

# The Relationship Between Natural Disasters and Economic Growth in Türkiye

## Türkiye’de Doğal Afetler İle Ekonomik Büyüme Arasındaki İlişki

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### ABSTRACT

Natural disasters significantly affect the physical, environmental, and social dynamics of societies, leading to substantial loss of life and property while disrupting economic activity. Additionally, they can result in long-term economic setbacks by causing lasting changes to both physical and human capital. The scale, severity, and economic impacts of natural disasters vary depending on a country's level of development. This highlights the existence of a relationship between natural disasters and development levels, emphasizing the need for economic research to explain this relationship. Such studies can contribute to a better understanding of the dynamics and aid in future planning. This study aims to analyze the relationship between natural disaster-induced damages and economic growth in Türkiye during the period 1960–2017, utilizing the ARDL bounds testing approach. The findings reveal a negative and statistically significant relationship between natural disaster losses and economic growth in both the short and long run. Moreover, long-term analyses show that capital stock and labour force are key determinants of economic growth. These results show that disasters have significant negative effects not only at the physical level but also at the macroeconomic level, highlighting the need to promote capital accumulation and improve the quality of the labour force for the sustainability of economic growth.

**JEL Codes:** Q54, O40, C32

**Keywords:** Natural disaster, Economic growth, Turkish economy, ARDL bounds test

### Öz

Doğal afetler toplumların fiziksel, çevresel ve sosyal dinamiklerini önemli ölçüde etkileyerek can ve mal kayıplarına yol açmakta ve ekonomik faaliyetleri kesintiye uğratmaktadır. Ayrıca, hem fiziksel hem de beşeri sermayede kalıcı değişimlere neden olarak uzun vadeli ekonomik gerilemelere yol açabilmektedir. Doğal afetlerin boyutu, şiddeti ve ekonomik etkileri ülkelerin gelişmişlik seviyelerine bağlı olarak farklılık göstermektedir. Bu durum, doğal afetler ile gelişmişlik düzeyi arasında bir ilişki olduğunu ortaya koymakta ve bu ilişkinin açıklanabilmesi için ekonomik çalışmalara olan ihtiyacı vurgulamaktadır. Böyle çalışmalar, bu dinamiklerin daha iyi anlaşılmasına ve geleceğe yönelik planlamaların yapılmasına katkı sağlayabilir. Bu çalışma, 1960–2017 dönemi için ARDL sınır testi yaklaşımını kullanarak Türkiye’de doğal afet kaynaklı zararlar ile ekonomik büyüme arasındaki ilişkiyi analiz etmeyi amaçlamaktadır. Elde edilen bulgular, doğal afetlerin hem kısa hem de uzun vadede ekonomik büyüme üzerinde negatif ve istatistiksel olarak anlamlı bir etkisinin olduğunu ortaya koymaktadır. Ayrıca, uzun vadeli analizler, sermaye stoku ve iş gücünün ekonomik büyümenin temel belirleyicileri arasında yer aldığını göstermektedir. Bu sonuçlar afetlerin yalnızca fiziksel değil, aynı zamanda makroekonomik düzeyde de önemli olumsuz etkilere neden olduğunu göstermekte ve ekonomik büyümenin sürdürülebilirliği için hem sermaye birikiminin teşvik edilmesi hem de iş gücünün niteliksel olarak geliştirilmesi gerektiğini ortaya koymaktadır.

**JEL Codes:** Q54, O40, C32

**Keywords:** Doğal afet, Ekonomik Büyüme, Türkiye Ekonomisi, ARDL sınır testi

## Introduction

Disasters are important occurrences that have a profound impact on institutional systems and social life. There are several formal definitions of disaster, but no universally accepted one. According to the Annotated Glossary of Disaster Management Terms, a disaster is defined as “a natural, technological or man-made event that results in physical, economic and social losses for either the entire society or specific segments, disrupts normal life and human activities, and surpasses the coping capacity of the affected society”. A disaster is defined by the Catholic University of Louvain's Center for Research on the Epidemiology of Disasters (CRED) as a natural condition or event that surpasses local capability and/or requires a call for outside assistance. According to this definition, the disruption caused by a disaster should have effects on the economic system such as loss of production, tax revenues and employment; it should also have consequences that go beyond the loss of assets and monetary expenditures to replace damaged property (Hallegatte & Przulski, 2010). Natural disasters can be defined as national and global events that reduce Gross Domestic Product (GDP), consumption and wealth, and thus reduce the capital stock and/or the productive efficiency of capital (Pindyck & Wang, 2009). Economically speaking, a disaster is any natural occurrence that disrupts the way the economy functions and has a major detrimental impact on resources, output, employment, consumption, or production variables (Hallegatte, 2012).

