that the number of deaths increases as the intensity of disasters increases (Escaleras et al., 2007; Keefet et al., 2011; Fereira et al., 2013). Huynh and Hoang (2022) determined that climate change and carbon emissions also increase natural disaster-related deaths. However, the results of the research on the effects of the increase in the number of disasters and the country's surface area on the number of natural disaster-related deaths are ambiguous. Although some studies revealed that the increase in the number of disasters increases the number of natural disaster-related deaths (Kellenberg & Mobarak, 2008; Yamamura, 2010; Gaiha et al., 2015), some other studies determined that the increase in the total number of disasters is negatively related to the number of deaths (Escaleras et al., 2007; Lin, 2015). Raschky (2008) determined that the country's area did not have a significant effect on disaster-related deaths, whereas Padli and Habibullah (2009) determined that it was negatively correlated and Rubin (2014) detected a positive correlation. These differences between studies are closely related to the types of natural disaster that is the subject of the research. Padli and Habibullah (2009) analyzed deaths due to all natural disasters in their research, whereas Rubin (2014) focused only on deaths due to meteorological disasters.

There is a strong consensus in the literature that there is a negative relationship between socioeconomic development and the number of natural disaster-related deaths. Many studies provide empirical evidence to support this finding. In the literature, studies that provide evidence of insignificant (George et al., 2021) or nonlinear (U-shaped) relationships between income and natural disaster-related losses can be found (Kellenberg & Mobarak, 2008; Raschky, 2008; Padli et al., 2010; Zhou et al., 2014). However, many studies provide strong evidence of a negative relationship between income level and disaster fatality at the macro level, both for households at the micro level (Yamamura, 2010; Yonson et al., 2018) and for the economy as a whole (Kahn, 2005; Anbarci et al., 2005; Toya & Skidmore, 2007; Padli et al., 2018). By contrast, many studies revealed that deaths caused by natural disasters will be relatively less in countries with more open economies (Toya & Skidmore, 2007; Raschky & Schwindt, 2016; Padli et al., 2018), more developed financial systems (Kahn, 2005; Toya & Skidmore, 2007), higher educated population (Toya & Skidmore, 2007; Raschky & Schwindt, 2016; Padli et al., 2018, Yonson et al., 2018), higher social capital (Yamamura, 2010; 2012), and better investment climate (Raschky, 2008; Padli et al., 2018). However, the literature provides evidence of a mixed but generally positive relationship between income inequality, unemployment, population demographics, ethnic fractionalization, and natural disaster-related deaths. Notably, the empirical evidence for the relationship between income inequalities and death toll from natural disasters is inconclusive. In the literature, studies showing that income inequalities increase natural disaster-related deaths (Kahn, 2005; Anbarci et al., 2005) and income inequality decreases natural disaster-related deaths (Lin, 2015) or that this relationship is statistically insignificant (Strömberg, 2007; Skidmore & Toya, 2013) can be found. Significant relationships between the demographic characteristics of countries and natural disaster-related deaths can be detected. Some studies generally revealed that population growth rate (Escaleras et al., 2007; Kellenberg & Mobarak, 2009; Skidmore & Toya, 2013; Zhou et al., 2014), population density in cities (Skidmore & Toya, 2013; Rubin, 2014; Songwathana, 2018), and increases in the proportion of vulnerable populations, such as the young, elderly, or immigrants (Yamamura, 2010), increase natural disaster-related deaths. The relationship between ethnic fractionalization and natural disaster-related deaths is unclear. Kahn (2005), one of the early studies examining this relationship, revealed an unexpected result that ethnic fractionalization reduces natural disaster-related deaths. The author stated that the effect of ethnic fractionalization can change when income inequalities, country characteristics, and disaster types are controlled. Some later studies (Skidmore & Toya, 2013; Gaiha et al., 2015) supported this result but observed a meaningless relationship. Examining the effect of ethnic polarization instead of ethnic fractionalization on natural disaster-related deaths, Yamamura (2012) determined that ethnic polarization increases natural disaster-related deaths.

There is a consensus in the literature that deaths caused by natural disasters will be lower in countries with strong institutions. Most of the studies that consider democracy, state capacity, and rights and freedom as representations of institutional capacity provide strong evidence that higher institutional capacity is associated with fewer natural disaster-related deaths. Apart from Gaiha et al. (2015), many studies (Kahn, 2005; Strömberg, 2007; Keefer et al., 2011; Lin, 2015) determined that democracy is effective in reducing natural disaster-related losses, including natural disaster-related deaths.

Furthermore, the literature analyzing the relationships between institutional factors and natural disaster-related deaths provides additional important results. First, the literature, in line with expectations, showed that political stability (Raschky, 2008), better state capacity (Kahn, 2005; Strömberg, 2007; Lin, 2015; Raschky & Schwindt, 2016; Hyunh & Hoang, 2022), the rule of law (Raschky & Hoang, 2022; Schwindt, 2016), effective public bureaucracy (Strömberg, 2007; Raschky & Schwindt, 2016), and the development of rights and freedom (Hyunh & Hoang, 2022) are associated with fewer natural disaster-related deaths. Second, in the analysis of the impact of the size of the government on natural disaster-related deaths, a generally meaningless relationship (Toya & Skidmore, 2007; Skidmore & Toya, 2013; Lin, 2015) is detected (except for Yamamura, 2012). Therefore, these results indicate that the share of the state in the economy is unrelated to natural disaster-related deaths. However, some other research results revealed that the efficiency of the allocation of public resources and how the authorities are shared between central and local administrations are more important in terms of natural disaster-related deaths than the size of the government. According to the results of some studies, corruption, which represents the inefficient allocation of public resources and low public bureaucracy quality, is associated with more natural disaster-related deaths (Escaleras et al., 2007; Lin, 2015; Escaleras & Register, 2016; Padli et al., 2018). Other studies provided evidence that higher fiscal decentralization rates are associated with lower natural disaster-related deaths (Skidmore & Toya, 2013; Yonson et al., 2018).

Table 1

Determinants of Death Tolls from Natural Disasters

Determinants/Indicators	**Expected Effects**	**Observed Effects (References)**
(I). **PHYSICAL**		
1. Topography	Mixed	Kahn (2005), Raschky & Schwindt (2016), Yonson et al. (2018)
2. Type of hazards	Mixed	Kahn (2005), Kellenberg & Mobarak (2008)
3. Total number of hazards	Positive	Escaleras et al. (2007)[a], Kellenberg & Mobarak (2008)[b], Yamamura (2010)[b], Gaiha et al. (2015)[b], Lin (2015)[a]
4. Magnitude of hazards	Positive	Escaleras et al. (2007)[b], Keefer et al. (2011)[b], Fereira et al. (2013)[b], Rubin (2014)[b], Raschky & Schwindt (2016)[b]
5. Land area	Positive	Raschky (2008)[c], Padli & Habibullah (2009)[a], Gaiha et al. (2015)[b]
6. Temperature	Positive	Huynh & Hoang (2002)[b]
7. CO_2 emissions	Positive	Huynh & Hoang (2002)[b]
(II). **SOCIOECONOMIC**		
1. GDP/GDP per capita	Negative	Kahn (2005)[a], Anbarci et al. (2005)[a], Escaleras et al. (2007)[a], Toya & Skidmore (2007)[a], Kellenberg & Mobarak (2008), Raschky (2008), Padli et al. (2010), Keefer et al. (2011)[a], Skidmore & Toya (2013)[a], Fereira et al. (2013)[c], Zhou et al. (2014), Rubin (2014)[a], Gaiha et al. (2015)[b], Padli et al. (2018)[a], Yonson et al. (2018)[a], George et al. (2021)[c]