An incident must result in losses to human communities and settlements and have an impact on one or more settlements by halting or disrupting human activity in order to qualify as a disaster. Therefore, disaster is seen as the consequences of the event rather than the event itself. However, the perception of disaster can vary according to the level of development of societies and the time. It is also seen that some events that developed societies accept as disasters are not accepted as disasters by less developed societies, or events that were not previously perceived as disasters are later accepted as disasters (Yildirim, 2004).

Although various national and international databases on natural disasters exist, the most widely used and academically accepted source in disaster research is the Emergency Events Database (EM-DAT), developed by the Centre for Research on the Epidemiology of Disasters (CRED) in Belgium. EM-DAT provides a comprehensive dataset on disasters that have occurred since 1900, including key indicators such as frequency, economic

losses, mortality rates and the number of people displaced. The economic losses reported in the database are limited to direct damage to infrastructure, housing and agriculture.

For an event to be classified as a 'natural disaster' in the EM-DAT database, at least one of the following four criteria must be met: at least 10 deaths, at least 100 people affected, a declaration of a state of emergency, or a formal request for international assistance (EM-DAT, 2014a). These criteria allow disasters to be classified according to objective standards and allow for international comparability.

The concept of disaster cannot be reduced to a single definition in the literature, and there is no definitive and absolute method for its classification. It is seen that various approaches are adopted in this regard. Disasters are generally examined under various categories such as human-induced, natural, minor or major events. In international classifications, disasters are divided into natural, semi-natural and man-made disasters or natural and technological disasters according to their sources of occurrence. In addition, they are classified as sudden and slow-developing disasters according to their speed of occurrence, internal and external disasters according to their magnitude of impact, and small and large-scale disasters according to the number of human impact and economic losses.

The most common approach in international classifications is to group disasters according to their origins or natural events. According to this approach, disasters are considered in six main groups as geological (Geo.), meteorological (Met.), hydrological (Hyd.), climatic (Cli.), biological (Bio.) and disasters originating from extraterrestrial events (Ext.) (emdat.be). Table 1 presents the most common categorization of natural disasters in the literature.

**Table 1.**

### *Classification of Natural Disasters*

Geo. Event	Met. Event	Hyd. Event	Cli. Event	Bio. Event	Ext. Event
Earthquake	Storm	Flood	Drought	Epidemic	Space movements
Mass Movement (dry)	Extreme Heat	Landslide	Glacial Lake Explosion	Insect Infestation	Coup
Volcanic Activity	Fog	Wave Motion	Forest fire	Animal Accident	

**Source:** Sapir-Hoyois, E., & Below, R. (2013). *Topics geo: Natural catastrophe know-how for risk management and research*. Munich Re Group. Retrieved from <http://www.emdat.be/classification>

The aim of this study is to analyze the impact of natural disasters that occurred in Türkiye between 1960 and 2017 on Türkiye's economic growth. The next section of the study covers the empirical literature examining the relationship between the effects of natural disasters and the country's economic growth. The third section includes economic analyses, and in the last section, the findings are evaluated, suggestions are presented, and the study is completed.

### **Theoretical Background and Literature Review**

In countries where natural disasters occur, various effects occur. Although the intensity of the effects varies in each case, natural disasters cause different results in the region where they are located. Disasters cause loss of life and injuries among the population, disruption of basic services, damage to social and economic infrastructure, and also stock and production losses (Jovel, 1989). These effects can be examined under four main headings: physical, social, environmental and economic. Physical effects are damages in infrastructure, transportation, communication and energy sectors. Social effects are negative results seen in areas such as population, health, education and housing. Environmental effects include the damage caused to biodiversity and natural habitats. The United Nations Economic Commission for Latin America and the Caribbean (ECLAC) has developed a classification system that categorizes economic impacts into three groups: direct, indirect, and secondary (ECLAC, 2003; Pelling et al., 2002). Damage and devastation that happen right after a disaster happens are referred to as direct effects.

This includes loss of life, injuries, loss of labor, and capital losses resulting from damage to physical property (houses, factories, and infrastructures) (Benson, 1997; ECLAC, 1991; Mechler, 2003; Pelling et al., 2002; Sapir et al., 2004). Indirect effects of natural disasters originate from the direct damage to production capacity, social, and economic infrastructure, starting immediately after the disaster and continuing throughout the reconstruction process. These effects refer to interruptions in the flow of goods and services (Benson, 1997; Mechler, 2003; Pelling et al., 2002). Secondary effects of natural disasters are defined as the effects of disasters on macroeconomic variables by the United Nations Disaster Relief Agency (1979) and Friesema et al. (1979). These effects are reflected in indicators such as general and sectoral gross domestic product level and growth rate, trade balance, debt level, foreign exchange reserves, public finance and gross investment. Secondary effects emerge after a while

following the disaster and lead to results such as slowdown in economic growth, increased inflation, balance of payments problems, increase in fiscal expenditures and decrease in monetary reserves (Gökçe et al., 2008; Güvel, 2008; Jovel, 1989; Mechler, 2003; Otero & Marti, 1995). The effects of natural disasters on economic parameters are typically characterized by a substantial decline in production and investment growth, a smaller decline in consumption growth and a deterioration in the balance of payments (Ayoo, 2005). When analyzing these effects on macroeconomic variables, researchers evaluate changes in post-disaster GDP, balance of payments, and fiscal budget (ECLAC, 1991; Pelling et al., 2002).