Determinants/Indicators	Expected Effects	Observed Effects (References)
2. Income inequality	Positive	Kahn (2005)[b], Anbarci et al. (2005)[b], Strömberg (2007)[c], Skidmore & Toya (2013)[c], Lin (2015)[a], Yonson et al. (2018)[b]
3. Openness	Negative	Toya & Skidmore (2007)[a], Skidmore & Toya (2013)[a], Raschky & Schwindt (2016)[a], Padli et al. (2018)[a]
4. Financial development	Negative	Kahn (2005)[a], Toya & Skidmore (2007)[a]
5. Education	Negative	Toya & Skidmore (2007)[a], Padli & Habibullah (2009)[a], Skidmore & Toya (2013)[a], Padli et al. (2018)[a], Yonson et al. (2018)[a], George et al. (2021)[c]
6. Investment	Negative	Raschky (2008)[a], Padli et al. (2018)[a]
7. Unemployment	Positive	Zhou et al. (2014)[c]
8. Urbanization	Positive	Skidmore & Toya (2013)[b], Rubin (2014)[b], Songwathana (2018)[b], George et al. (2021)[c]
9. Population	Positive	Escaleras et al. (2007)[b], Raschky (2008)[a], Kellenberg & Mobarak (2008)[b], Yamamura (2010)[b], Skidmore & Toya (2013)[b], Zhou et al. (2014)[b]
10. Population density	Positive	Skidmore & Toya (2013)[c], Gaiha et al. (2015)[c], Lin (2015)[c], Padli et al. (2018) [b], George et al. (2021)[b]
11. Dependent population	Positive	Yamamura (2010)[b]
12. Ethnic fractionalization	Positive	Kahn (2005)[a], Yamamura (2012)[b], Skidmore & Toya (2013)[c], Gaiha et al. (2015)[c]
13. Social capital	Negative	Yamamura (2010)[a]
14. Immigration	Positive	Yamamura (2010)[b]
(III). **INSTITUTIONAL**		
1. Democracy	Negative	Kahn (2005)[a], Strömberg (2007)[a], Keefer et al. (2011)[a], Gaiha et al. (2015)[c], Lin (2015)[a]
2. State capacity	Negative	Kahn (2005)[a], Lin (2015)[a]
3. Political stability	Negative	Raschky (2008)[a]
4. Government effectiveness	Negative	Strömberg (2007)[a], Raschky & Schwindt (2016)[a]
5. Rule of law	Negative	Raschky & Schwindt (2016)[a]
6. Government integrity	Negative	Huynh & Hoang (2002)[a]
7. Corruption	Positive	Escaleras et al. (2007)[b], Lin (2015)[b], Escaleras & Register (2016)[b], Padli et al. (2018)[b]
8. Size of the government	Negative	Toya & Skidmore (2007)[c], Yamamura (2012)[a], Skidmore & Toya (2013)[c], Lin (2015)[c]
9. Fiscal decentralization	Negative	Skidmore & Toya (2013)[a], Yonson et al. (2018)[a]
10. Economic liberties	Negative	Huynh & Hoang (2002)[a]
11. Property rights	Negative	Huynh & Hoang (2002)[a]

Notes. [a], [b], and [c] denote negative relationships, positive relationships, and statistically insignificant relationships with natural disaster-related deaths, respectively.

Empirical Analysis

In this study, the effects of economic and state capacities on the death toll from natural disasters in 31 countries over the period 2007–2020 are analyzed. For this purpose, the Macroeconomic Resilience Index is used as a representation of economic capacity, and the Fragile State Index variables are used as a representation of state capacity. The 31 countries used in the study are listed in Table 2. The countries selected in the study are those for which data are available.

Table 2

Lists of Countries Included in this Study

Australia	Finland	Japan	South Korea
Austria	France	Mexico	Spain
Belgium	Germany	Netherlands	Sweden
Brazil	Greece	New Zealand	Switzerland
Canada	Hungary	Norway	Turkey
Chile	India	Portugal	United Kingdom
China	Ireland	Russia	United States
Denmark	Italy	South Africa	

The main emphasis of this study is that the death toll from natural disasters will be higher in countries with low economic and state capacity. In these countries, the success of implementing measures against natural disasters and combating disasters is lower than in other countries; therefore, these countries are more likely to experience shock and have a higher number of deaths from shock. Figure 1 shows the relationship between the Fragile State Index and Average Total Deaths. The graph shows a positive relationship between the variables. Accordingly, the average number of natural disaster-related deaths is also high in countries where the Fragile State Index is high, i.e., the state capacity is low. Figure 2 shows the results of the analysis of the relationship between the Macroeconomic Resilience Index and Average Total Deaths. The graph shows a negative relationship between economic resilience and average number of deaths. In this case, the number of deaths caused by natural disasters is low in countries with high economic capacity.

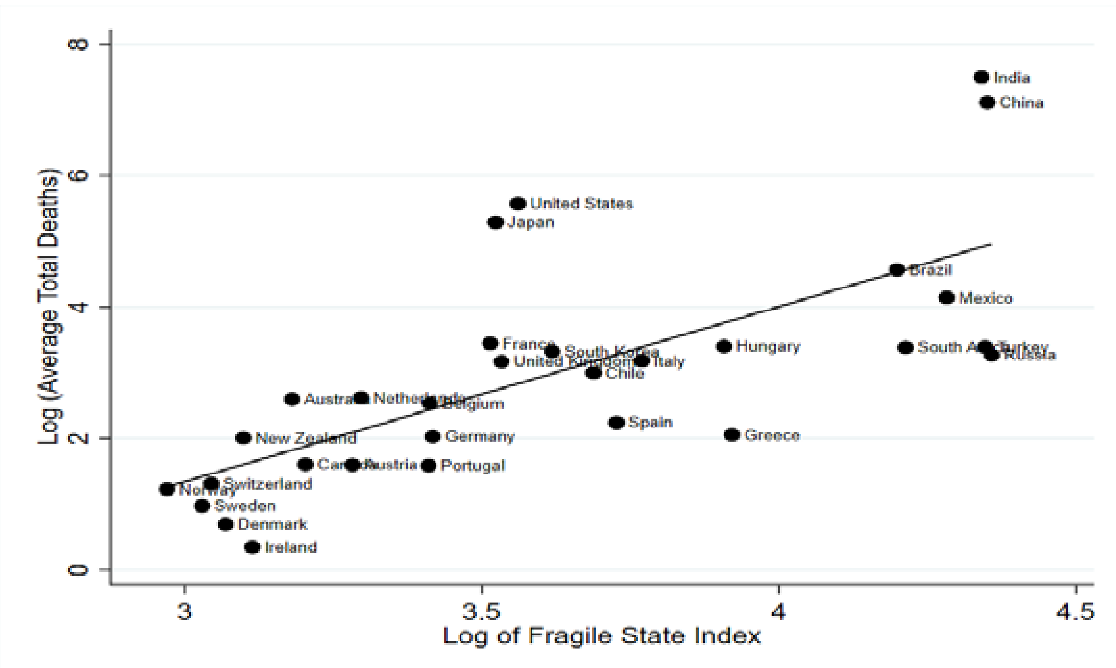

Figure 1. Relationship between average total deaths and fragile state index.

The data used in this study were collected from EM-DAT, SWISS RE, FFP, and WB-WDI data for 31 countries. The definition and sources of the data used in the analysis are given in Table 3.