Disasters generally cause a decrease in GDP growth in the year of the disaster, but growth increases again with the reconstruction programs implemented afterwards. According to Chibber & Laajay (2008), disasters can have four different effects on economic growth. Firstly, disasters can have a temporary negative effect and post-disaster growth can return to the pre-disaster level. Secondly, in the aftermath of a disaster, growth may temporarily exceed pre-disaster levels due to the influx of substantial foreign aid, but it eventually stabilizes to its normal rate over time. Thirdly, natural disasters can have a lasting impact on economic growth; a permanent reduction in the capital stock may lead to the establishment of a new growth trajectory at a level lower than that observed before the disaster. Finally, according to a scenario based on Schumpeter's concept of "creative destruction", the new growth path can be higher than the pre-disaster level as a result of the renewal of capital with more advanced technology. In this context, disasters not only generate destructive impacts but may also present an opportunity for development by enabling the renewal of capital stock through improved infrastructure, the adoption of innovative technologies, the enhancement of system resilience to risks, and the overall improvement of living standards (Jha et al., 2018). This positive transformation potential is also referred to as the "corrective effect" of disasters in the literature (Xiano, 2011).

Although the damage resulting from natural disasters is usually very large, the macroeconomic effects may not always be apparent in terms of economic output for various reasons (Strobl, 2012). First, natural disasters are usually regional events and therefore affect only a certain part of the economy. Second, natural disasters usually cause losses in physical and human capital. However, since GDP is calculated as the total national output, the reserve capital created as a result of activities such as disaster

recovery, aid and infrastructure works can make GDP appear higher (Horwich, 2000). In other words, natural disasters can cause a new production flow by creating opportunities for reinvestment, capital renewal and technological developments, which can increase economic growth (Noy, 2009). Third, the total degree of damage caused by disasters is largely related to the country's level of economic development, with developing countries generally experiencing greater damage and these effects being more devastating (Cavallo & Noy, 2009; Mecher, 2007). For instance, the earthquakes that occurred in both the United States and El Salvador in 2001 resulted in economic losses of approximately two billion US dollars in both countries. While this figure seems insignificant for the United States economy, it amounted to 15% of El Salvador's GDP and the country experienced a serious economic crisis (Coppola, 2006).

Kahn (2005) found in his research on countries with different levels of development that although high-income nations do not suffer from fewer or less severe natural disasters, the losses and damages in these countries are considerably lower. The study determined that in a low-income nation (GDP per capita under \$2000), the average mortality rate is 9.4 deaths per million individuals annually, whereas in a high-income nation (GDP per capita exceeding \$14,000), the rate is merely 1.8 fatalities. Economic development plays a major role in reducing a country's vulnerability to disaster events; a disaster of similar magnitude negatively affects developing countries more than developed countries (Fomby et al., 2009; Loayza et al., 2009). Developing nations tend to allocate fewer resources than developed countries to the prevention and mitigation of natural disasters. Moreover, these countries have a limited ability to manage the economic repercussions of disasters, reinforced by the fact that some policy interventions to mitigate disaster impacts (such as land-use planning, building codes and engineering solutions) are less common (Freeman et al., 2003; Jaramillo, 2009).

Empirical studies examining the macroeconomic impacts of natural disasters generally focus on developing countries and evaluate post-disaster effects using statistics based on real historical events. These studies reveal that natural disasters have significant macroeconomic consequences in the short and medium term, and with the exception of a few opposing views, the idea that natural disasters constitute an obstacle to long-term development is widespread (Mechler, 2009).