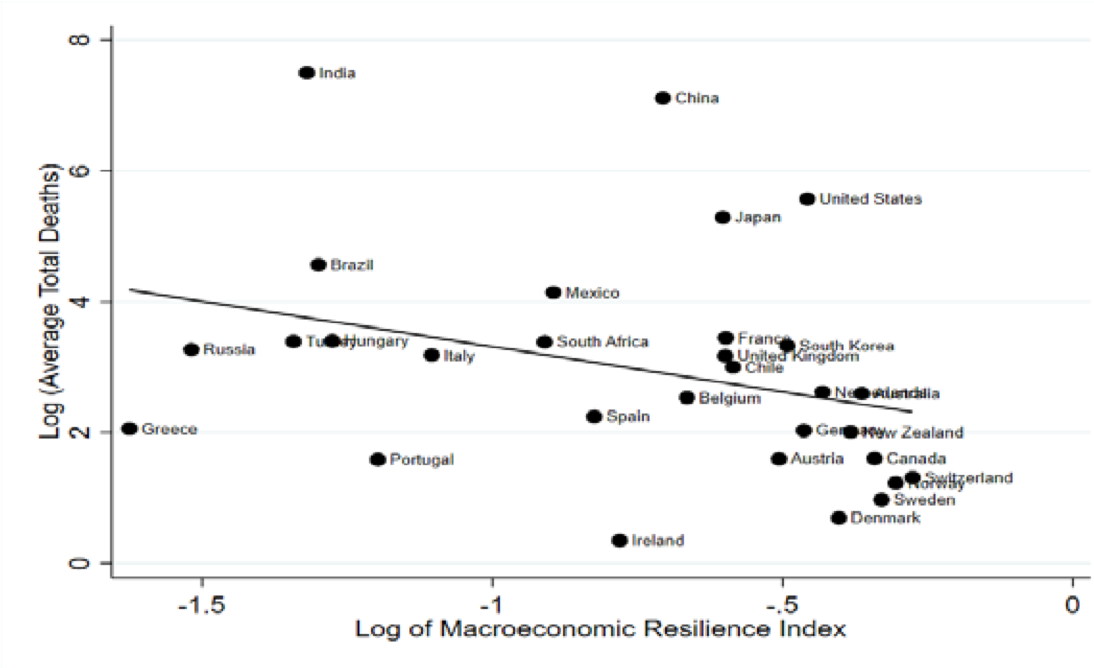

Figure 2. Relationship between average total deaths and macroeconomic resilience index.

Table 3

Definitions and Sources of Variables

Variable	**Definition**	**Source**
Total deaths	Deaths + missing people	EM-DAT
Macroeconomic Resilience Index	Calculating with using Monetary policy space, Fiscal space, Financial market development, Banking industry backdrop, Economic complexity, Human capital, Labor market efficiency, Insurance penetration, Low-carbon economy ve Income inequality indicators	SWISS RE
Fragile State Index	Calculating with using Cohesion, Economic, Political, Social and Cross-Cutting indicators	FFP
GDP per capita	GDP per capita (constant 2015 US$)	WB-WDI
Openness	Openness is the sum of exports and imports of goods and services measured as a share of GDP.	WB-WDI
Population density	Population density (people per square kilometer of land area)	WB-WDI
Size of the government	General government final consumption expenditure (% of GDP)	WB-WDI
CO_2 emissions	CO_2 emissions (metric tons per capita)	WB-WDI
Corruption	This refers to the extent to which public power is used for private gain.	WB-WGI

Note. EM-DAT: Emergency Events Database, SWISS RE: Swiss Re Institute, FFP: Fund for Peace, WB-WDI: World Bank–World Development Indicators.

In this study, two model estimations are made to analyze the effects of economic and state capacities on the death toll from natural disasters. Accordingly, the first model estimation is expressed as follows:

$$Model\,1: \log(Total\ Deaths)_{it} = \alpha_i + \beta_1 \log(Macroeconomic\ Resillience\ Index)_{it} + \beta_2(Openness)_{it} + \beta_3(Population\ Density)_{it} + \beta_4(\text{¿}\,the\ Government)_{it} + \varepsilon_{it}$$

(Eq. 1)

In the first model, the effect of economic capacity on the death toll from natural disasters is analyzed, where *Total Deaths*$_{it}$ is the natural logarithm of death + missing people caused by natural disasters in country *i* during period *t*, *Openness* is the trade openness, *Population Density* is the people per square kilometer of land area, *Size of the Government* is the general government final consumption expenditure (% of GDP), and is the error term.

The second model estimation is used to analyze the effects of state capacity on the death toll from natural disasters and is expressed as follows:

$$Model\,2: \log(Total\ Deaths)_{i} = \alpha_{i} + \beta_1 \log(Fragile\ State\ Index)_{i} + \beta_2 \log(GDP\ per\ Capita)_{i} + \beta_3 (Openness)_{i} + \beta_4 (Population\ Density)_{i} + \beta_5 (¿Government)_{i} + \beta_6 (CO_2\ Emissions)_{i} + \beta_7 (Corruption)_{i} + \varepsilon_{i}$$

(Eq. 2)

where *GDP per Capita* is the natural logarithm of GDP per capita (constant 2015 US$), *$CO_2$ Emissions* is the CO_2 emissions (metric tons per capita), *Corruption* is the index, which expresses the extent to which public power is used for private gain, and is the error term. Other variables are expressed similarly to that in Model 1.

Descriptive statistics of the variables are given in Table 4. The mean, standard deviation, minimum, and maximum values of the descriptive statistics of the variables are also given in the table. The values included in the table are the level values of the data.

Table 4

Descriptive Statistics

Variable	**Mean**	**Std. Dev.**	**Min**	**Max**
Total deaths	717.383	5,797.678	0	88,450
Macroeconomic Resilience Index	.518	.184	.11	.85
Fragile State Index	40.557	19.997	14.627	84.6
GDP per capita	33,702.382	20,911.196	1,075.99	88,413.2
Openness	77.183	41.381	22.106	252.335
Population density	142.956	147.311	2.711	531.545
Size of the government	18.894	4.164	9.862	27.935
CO_2 emissions	7.638	3.747	1.13	19.043
Corruption	1.07	.995	−1.132	2.447

The econometric estimation results of Model 1 expressed in Equation 1 are given in Table 5. The estimation results show that all variables in the econometric model are statistically significant at 1%. Notably, the effect of the Macroeconomic Resilience Index, one of the main variables of the study, on the number of deaths caused by natural disasters is negative and significant ($\beta_1 = -1.832$, $p < 0.01$). This result is consistent with the expectations because the improvements in this variable, which represents economic capacity in this study, are expected to reduce the number of natural disaster-related deaths. The high economic capacity of the countries provides significant benefits to reducing natural disasters and their effects. The effect of the openness variable on the total number of deaths was negative ($\beta_2 = -0.025$, $p = < 0.01$). Accordingly, the trade openness of countries has a reducing effect on the number of deaths. The reducing effect of the openness variable is attributed to the increase in income due to the increase in the foreign trade volume of the country. The coefficient of the population density variable is positive ($\beta_3 = 0.005$, $p < 0.01$). The results also show that the increase in people per square kilometer of land area causes an increase in deaths caused by natural disasters. The effect of the Size of the Government variable on the number of deaths is negative ($\beta_4 = -0.136$, $p < 0.01$). Accordingly, the increase in the share of the state in the economy has a decreasing effect on the total number of deaths.

Table 5

Linear Regression for Model 1

Log(Total deaths)	Coef.	St. Err.	*t* value	p value	[95% Conf	Interval]
Log(Macroeconomic Resilience Index)	−1.832	.658	−2.79	.006	−3.127	−.538
Openness	−.025	.004	−7.08	.000	−.032	−.018
Population density	.005	.001	6.72	.000	.003	.006
Size of the government	−.136	.029	−4.62	.000	−.194	−.078
Constant	7.741	.617	12.55	.000	6.527	8.955

Mean dependent var	3.491	SD dependent var	2.294
R-squared	0.313	Number of obs	288
F test	47.307	Prob > *F*	0.000
Akaike crit. (AIC)	1,196.709	Bayesian crit. (BIC)	1,215.024
****p* <.01, ***p* <.05, **p* <.1.			

The econometric estimation results of Model 2 expressed in Equation 2 are given in Table 6. The estimation results show that all variables in the model, except for the corruption variable, are statistically significant at least at 5%. The effect of the Fragile State Index variable, which is another main variable of this study, on deaths caused by natural disasters is positive and significant as expected ($\beta_1 = 1.589$, $p < 0.05$). The low state capacity emerges as a variable that negatively affects countries' capability to cope with natural disasters and therefore has a positive effect on the number of deaths. The coefficient of the GDP per capita variable is negative ($\beta_2 = -0.633$, $p < 0.01$). The increase in per capita income is a factor that increases the capability of countries to respond to disasters and has a reducing effect on the number of deaths, which is in line with the expectations. The coefficients of the openness, population density, and size of the government variables are similar to the results of Model 1 (i.e., $\beta_3 = -0.019$, $p < 0.01$; $\beta_4 = 0.004$, $p < 0.01$; $\beta_5 = -0.076$, $p < 0.05$). The effect of the CO_2 emissions variable on the number of deaths is positive and significant ($\beta_6 = 0.075$, $p < 0.05$). Thus, the increase in carbon emissions, which is used as a climate variable, has an increasing effect on deaths caused by natural disasters. The coefficient of the last variable, i.e., corruption, in the model is statistically insignificant ($\beta_7 = 0.395$, $p > 0.05$).