Research investigating the economic impacts of natural disasters has demonstrated that these impacts may vary concerning growth. From a macroeconomic perspective, the impacts of disasters on growth may be positive, negative, or neutral. Therefore, in line with the purpose of the study, the existing literature has been structured and examined according to the positive and negative effects of natural disasters on growth in the short and long term. According to the examined studies, natural disasters typically exert a detrimental impact on economic growth (Cavallo et al., 2010; Hochrainer, 2009; Jaramillo, 2009; Hsiang-Jina, 2014; Kahn, 2005; Klomp & Vackx, 2014; Leiter et al., 2009; Markandya-Galinato, 2009; Mechler, 2009; Mel et al., 2010; Noy, 2009; Raddatz, 2007; 2009; Rodrigues-Oreggiat, 2009; Schumacher-Strobl, 2011; Selçuk & Yeldan, 2001; Shabnam, 2014; Strobl, 2008; Toya-Skidmore, 2007). According to some research, disasters may have a positive or negligible impact on economic growth (Ahlerup, 2013; Albala-Bertrand, 1993; Fomby et al., 2009; Kim, 2010; Loayza et al., 2009; Skidmore & Toya, 2002).

This study aims to examine the impact of natural disasters on economic growth in the specific context of Türkiye. A review of the existing literature reveals that studies focusing on Türkiye are limited in number and primarily concentrate on the short-term effects of disasters or are confined to specific types of disasters. In contrast, this study offers a broader perspective by covering a longer period and employing a comprehensive and up-to-date damage variable to measure the impact of natural disasters. Furthermore, the use of the ARDL model allows for the simultaneous analysis of both short- and long-term effects, thereby providing a more nuanced understanding of the temporal dynamics of disaster impacts on growth. In this respect, the study not only stands out as one of the few empirical analyses on the disaster-growth nexus in Türkiye, but also contributes significantly to the literature in methodological and conceptual terms.

## **Empirical Analysis**

### **Data and Model**

The purpose of this study is to examine the short- and long-term effects of natural disaster damage on economic growth within the context of the Turkish economy. For this purpose, real GDP per capita ( $y$ ) was used as the dependent variable. Annual capital stock ( $ss$ ), labor force ( $ig$ ) and disaster damage variable ( $daz$ ) were included in

the model as independent variables.

The study examines the period from 1960 to 2017, utilizing annual data for the analysis. The fact that uninterrupted data for the variables examined can be accessed starting from 1960 caused the analysis period to start from this date. To linearise non-linear relationships between series, analyze proportional (percentage) effects between variables, and stabilize series variance, all variables except the natural disaster damage variable were converted and used in logarithmic form. The data for real GDP per capita, capital stock and labor force variables required in the application phase were sourced from the Penn World Table 9.1 database prepared by the Center for International Comparisons of the University of Pennsylvania and the World Bank Development Indicators (WDI). The data for the natural disaster damage variable were sourced from the Emergency Event Database (EM-DAT) established by the Center for Disaster Epidemiology Research (CRED). In this study, the natural disaster damage variable includes earthquakes under the category of geological disasters, and floods and storms under the category of meteorological disasters. These types of disasters have a more significant impact in Türkiye compared to other disaster types, both in terms of frequency and the economic losses they cause. Accordingly, other disaster types with limited observational frequency and economic impact were excluded from the analysis. In measuring the damage for each type of disaster, the monetary damage indicators used by Fomby et al. (2009) and Noy (2009)<sup>1</sup> were taken as a reference, and a similar impact variable was calculated. According to the EM-DAT database, natural disaster damage includes damages to property, crops and livestock, and the value of these damages is expressed in US dollars ('000). The damage amount stated for each disaster reflects the damage value valid for the year in which the event occurred (emdat.be).

In studies examining economic growth and its determinants, the Cobb-Douglas production function is typically employed as a means of analysis. The study conducted an analysis based on a fixed-return Cobb-Douglas production function to investigate natural disaster damage's short- and long-term effects on economic growth. In this context, the production function was created as follows:

$$Y_t = A_t K_t^a (H_t \times L_t)^{1-a} \quad (1)$$

<sup>1</sup> Natural Disaster Damage (daz) = (Disaster Damage Index (geological disaster + meteorological disaster) / GDP) \* 100

$$\text{Log}Y_t = \text{Log}A_t + a\text{Log}K_t + (1 - a)\text{Log}(H_t \times L_t) \quad (2)$$

the literature review appropriate to the purpose of the study, the model created and the variables to be used were determined based on the studies of Skidmore and Toya (2002) and Hsiang and Jina (2014). Within the scope of the research, a model appropriate to the target of the study was created by adding the disaster variable to equation number 3.2 and expressed in the following form:

$$\ln y_t = \ln a_t + a \ln s_t + (1 - a) \ln i_g t + b \text{daz}_t \quad (3)$$

In Equation 3,  $y$  represents real GDP per capita,  $ss$  represents capital stock,  $ig$  represents labor force and  $daz$  represents total damage from natural disasters. The natural disaster damage variable is divided into two subcategories; geological disasters including earthquake disasters and meteorological disasters including flood and storm disasters. The focus of this study on geological (earthquakes) and meteorological (floods and storms) disasters is due to the fact that these types of disasters are more frequent and have a greater economic impact in Türkiye than other disaster types. Accordingly, disaster types with low representativeness were excluded from the analysis.

## Methodology

In econometric analyses, in order to analyze the relationship between variables, it is first necessary to examine whether the variables are stationary. The stationarity of a time series is defined as the fact that its mean and variance do not change over time and represents a fixed stochastic process (Gujarati, 2004). Non-stationary series should be made stationary by taking their differences; thus, the real relationship between the variables can be revealed by preventing the spurious regression problem. In this context, the stationarity of the series was tested using the Generalized (Augmented) Dickey-Fuller (ADF) unit root test developed by D. Dickey and W. Fuller in 1981 and the unit root tests developed by P. Phillips & P. Perron in 1988, which are sensitive to correlation and heteroscedasticity in error terms.

In this study, Distributed Lag Autoregressive Model (ARDL) is employed to examine the short- and long-term effects of natural disasters on economic growth. In the ARDL bounds testing approach developed by MH Pesaran, Y. Shin, and RJ Smith in 2001, the cointegration

relationship among variables can be examined without the need to determine whether the variables are I(0) or I(1). In other words, the variables are not required to be stationary at the same level; if the series become stationary at level or first difference, a cointegration relationship among them can be identified (Dritsakis, 2011). The ARDL model also provides the opportunity to analyze with a single equation and fewer parameters (Pesaran et al., 2001) and offers the opportunity to estimate both short-term and long-term dynamics (coefficients) simultaneously within the framework of the Unrestricted Error Correction Model it contains. For this reason, the use of the ARDL bounds test contributes to more reliable and accurate results. In the initial stage of the ARDL method, which follows a two-stage procedure, the presence of a long-term relationship, or cointegration, among the variables in the model is tested. The second stage involves estimating both the long-term and short-term coefficients (Narayan & Smyth, 2006; Şoltan, 2009).

In this research, whether there is a long-term relationship between the variables is investigated by testing the unrestricted error correction equation in equation 4.

$$\Delta y_t = \gamma_0 + \gamma_1 y_{t-1} + \gamma_2 ss_{t-1} + \gamma_3 ig_{t-1} + \gamma_4 daz_{t-1} + \sum_{i=1}^k \gamma_{5i} \Delta y_{t-i} + \sum_{i=0}^l \gamma_{6i} \Delta ss_{t-i} + \sum_{i=0}^m \gamma_{7i} \Delta ig_{t-i} + \sum_{i=0}^n \gamma_{8i} \Delta daz_{t-i} + \varepsilon_{2t} \quad (4)$$

Within the scope of ARDL bounds test, the following hypotheses were created to test the cointegration relationship:  $H_0: \gamma_1 = \gamma_2 = \gamma_3 = \gamma_4 = 0$  (there is no long-term relationship) and  $H_1: \gamma_1 = \gamma_2 = \gamma_3 = \gamma_4 \neq 0$  (there is a long-term relationship). If  $H_0$  the hypothesis is rejected, this means that there are long-term relationships between the variables. After determining the optimum lag length, the equation is estimated with the Least Squares method (LSM) to calculate the F statistic. In the studies of Pesaran et al. (2001), two critical values were produced to compare the obtained F statistic. The upper critical value assumes that all variables are I(1) (stationary in first differences), whereas the lower critical value assumes that all variables are I(0) (stationary at level). An F-statistic below the lower critical value indicates the absence of a cointegration relationship, while a value above the upper critical value indicates the presence of a cointegration relationship. However, if the calculated F statistic remains between these two critical values, a definite decision cannot be reached about the long-term relationship.

The ARDL equation to be estimated for analyzing the long-term relationship between the variables is presented as follows, based on equation (3);

$$y_t = \gamma_0 + \sum_{i=1}^k \gamma_{1i} y_{t-i} + \sum_{i=0}^l \gamma_{2i} ss_{t-i} + \sum_{i=0}^m \gamma_{3i} ig_{t-i} + \sum_{i=0}^n \gamma_{4i} daz_{t-i} + \varepsilon_{2t} \quad (5)$$

Long-term coefficients are calculated using the parameters in this equation.

In order to determine how short-term imbalances are eliminated in the long term, the error correction model based on the ARDL approach is created as follows, based on equation (4):

$$\Delta y_t = \theta_0 + \sum_{i=1}^k \theta_{1i} \Delta y_{t-i} + \sum_{i=0}^l \theta_{2i} \Delta ss_{t-i} + \sum_{i=0}^m \theta_{3i} \Delta ig_{t-i} + \sum_{i=0}^n \theta_{4i} \Delta daz_{t-i} + hdt_{t-1} \quad (6)$$

in the equation  $hdt_{t-1}$  represents the error correction term. This term represents the one-period lagged value of the residuals from the long-term relationship between the variables, and the coefficient of  $hdt_{t-1}$  indicates the extent to which short-term imbalances will be corrected in the long term. It is anticipated that the error correction term will be negative and statistically significant.