Table 6

Linear Regression for Model 2

Log(Total deaths)	Coef.	St. Err.	*t* value	p value	[95% Conf	Interval]	Sig.
Log(Fragile State Index)	1.589	.708	2.24	.026	.194	2.983	**
Log(GDP per capita)	−.633	.197	−3.21	.002	−1.022	−.244	***
Openness	−.019	.004	−4.91	.000	−.027	−.012	***
Population density	.004	.001	5.21	.000	.002	.005	***
Size of the government	−.076	.032	−2.36	.019	−.139	−.013	**
CO_2 emissions	.075	.036	2.10	.037	.005	.145	**
Corruption	.395	.3	1.32	.188	−.195	.985	
Constant	4.922	3.9	1.26	.208	−2.758	12.602	

Mean dependent var	3.435	SD dependent var	2.269
R-squared	0.398	Number of obs	268
F test	41.902	Prob > *F*	0.000
Akaike crit. (AIC)	1,078.754	Bayesian crit. (BIC)	1,107.482
****p <.01, **p <.05, *p <.1*			

Conclusions

In every period of history, humanity is constantly facing natural disasters, either small or large. However, the increase in the number and intensity of natural hazards and the transformation of natural hazards into natural disasters are a result of the interaction between humans and nature. Irrational human activities cause the environment to deteriorate faster. Climate changes due to global warming, particularly in recent years, are the clearest manifestations of this result. Although climate change does not trigger some natural hazards, it increases the number, intensity, and losses caused by climatic disasters. Humanity has no power to end natural dangers. However, it is possible to reduce the number of natural disasters and their other effects, particularly deaths.

Like nature, the economy and the state are the basic social institutions that meet the needs of people. However, how people formulate their economic and political preferences to reduce natural disasters is also important. Depending on their preferences, the effects of the economic and institutional characteristics of countries on natural disaster-related losses can be mitigated or exacerbated. The economic capacities of countries were measured using the Macroeconomic Resilience Index with nine indicators calculated by the Swiss Re Group, and the state capacities were measured using the Fragile State Index with 12 indicators calculated by The Fund for Peace. The openness, population density, size of the government, control of corruption, and CO_2 emissions variables are the control variables included in the estimations. The first three of these variables are included in the first model, which examines the effects of macroeconomic resilience on the death toll from natural disasters, and all of them are included in the second model, which examines the effects of state fragility on the death toll from natural disasters. According to the econometric estimation evidence, the following conclusions were reached:

- Macroeconomic resilience has a strong and reducing effect on natural disaster-related deaths. This finding indicates that a 1% increase in the Macroeconomic Resilience Index during the analysis period reduces natural disaster-related deaths by 1.83%.
- State fragility also has a strong and increasing effect on natural disaster-related deaths. We determine that a 1% increase in the Fragile State Index increases natural disaster-related deaths by 1.59%.
- The trade openness of countries has a reducing effect on natural disaster-related deaths, albeit weakly.
- Increases in population density affect natural disaster-related deaths in a statistically significant and positive manner, although the coefficient is low.
- Increases in CO_2 emissions have a statistically significant and positive effect on natural disaster-related deaths.
- The size of the government and corruption has been included in research models as other proxies of state capacity. As expected, the expansion in the size of the government reduces the number of natural disaster-related deaths. However, contrary to the expectations, the effect of control of corruption on natural disaster-related deaths is statistically insignificant. There are two possible reasons for this contradictory result. First, most of the countries in the panel are developed countries and the control of corruption is high in these countries. Second, because the analysis period is short, the control of corruption does not show a high variation.

Our research findings may have important policy implications. First, to reduce deaths caused by natural disasters, policy reforms aimed at expanding the macroeconomic capacities of countries and improving the effectiveness of the state should be prioritized. A strong economic structure and effective government intervention can help prevent disaster-related deaths. Second, widespread and quality public services and the right population mobility policies can help reduce disaster-related deaths. Third, measures to limit carbon emissions, such as renewable energy policies, can be beneficial, particularly in reducing deaths from climatic disasters.

We acknowledge that our research has certain limitations. The most important limitation of our research is that it examines the relationships in a narrow sample and a short period because of the data accessibility problem. Another limitation of our research is that it does not reveal which component of economic resilience and state fragility has an impact on natural disaster-related deaths. Future research can discuss our results with these limitations.

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