## Research Findings

When determining the method to be followed in econometric analysis, the initial stage is to test whether the series contain a unit root. Accordingly, since it is sufficient for the model variables to be I(0) and/or I(1), ADF and PP unit root tests were directly applied to the first differences of the variables, and the test results are presented in Table 2. The test findings indicate that all variables are stationary at the first difference at the 1% significance level, except for the fixed capital variable, which is stationary at the 5% significance level. In other words, all series are stationary at the I(1) level. Therefore, the ARDL bounds testing approach developed by Pesaran, Shin, and Smith (2001) was employed to examine both short- and long-term effects of the model without requiring all variables to be of the same order of integration, as long as they are I(0), I(1), or a combination of both.

**Table 2.***ADF and PP Unit Root Test Results*

Variables	ADF		PP		
	Prob	Lag	Prob	Stats.	Prob
$\Delta y_t$	0.000 *	0	0.000 *		
$\Delta ss_t$	0.044 **	0	0.044 **		
$\Delta ig_t$	0.000 *	0	0.000 *		
$\Delta daz_t$	0.000 *	1	0.001 *		
Method	Stats.	Prob	Method	Stats.	Prob
ADF Fisher Chi-square	203,017	0.000*	PP Fisher Chis-quare	128,109	0.000*
ADF Choi Z-stat	-12.547	0.000*	PP Choi Z-stat	-9.573	0.000*

Note: \*, \*\* indicate 1% and 5% significance levels, respectively.

In the ARDL model, before determining the cointegration relationship between the variables, the appropriate lag lengths of the series must be determined. For this purpose, the Akaike Information Criterion (AIC) was employed in order to ascertain the optimal lag lengths and the most appropriate model was selected as (2,2,1,2).

Table 3 shows whether a cointegration connection exists between the variables. The results of the test indicated that the calculated F statistic value was 5.215. In comparison to the critical values established by Pesaran et al. (2001), the null hypothesis (indicating the absence of a cointegration connection among variables) was rejected, as the computed F statistic exceeded the upper critical value of 4.66 at the 1% significance level. The test results indicate a cointegration relationship among the variables. According to this result, there is a significant relationship between the real per capita GDP, capital stock, labor force and natural disaster total loss variables in the long term.

**Table 3.***Bounds Test Results*

F-Statistic	5.215 *	Critical table values for F test	
		Lower Limit	Upper Limit
		10%	2.37
		5%	2.79
		1%	3.65
			4.66

Note: The critical values were derived from the study of Pesaran et al. (2001).

After a cointegration relationship was detected between the variables, the long-term coefficients were estimated from equation number 5 in order to determine the direction of this relationship. The estimation results of the long-term coefficients are presented in Table 4. According to the estimation results, all variables were determined to be statistically significant. When the indications of the coefficients are examined, it is seen that

the capital stock and labor force variables are positive, while the natural disaster damage variable is negative. These findings show that a 1% increase in the fixed capital stock in the long term increases the real GDP per capita, which represents the level of development, by 0.59%, and a 1% increase in the labor force increases the real GDP per capita by 0.47%. On the other hand, a 1% increase in the total natural disaster damage leads to a 0.02% decrease in the real GDP per capita. These findings are parallel to studies in the literature that find a negative relationship between natural disasters and economic growth (Baig et al., 2018; Hochrainer, 2009; Klomp & Valckx, 2014; Jaramillo, 2009; Loayza et al., 2009; Noy 2009; Raddatz 2009).

**Table 4.***ARDL Model Estimation Results: Long-Term Coefficients*

Variables	Coefficients	Standard Error	Probability Value
$ss_t$	0.590	0.058	0.000 *
$ig_t$	0.478	0.112	0.001 *
$daz_t$	-0.029	0.014	0.045 **
$c$	2.177	0.397	0.045 **

Note: \*, \*\* indicate 1% and 5% significance levels, respectively.

The estimation results of the short-term error correction model created to examine how short-term imbalances between variables are eliminated in the long term are presented in Table 5.

**Table 5.***ARDL Short-Term Relationship and Error Correction Model*

Variable	Coefficients	Standard Error	Probability Value
$\Delta y_{t-1}$	0.143	0.092	0.128
$\Delta ss_t$	1.747	0.190	0.000 *
$\Delta ss_{t-1}$	-0.644	0.241	0.010 *
$\Delta ig_t$	-0.063	0.126	0.616
$\Delta daz_t$	-0.005	0.002	0.023 **
$\Delta daz_{t-1}$	0.007	0.002	0.003 *
$hdt_{t-1}$	-0.429	0.080	0.000 *
$R^2$	0.721	Dep. value avg.	0.047
Adj. $R^2$	0.687	Dep. value. Stand. range.	0.038
Reg. std. Error	0.021	AIC	-4.699
RSS	0.023	Schwarz Inf. criterion	-4.446
LL	8.598	H-QIC	-4.601
DW Stat.	1.894		

**Diagnostic Tests**

$\chi^2_{SC}$ : 0.448(0.799)  $\chi^2_{HET}$ : 12.662(0.243)  $\chi^2_{NOR}$ : 4.395(0.111)  
 $\chi^2_{FF}$ : 1.922(0.172)

Note: ( $\chi^2_{SC}$ ,  $\chi^2_{HET}$ ,  $\chi^2_{NOR}$  ve  $\chi^2_{FF}$  are autocorrelation, heteroscedasticity, normality and model fitting statistics respectively).

\*, \*\*, \*\* expressions indicate 1% and 5% significance levels, respectively.

In the model, the lagged value of the growth variable

and the labor force variable were not found to be statistically significant, but all other variables were found to be statistically significant. The natural disaster total loss variable was found to be statistically significant. Real GDP per capita in the current period is negatively correlated with this statistic, although its one-period lag value is positively correlated. In other words, the increase in the total loss from natural disasters reduces GDP in the current period; however, in the lagged period, this negative effect disappears with the recovery effect and leads to an increase in GDP. As a result, independent variables that have a significant impact on real GDP per capita in the short term affect economic performance.

The one-period lagged value of the error terms derived from the long-term connection is represented by the error correction coefficient ( $hdt_{t-1}$ ) in the model. This coefficient indicates the extent to which short-term imbalances can be rectified over time. According to the estimation results, the error correction coefficient was found to be negative (-0.429) and statistically significant, as expected. This result shows that the imbalances in the current period have started to be corrected in the next period. The estimation results show that approximately 42% of the imbalances that occur in the short term will be corrected in the first year and the effect of the shock will completely disappear after approximately 2.5 years.

The diagnostic test results for the ARDL bounds test in the study are shown in Table 5. These results show that the series are normally distributed, do not contain autocorrelation and heteroscedasticity, and there is no model building error.

### Conclusion and Recommendations

Türkiye frequently experiences natural disasters that result in significant loss of life, injuries, and material damage. Events such as earthquakes, landslides, floods, rock and avalanche falls, storms, droughts, and forest fires cause widespread physical, social, and environmental destruction across the country. These disasters lead to substantial economic losses and are among the key factors that adversely affect Türkiye's economic growth.

This study investigates the short- and long-term effects of natural disasters on Türkiye's economic growth over the period 1960–2017 using the Autoregressive Distributed Lag (ARDL) approach. The analysis reveals a positive long-term relationship between economic growth and both capital stock and labor force, while a negative relationship

is observed between natural disaster damages and economic growth in both the short and long term. These findings, consistent with theoretical expectations, indicate that increases in capital stock and labor force contribute positively to growth, whereas increases in natural disaster damages hinder it.

The study's results demonstrate that natural disasters exert a negative impact on Türkiye's economic growth, even over the long term. This outcome contrasts with some studies (e.g., Loayza et al., 2012; Skidmore & Toya, 2002), which suggest that disasters may stimulate growth in the long run through reconstruction-driven investment. However, it aligns with findings from researchers such as Cavallo and Noy (2009), who argue that disasters often result in permanent economic losses. These divergent results may stem from differences in disaster management capacity, the efficiency of post-disaster reconstruction efforts, or methodological approaches (e.g., distinctions among disaster types). In this regard, the study offers a valuable contribution to the ongoing debate in the literature and provides a country-specific perspective for Türkiye.

It is accepted as a fact that the country cannot change its geographical location, cannot choose disasters, and that the occurrence of natural disasters cannot be prevented due to their nature. However, it is possible to reduce the impact of the damage resulted in disasters and thus alleviate their negative effects on economic growth.

In this context, it is suggested that the most effective way for Türkiye to sustain long-term growth is to be prepared for disasters and to develop plans suitable for future disasters by focusing on recovery processes. When determining economic policies, a disaster management system that includes policies and actions to reduce disaster risk and damage should definitely be included in strategies aimed at growth targets. In the effective implementation and monitoring of this system, it is critical that central and local governments, civil society organizations, volunteers and the public act in cooperation and create a conscious society. In this regard, a robust disaster risk financing framework should be established to mitigate the economic impacts of natural disasters. For instance, national-level disaster risk financing strategies should be developed to rapidly meet post-disaster funding needs, emergency response funds should be created, and innovative financial instruments such as catastrophe bonds should be employed to alleviate fiscal pressures. Additionally, to ensure compensation for post-disaster losses, the

coverage of the compulsory earthquake insurance (DASK) should be expanded to include small enterprises and public buildings. Agricultural insurance schemes (TARSİM) should be supported to strengthen risk-sharing mechanisms in the agricultural sector, and broad-based risk pools should be established. Moreover, community-based disaster management should be promoted; first-response equipment should be readily available at the neighborhood level, early warning systems should be installed, and financial support for resilient building structures should be provided to encourage urban transformation and structural reinforcement. This comprehensive approach would not only reduce disaster-related losses but also accelerate post-disaster recovery, thereby supporting sustainable economic growth. As a result, policies that will minimize the negative impacts of disasters on economic growth and accelerate reconstruction are of great importance. In addition, it is suggested that variables measuring disaster damages should be determined specifically for Türkiye and new research should be conducted to reduce these damages.

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## Genişletilmiş Özet

Doğal afetler toplumların fiziksel, çevresel ve sosyal dinamikleri üzerinde derin etkiler yaratarak ciddi can ve mal kayıplarına yol açmakta ve ekonomik faaliyetleri kesintiye uğratmaktadır. Bu afetler, aynı zamanda fiziksel ve beşeri sermayede kalıcı değişiklikler oluşturarak uzun vadede ekonomik kayıplara neden olabilmektedir. Afetin türü, büyüklüğü ve neden olduğu ekonomik kayıplar, ülkelerin gelişmişlik düzeyine göre farklılık göstermektedir. Bu durum, doğal afetler ile ülkelerin gelişim düzeyleri arasında bir ilişki olduğunu göstermekte ve bu ilişkinin daha iyi anlaşılması için ekonomik çalışmalara ihtiyaç duyulmaktadır.

Doğal afetlerin ekonomik etkilerine dair literatür incelendiğinde, Türkiye'ye yönelik çalışmaların oldukça sınırlı olduğu görülmektedir. Bu durum, Türkiye'deki doğal afetlerin ekonomik performans üzerindeki etkilerini kapsamlı bir şekilde ele alan yeni araştırmalara duyulan ihtiyacı ortaya koymaktadır. Bu çalışmanın amacı, Türkiye'de doğal afetler nedeniyle oluşan zararlar ile ekonomik büyüme arasındaki ilişkiyi incelemektir.

Çalışmanın amacına yönelik literatür taraması sonucunda, oluşturulan model ve kullanılacak değişkenler Skidmore ve Toya (2002) ile Hsiang ve Jina (2014) çalışmalarına dayanarak belirlenmiştir. Bu çerçevede, bağımlı değişken olarak kişi başına reel GSYH (y) kullanılmıştır. Bağımsız değişkenler ise yıllık sermaye stoku (ss), iş gücü (ig) ve afet zararları (daz) olarak modele dahil edilmiştir. Çalışma, 1960-2017 dönemini kapsamakta ve analizde yıllık veriler kullanılmaktadır. Doğal afet zararları dışındaki tüm değişkenler logaritmik forma dönüştürülerek analizde kullanılmıştır.

Doğal afetlerin ekonomik büyüme üzerindeki kısa ve uzun vadeli etkilerini incelemek için Gecikmeli Dağıtılmış Otoregresif Model (ARDL) yöntemi tercih edilmiştir. Pesaran ve arkadaşları tarafından 2001 yılında geliştirilen ARDL sınır testi, değişkenlerin aynı derecede durağan olma zorunluluğunu ortadan kaldırmakta; seriler seviye ya da birinci farkları alınarak durağan hale getirildiğinde eşbütünleşme ilişkisi belirlenebilmektedir. ARDL modeli, tek bir eşitlik ve daha az parametre ile analiz yapma imkânı sağlarken, Kısıtsız Hata Düzeltme Modeli çerçevesinde hem kısa hem de uzun dönem dinamiklerini eşanlı olarak tahmin etme olanağı sunmaktadır. Bu nedenle ARDL sınır testinin kullanılması, sonuçların güvenilirliğini ve doğruluğunu artırmaktadır.

Analiz bulgularına göre, uzun vadede büyüme ile sermaye stoku ve iş gücü arasında pozitif bir ilişki tespit edilmiştir. Buna karşın, doğal afet zararları ile ekonomik büyüme arasında hem kısa hem de uzun vadede negatif bir ilişki ortaya çıkmıştır. Bu sonuçlar, teorik beklentilerle uyumlu olarak, sermaye stoku ve iş gücündeki artışların ekonomik büyümeyi destekleyici bir etkisi olduğunu, doğal afet zararlarındaki artışların ise büyümeyi olumsuz yönde etkilediğini göstermektedir.